electronics

A McGRAW-HILL PUBLICATION

JUNE · 1953

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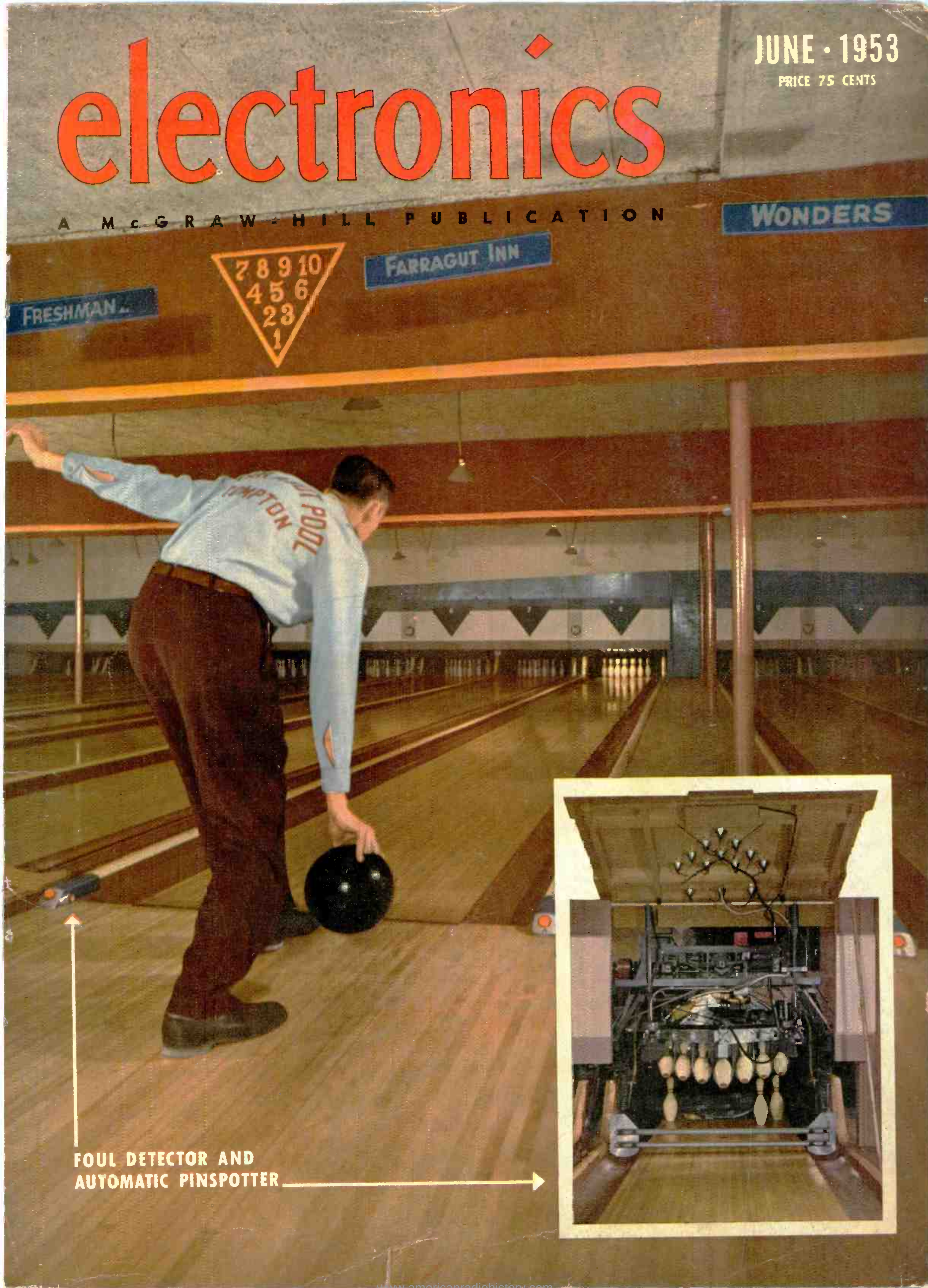
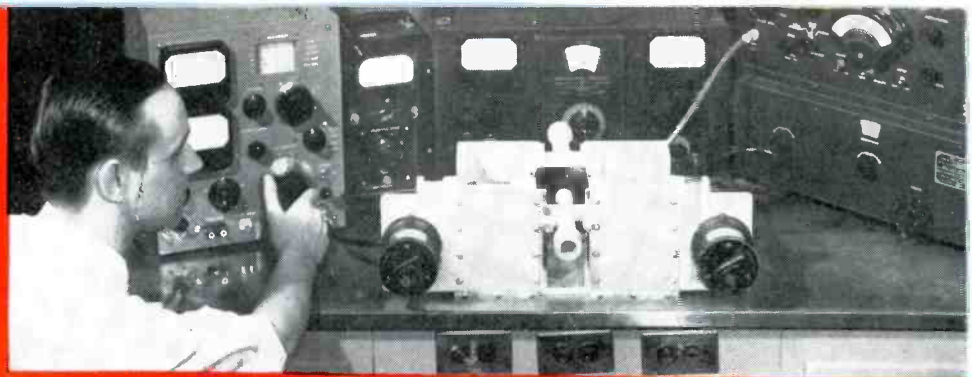
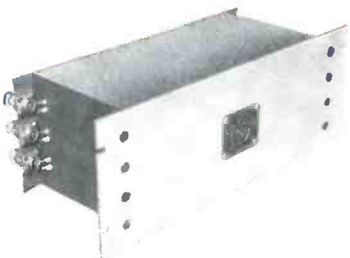


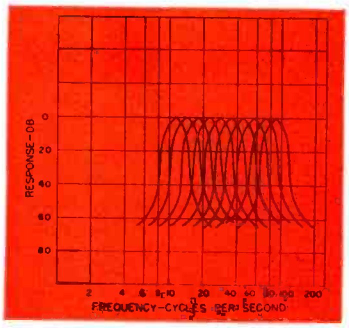
FOUL DETECTOR AND AUTOMATIC PINSPOTTER

for SPECIALIZED FILTERS

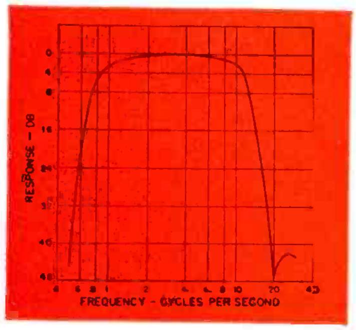


Decades of experience in the design and production of specialized filters have resulted in UTC being a first source for difficult filters. Fifteen years ago UTC was already the largest user of permalloy dust toroids in the world (exclusive of the telephone system). Present designs include a wide variety of core materials, structures, and winding methods to provide maximum performance in electrical requirements and stability. Illustrated below are a few of the thousands of special filter designs in present production.

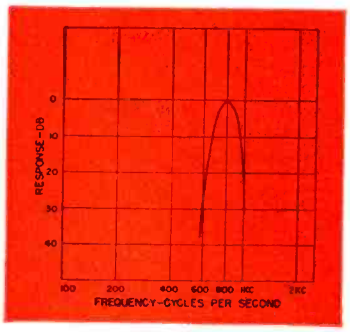




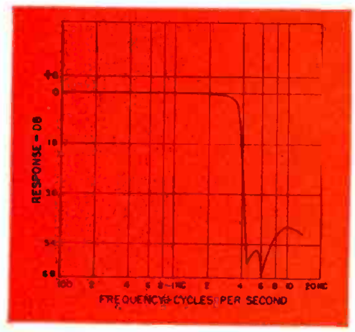
These low frequency band pass filters are held to 1 DB tolerance at the 3 DB crossover . . . 600 ohm . . . 4 filters per 7½" rack panel.



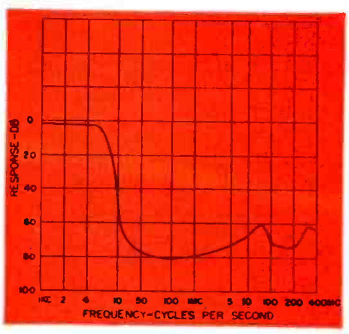
This ultra low frequency filter has a band pass range of one cycle to 10 cycles . . . 50,000 ohms . . . 700 cubic inches.



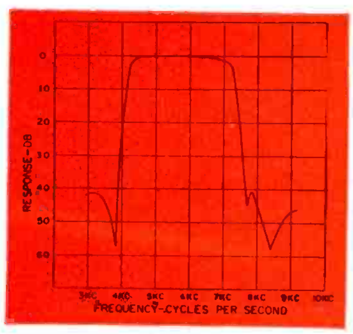
This 600 ohm miniaturized 1 KC band pass filter is housed in a case only 1" x 1¾" x 2½".



This 600 ohm miniaturized low pass filter is housed in a case only 1" x 1¾" x 2½".



This power line filter provides correct output voltages from sources of 50 to 400 cycles . . . noise attenuation is from 14 KC to 400 MC . . . 29 cubic inches.



This band pass filter is designed for sharp cut-off at both ends of the range . . . 10,000 ohms . . . case dimensions 1⅝" x 2½" x 3¼".

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FOUL DETECTOR AND AUTOMATIC PINSPOTTER—Action views of American Machine and Foundry's electronically controlled equipment. Photos by Syd Karsen at Farragut Pool Bowling Center, Brooklyn, N. Y. For details see p 148 .... COVER

June, 1953 ELECTRONICS Vol. 26, No. 6

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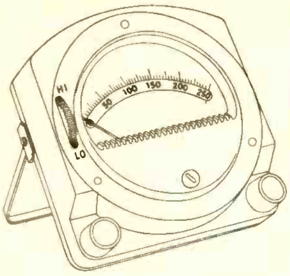

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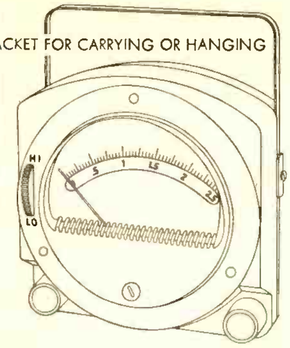

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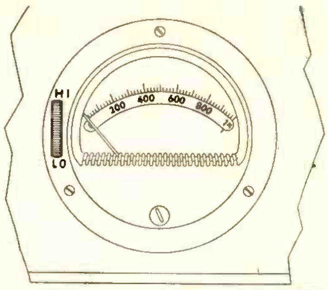

The Marion Multi-Dialer Model MD-1 shown here (ruggedized movement) is available with five self-contained ranges in volts, milliamperes, microamperes and amperes. It is also available custom-engineered to your end-product so that it may be installed on your panel and when appropriate scale is selected it will automatically insert the instrument with appropriate accessories into five separate measuring circuits and/or ranges in your equipment.

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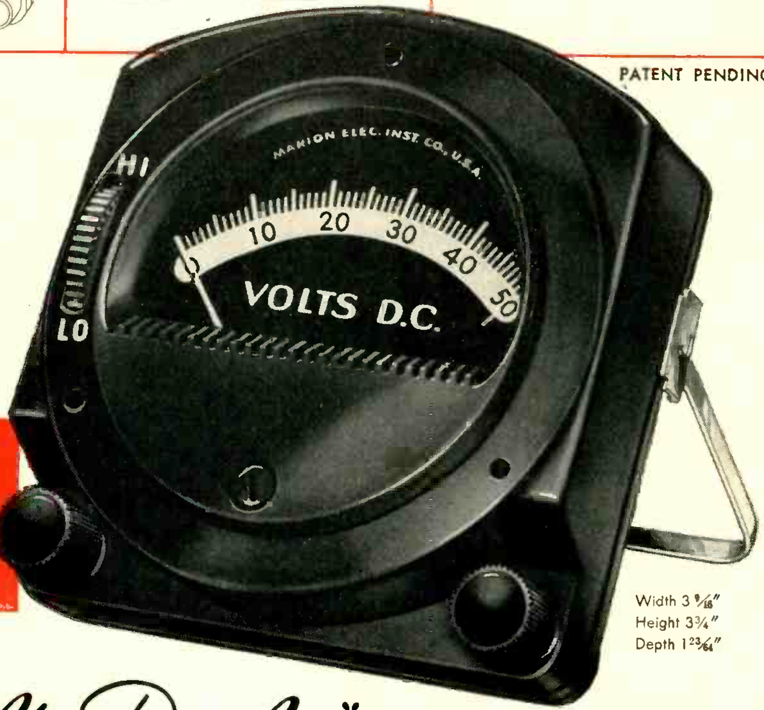
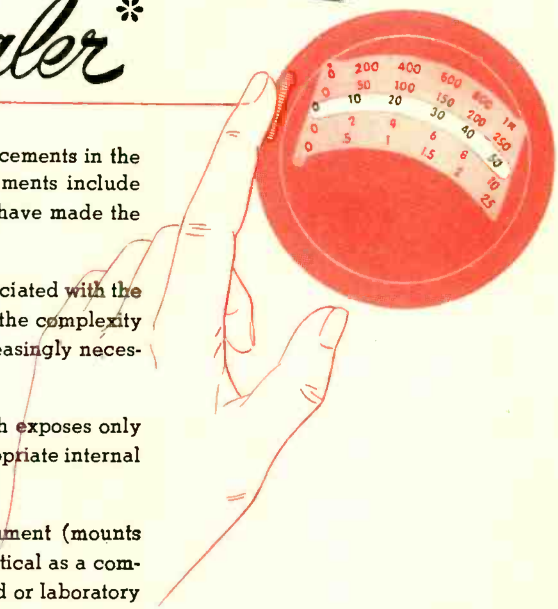


Width 3 9/16″
Height 3¾″
Depth 1 23/64″

marion *Multi-Dialer**



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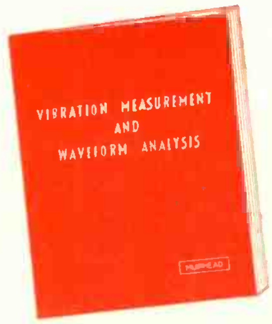

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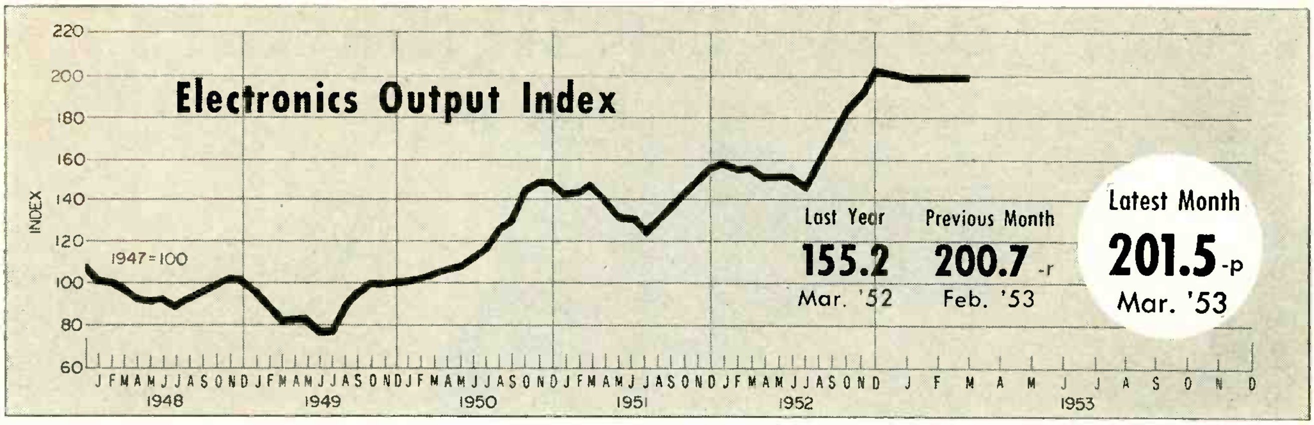


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago	Previous Month	Latest Month
	Mar. '52	Feb. '53	Mar. '53
Television sets	510,561	730,597	810,112
Home sets	357,689	402,742	442,101
Clock Radios	175,169	210,924	275,079
Portable sets	99,720	87,711	177,656
Auto sets	343,314	491,062	654,367

RECEIVER SALES

(Source: RTMA)	Year Ago	Previous Month	Latest Month
		Feb. '53	Mar. '53
Television sets, units	......	537,122	603,704
Radio sets (except auto)	......	507,527	516,618

RECEIVING TUBE SALES

(Source: RTMA)	Year Ago	Previous Month	Latest Month
	Mar. '52	Feb. '53	Mar. '53
Receiv. tubes, total units	30,935,220	40,024,475-r	44,691,200
Receiving tubes, new sets	19,513,454	27,730,235	31,367,831
Rec. tubes, replacement	7,231,186	9,217,982-r	9,949,321
Receiving tubes, gov't.	2,776,796	1,393,962-r	1,449,857
Receiving tubes, export	1,413,784	1,682,296	1,924,191
Picture tubes, to mfrs.	370,206	699,411	974,154

SEMICONDUCTOR SALES

(Source: RTMA)	Year Ago	Previous Month	Latest Month
		Feb. '53	Mar. '53
Germanium Diodes	......	1,466,421	1,172,475

INDUSTRIAL EQUIPMENT ORDERS

(Source: NEMA)	Quarterly Figures		
	Year Ago	Previous Quarter	Latest Quarter
	4th '51	3rd '52	4th '52
Dielectric Heating	$620,000	$320,000	$440,000
Induction Heating	$3,400,000	$1,760,000	$2,420,000
Welding Control	$1,430,000	$1,810,000	$1,390,000
Other Electronic Control	$860,000	$920,000	$970,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	Year Ago	Previous Quarter	Latest Quarter
	4th '51	3rd '52	4th '52
Vacuum (non-receiving)	$14,300,000	$10,580,000	$12,790,000
Gas or vapor	$3,170,000	$2,950,000	$3,480,000
Phototubes	$390,000	$570,000	$760,000
Magnetrons and velocity modulation tubes	$6,670,000	$8,500,000	$10,510,000
Gaps and T/R boxes	$2,120,000	$1,700,000	$2,090,000

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago	Previous Month	Latest Month
	Apr. '52	Mar. '53	Apr. '53
Sets in Use—total	16,939,100	22,551,500	23,256,000

BROADCAST STATIONS

(Source: RTMA)	Year Ago	Previous Month	Latest Month
	Apr. '52	Mar. '53	Apr. '53
TV Stations on Air	108	164-r	179
TV Stns CPs—not on air	0	255	264
TV Stns—Applications	536	639-r	612
AM Stations on Air	2,347	2,424	2,430
AM Stns CPs—not on air	68	133	135
AM Stns—Applications	324	250	249
FM Stations on Air	632	607	600
FM Stns CPs—not on air	14	21	21
FM Stns—Applications	9	7	9

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Year Ago	Previous Month	Latest Month
	Mar. '52	Feb. '53	Mar. '53
Aeronautical	32,176	37,825	38,822
Marine	34,843	39,001	39,425
Police, fire, etc.	10,592	12,482	12,682
Industrial	12,475	16,002	16,232
Land Transportation	4,847	5,636	5,660
Amateur	106,832	116,697	112,666
Citizens Radio	878	1,924	1,980
Disaster	29	101	189
Experimental	458	529	415
Common carrier	922	1,070	1,094

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Year Ago	Previous Month	Latest Month
	Feb. '52	Jan. '53	Feb. '53
Prod. workers, comm. equip.	273,100	410,900-r	418,700-p
Av. wkly. earnings, comm.	$65.14	$67.23-r	$65.93-p
Av. wkly. earnings, radio	$61.28	$63.74-r	$64.40-p
Av. weekly hours, comm.	41.2	41.5-r	40.7-p
Av. weekly hours, radio	40.8	40.6-r	40.5-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Year Ago	Previous Month	Latest Month
	Apr. '52	Mar. '53	Apr. '53
Radio—TV & Electronics	292.5	310.7	298.9
Radio Broadcasters	286.2	294.3	290.7

p—provisional; r—revised

FIGURES OF THE YEAR

	1952 Total	First Quarter Totals 1952	1953	Percent Change
Television set production	6,096,279	1,324,831	2,259,943	+ 70.58%
Radio set production	10,934,872-r	2,367,800	3,834,784	+ 61.96
Television set sales	6,144,990	1,279,783	1,780,899	+ 39.16
Radio set sales (except auto)	6,878,547	1,505,883	1,438,871	— 4.45
Receiving tube sales	368,519,243	85,934,322	122,058,756	+ 42.04
Cathode-ray tube sales	6,120,292	1,040,829	2,798,921	+ 168.91

INDUSTRY REPORT

International Hookup Televises Coronation

BBC marshals resources, picks up $171,500 tab to telecast ceremony

AN INTERNATIONAL television network will bring scenes of the June 2 coronation of Queen Elizabeth II to viewers in Great Britain, France, Holland, Belgium and Germany. The British Broadcasting Corporation will use 20 cameras manned by 101 engineers and eight commentators to give complete coverage of the ceremonies.

Cameras will be installed at several locations within Westminster Abbey and at four vantage points along the route of the procession. The complete program will last seven hours. Extra cost involved in televising the coronation will be $171,500.

▶ **Network**—Besides feeding the British television network, the signal will be transmitted by microwave to Paris where it will be used to feed the French 441 and 819-line transmitters after conversion from the British 405-line signal.

The French will also provide a microwave link from Cassel, on the London-Paris route to Lille. Here a Belgium-Dutch relay will carry the signal to Lopik in Holland via Breda. Conversion to the 625-line standard will take place at Breda and Dutch transmitters at Lopik and Eindhoven will broadcast the program to Belgian and Dutch viewers.

From Breda the 625-line signal will also go via microwave to Cologne where it will feed the NWDR television network linking seven German cities.

HYDROGEN THYRATRONS ranging from a few kilowatts to 40 megawatts produced from emergency development program led by Signal Corps engineers. Rapid expansion on M-Day is possible because . . .

Keyer Tube Resources Are Pooled

In a crash program, new tubes and machines to build and test them were evolved together

TO MEET an extreme emergency military demand, normal development and production procedures were short-circuited to get keyer tubes for vital defense equipment.

Late in 1950 a review of production against requirements showed hydrogen thyratrons, needed chiefly to pulse magnetrons in radars, were in short supply. The problem was presented to the Signal Corps, and a round-the-clock program was initiated at the Signal Corps Procurement Agency, Philadelphia.

▶ **Authority**—Anticipating future needs, the Signal Corps group decided to establish multiple sources for the production of hydrogen thyratrons in the shortest possible time. To cover possible anti-trust violation suits, authority was obtained from the Attorney General to allow pooling engineering know-how among competitive companies.

At integration committee meetings, representatives from all branches of the armed forces met with engineers from all the companies involved. According to B. D. Aaron, Signal Corps project engineer, "the most difficult problem at first was to get them to ask the right questions. Once we got past that, production and testing information and advice were freely swapped." Engineers from some companies toured other companies' plants, to learn how to make the equipment and tubes that grew as the program went along.

▶ **Ad Lib**—There were few specifications to guide the program and practically no prototypes. Small tubes were scaled up to big ones; interim types were made and finalized. Samples were flown to

Signal Corps Engineering Laboratories for aging and engineering evaluation. Heavy equipment to heat, treat and test the tubes was built from whatever parts could be found. Components were flown to a plant in the middle west where 35-kva aging units were designed, rushed into production and shipped to tube producers. Other units were built in California and air-shipped to reduce hazards of transportation damage and attendent delays.

▶ **Cooperation**—When a company worked the bugs out of its production problems, complete engineering specifications were made of findings, and copies were sent to every other company in the program. Engineering time for the crash program, and for future production programs, was thereby cut from several years to several months.

Pilot plant production runs were established and contracts were written specifying that companies involved maintain production know-how and tooling for a minimum of six years. "In case M-day comes," Aaron said, "production can be expanded immediately, without waiting for contracts to be negotiated, bids to be given and orders placed. The machinery is all there, all ready and working."

Thousands of type-approved thyratrons now roll off the lines, for use in the services' Skysweeper AA gun, among other things, and a precedent for similar future problems has been established.

▶ **Companies**—Among those manufacturers involved in the hydrogen thyratron program were, for equipment production: American Television Mfg. Corp., Kip Electronics, Chatham Electronics, Douglas Laboratories, General Electric, Girdler Corp., Manson Laboratories, Marchant Research, Westinghouse.

For tube production: Amer. Television Mfg. Corp., Amperex Electronics, Bomac Laboratories, Chatham Electronics, General Electric, Kuthe Laboratories, Machlett Laboratories, Penta Laboratories, Radio Corp. of America, Sylvania Electric, Westinghouse.

The companies included stretch cross country from New England to California.

Business Briefs

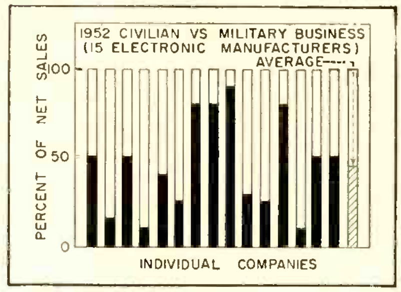
Controls—Last of price controls have been dropped in accord with Eisenhower's 'orderly decontrol of prices'. OPS plans June 30 exit.

Depreciation — Treasury is giving more liberal treatment of regulations on how fast plant and equipment can be written off for tax purposes.

Labor—End of price and wage controls brought some price rises, rumbles of reopening wage contract negotiations. Unemployment is about 1.8 million, near last year's 1.7 million, but employment is 1.8 million higher, which makes the labor market tight. Midsummer record of 63 million employed is expected.

Buy American—Enacted in 1933 under outgoing Hoover, the Buy American Act was upheld by Defense Secretary Wilson who turned down British low bid on Army contract. President Eisenhower backed Wilson, bucked Dulles and Stassen. The law's '25-percent under' interpretation, broken last June, is holding again.

Copper—Price is down to 30 cents per pound. It's a buyer's market now; National Production Authority has stopped allocating the metal because of 'favorable developments in the overall supply.' Imports and scrap production are up.



DEFENSE volume shows as . . .

Electronic Companies Size Up Military Sales

As defense spending cuts loom ahead, manufacturers look at military sales percentages

ELECTRONIC manufacturers, both large and small, will do well to prepare for an increase in their commercial business and a decline in their military production, Glen McDaniel, RTMA general counsel, told west coast electronic manufacturers recently. He declared it appears likely that military expenditures will be reduced or stretched out, "but how fast I don't know. Of one thing we can be sure, electronics and aircraft will remain paramount in whatever armament program is decided upon for the years ahead."

▶ **Ratios**—A survey of 15 manufacturers in the field reveals that defense sales in 1952 (black columns) ranged from 10 to 90 percent of total net sales, with an average for the companies of 45 percent. This is lower than an estimate made last year by the Defense Department who set military sales at 53.3 percent of total sales in 1952. (ELECTRONICS, p 6, Aug. 1952) The percentage was expected to be lower as the defense delivery schedule "stretch out" went into effect last year.

▶ **Companies**—In 1951, smaller electronic companies reported proportionately more military business than did large firms. But major electronic manufacturers indicate they increased their defense business substantially in 1952.

Shipments of electronic apparatus

(Continued on page 8)

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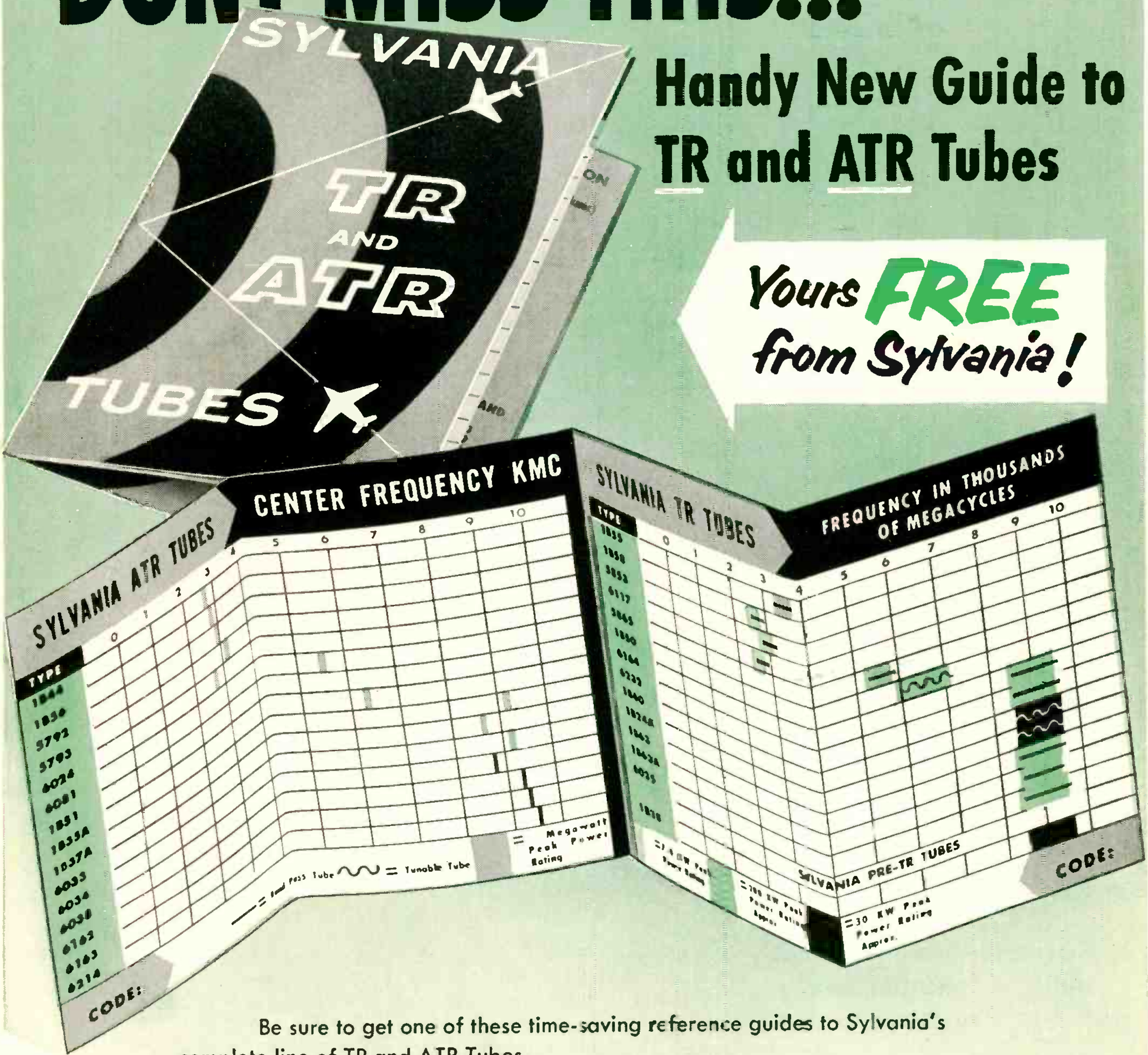

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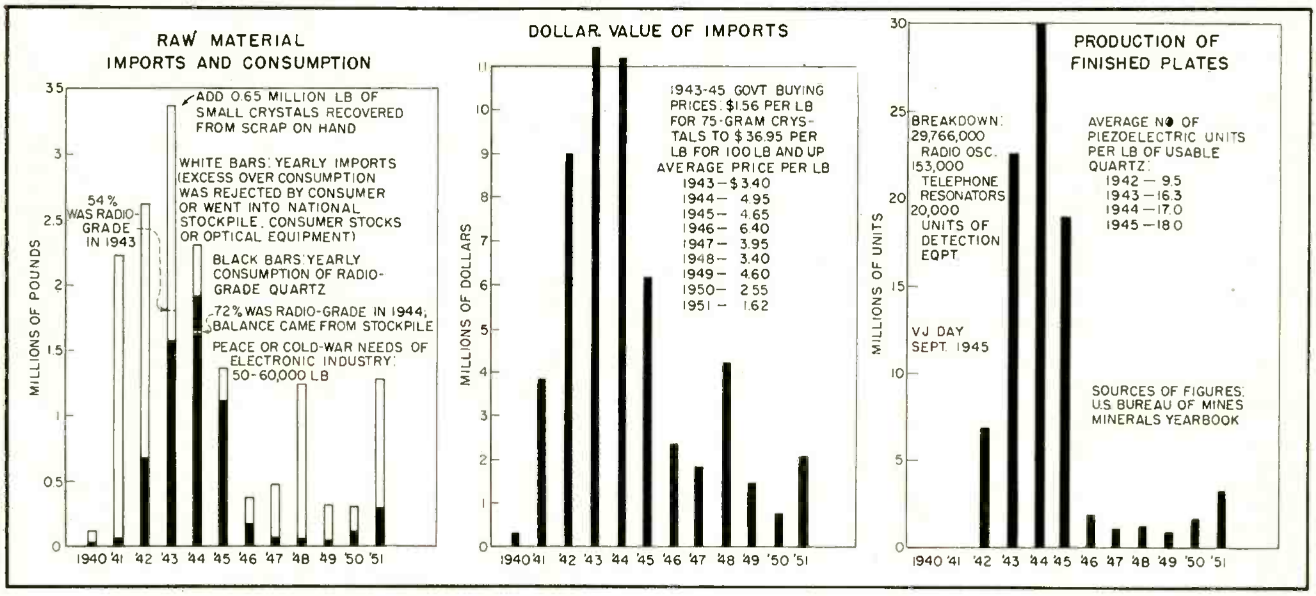
for the armed forces by RCA were approximately double those of 1951. Sylvania estimates that 28.5 percent of its net sales in 1952 were accounted for by defense products, nearly double 1951's volume. Zenith also reported that production and shipment of material for the military services, at a low level in 1951, increased materially in 1952 and amounted to approximately 10 percent of the company's net sales.

▶ **Future**—Although electronic manufacturers are concerned about the effect of a military cut-off on the industry, many would welcome the return to full civilian production. Profits are higher and the commercial sales outlook for 1953 is very promising. Already most companies have experienced record first quarters. But even without top civilian sales the present electronic defense backlog, which is at a peak, could carry the industry's big volume well into 1954.

ELECTRONIGRAPH—Natural Quartz Crystals



Status of Quartz Crystal Growing Plants in U.S.

Industry changeover to small crystals, in plentiful supply from Brazil, eases needs

PRODUCTION plants for growing synthetically the wartime needs of radio-grade quartz crystals could be built and equipped within a year if necessary. It may be assumed that military stockpiling of natural crystals has been geared to this time figure, hence there should be no shortages even if the Brazilian supply were cut off today.

Brazilian domination of the quartz market has been a bugaboo for a nation geared to the philosophy of always having a second source of supply. Most critical years were 1942 and 1943, when U-boats were sinking supply ships in the Caribbean. An air lift solved this problem. Tension eased further, after the war, with the announcement that Signal Corps sponsored research on quartz crystal growing had paid off.

▶ **Change in Demand**—Crystals under 200 grams, considered as scrap early in World War II, now serve because the industry has become adapted to use of finished plates approximately ½ inch square or round. Small natural crystals cost only $1.25 to $4 a pound, as contrasted to $15 and up for the pound-size and larger crystals considered necessary heretofore.

Small crystals usually have much less twinning, hence give an even greater yield per pound despite increased geometric losses. With larger crystals, only 30 to 40 percent of the weight ordinarily is usable because of defects.

▶ **Growing Costs**—Under developmental conditions at Bell Telephone Laboratories and at Brush Laboratories, costs have approximated $50 per pound for synthetic crystals. With organized mechanized handling of the heavy autoclaves for loading and unloading, this cost may be better than halved in full production.

A further reduction in net cost per finished plate is possible because synthetic crystals are relatively free from flaws and hence may approach 100-percent usability except for geometric losses in cutting. By varying growing time and

(Continued on page 10)

Batch of 11 perfect 160-gram quartz crystals being unloaded by A. C. Walker after growing 48 days in 4-foot autoclave at Bell Telephone Labs in Murray Hill, N. J. Threaded cap is removed with huge wrench and chain hoist, after which welded-steel inner liner is sawed open. Project is sponsored by Signal Corps Engineering Labs of Fort Monmouth

choosing the right angle for the quartz seed plate, the synthetics can be made almost exactly the optimum size and orientation for cutting a particular type of plate with minimum cutting waste. Despite all this, the present cost of the synthetic product is way more than the current rate for radio-grade Brazilian quartz. However, it is reasonable to believe that large-scale commercial production eventually will be feasible because of a greater potential yield from synthetic quartz.

In the military picture, cost of raw quartz is secondary to availability. This is partly why the Signal Corps sponsors crystal-growing research at both BTL and Brush.

▶ **Process Details**—Both labs grow the crystals by suspending seed plates in an alkaline solution between 350C and 400C and high pressure, with scrap natural quartz at the bottom. BTL uses a welded autoclave at 15,000 lb per sq inch (ELECTRONICS, p 96, April 1951), and gets about 5 lb of quartz per month per cu ft of autoclave space.

Brush uses a continuously-rocked double-chamber autoclave at 5,000 lb per sq inch (ELECTRONICS, p 238, April 1953), and gets about the same output per cu ft.

Broadcasters Made Money In '52

Station revenues for 1952 are 5 percent higher than total dollar take in 1951

TOTAL revenue of the radio-broadcasting industry in 1952 amounted to $473.1 million, 5 percent above the previous year. Figures are from a preliminary FCC report. While 7 networks, including owned stations, estimated total revenues of $101.0 million or 2.9 percent below 1951, more than 2,300 radio stations estimated total revenues of $372.1 million, an increase of 7.4 percent above 1951. Thus radio income for networks and individual stations followed the same pattern as did tv income for networks and individual stations in 1952. (ELECTRONICS, p 22, May, 1953)

Added to the estimated $336.3 million total revenues of tv broadcasters, the combined industry revenues in 1952 reached $809.4 million showing a marked increase of 18 percent above 1951.

▶ **Income vs Revenue**—Radio industry income before federal income taxes rose to $62.6 million in 1952 after having dropped to $57.5 million in 1951 from a peak of $68.2 million in 1950. Networks, including owned and operated stations, estimated 1952 income at $11.2 million or 11 percent above 1951. Total income of 2,300 radio stations was estimated at $51.4 million or 8.4 percent above 1951. The 814 a-m stations licensed in 1941 and prior years, comprising slightly more that ⅓ of all a-m stations, accounted for almost ⅗ of the total revenues and ¾ of the total income of all a-m stations.

▶ **TV vs Radio**—A total of 470 a-m stations in tv markets estimated their 1952 revenues at $171.5 million or 2 percent above 1951. In non-tv markets, 1,629 a-m stations estimated their total revenues at $199.6 million, almost 11 percent above 1951. Increased total revenues in 1952 were reported by about three out of five a-m stations in the tv markets and by four out of five a-m stations in the non-tv markets. Overall, 74 percent of the total stations reported increased revenues in 1952.

Losses were reported by 15.9 percent of the 2,276 a-m stations. This is the smallest number since 1946 when 11 percent of the 1,015 then operating were unprofitable.

U.S. Surveys Labor Picture

Number of stoppages has declined sharply since 1950 but total man-days idle have risen

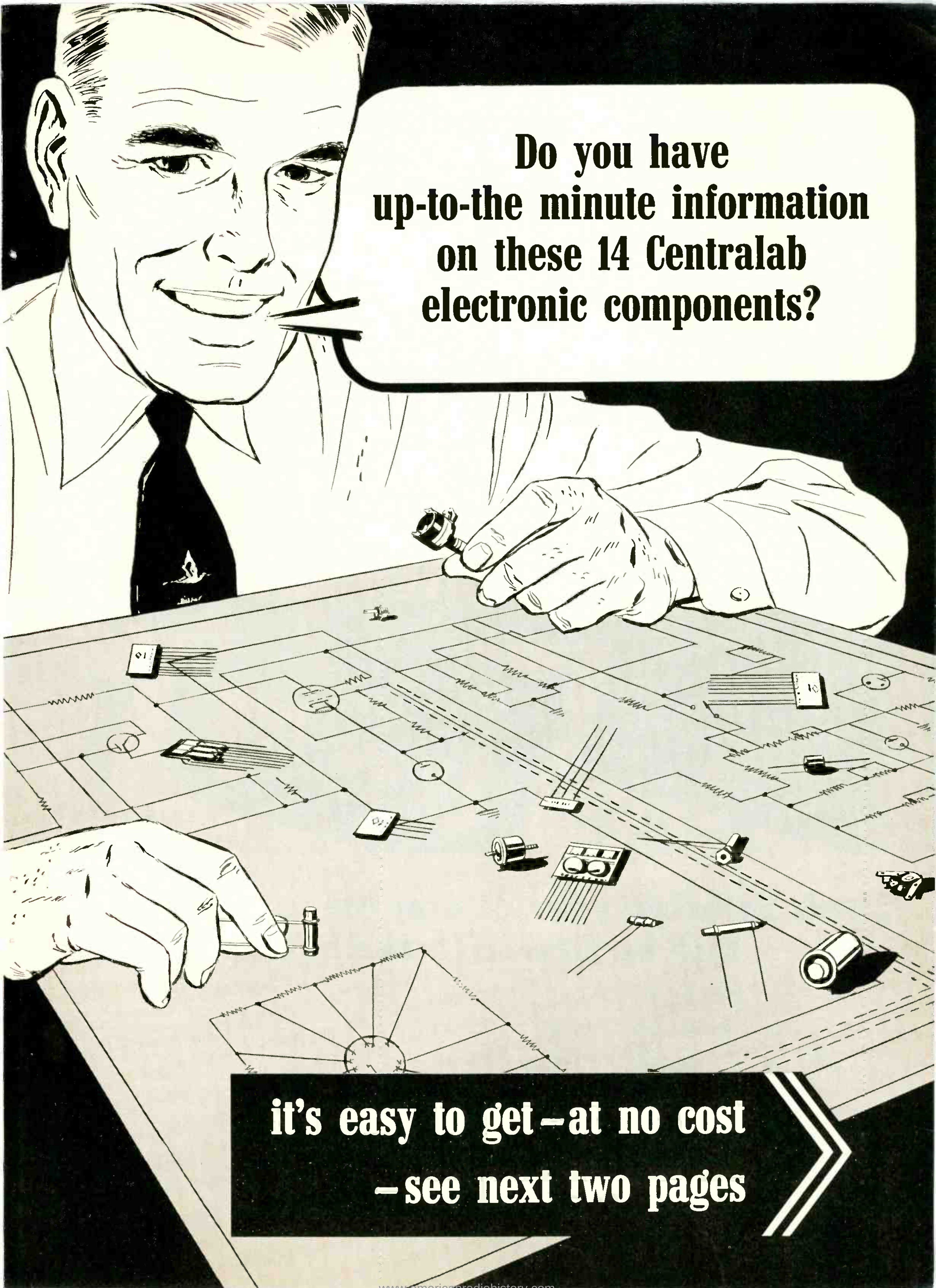
TREND in work stoppages involving six or more workers and lasting for a full shift or longer shows up in a report by the Labor Department. Last year there were 30 such stoppages in the communications equipment field, radio, tv, equipment and parts manufacturers. This was the lowest number of disputes to be recorded since 1949. However, man-days idle as a result of the 30 stoppages totalled 327,000, the largest number since 1950 when total reached 368,000.

Although the number of disputes was lower, the stoppages evidently affected larger companies for longer periods of time. In 1952, two companies in the electronics field had strikes involving 10,000 or more workers, while in 1951 there was only one such stoppage.

▶ **Pattern**—According to the Labor Department, the largest number of work stoppages have been caused by disputes over wages and shorter hours. Other prevalent reasons are: union organization, working conditions, interunion and intraunion matters.

Fluctuation, as seen in total man-days idle, seems to follow the sales pattern of the radio-tv industry. In

(Continued on page 14)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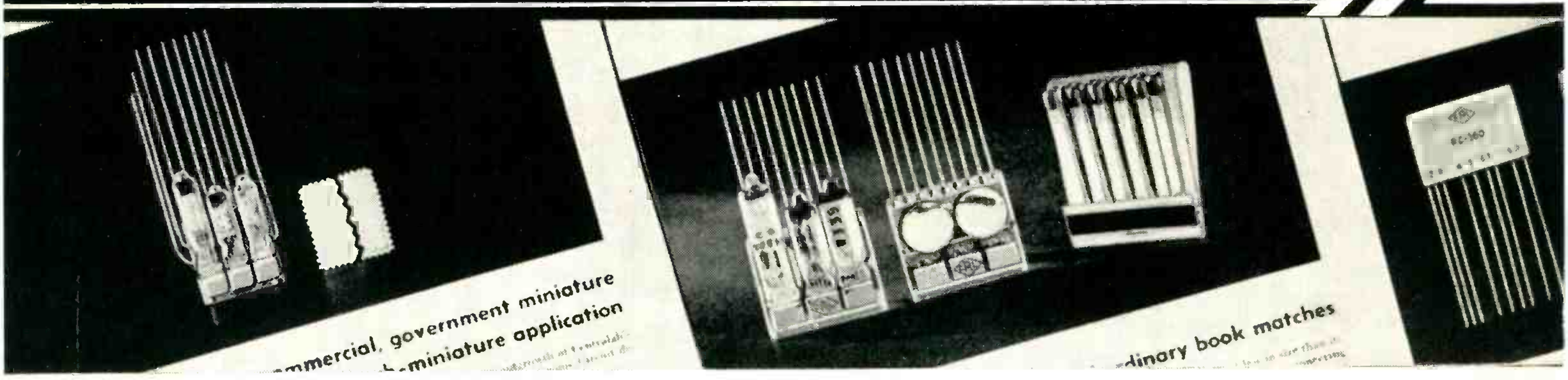

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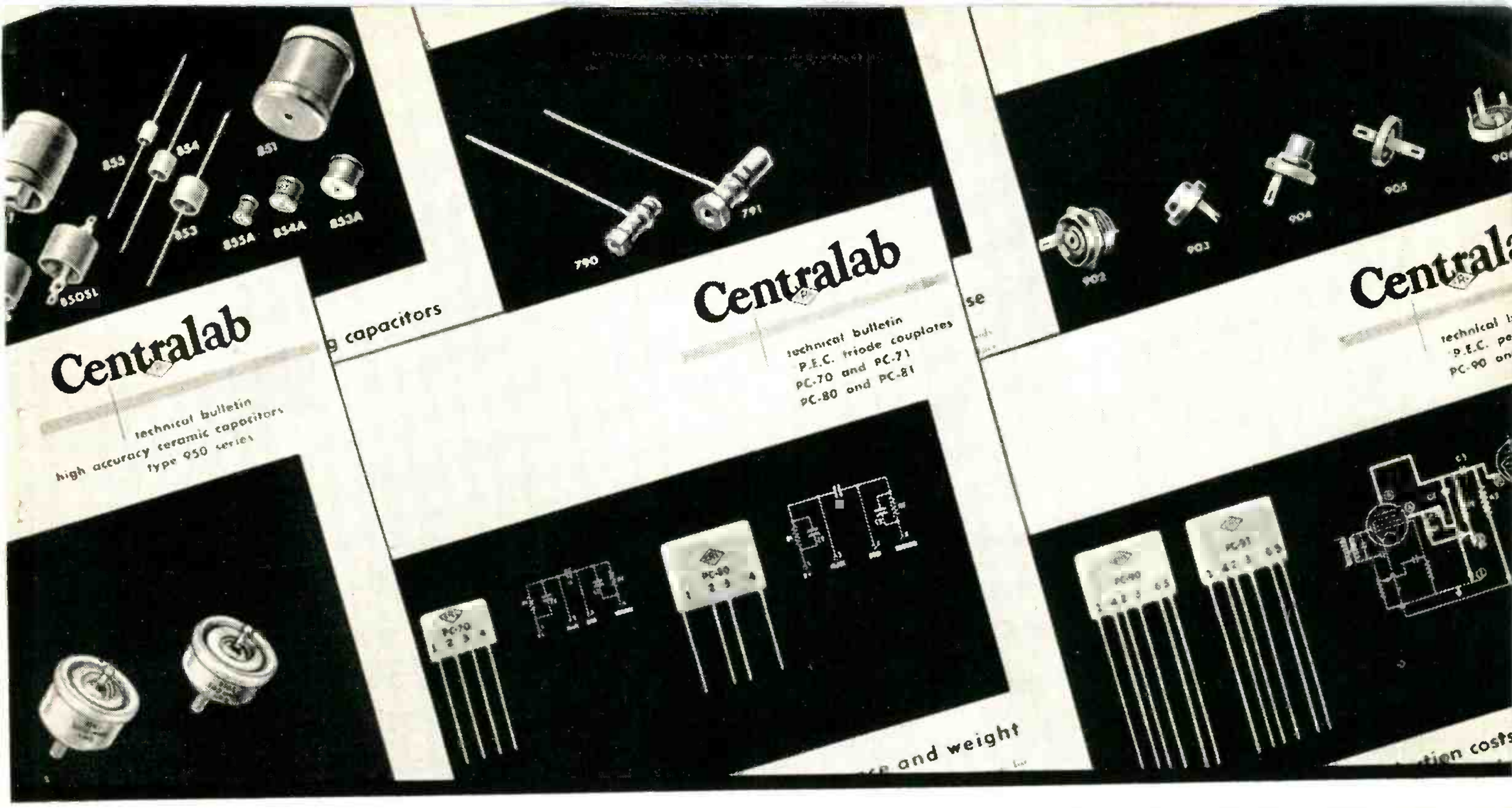

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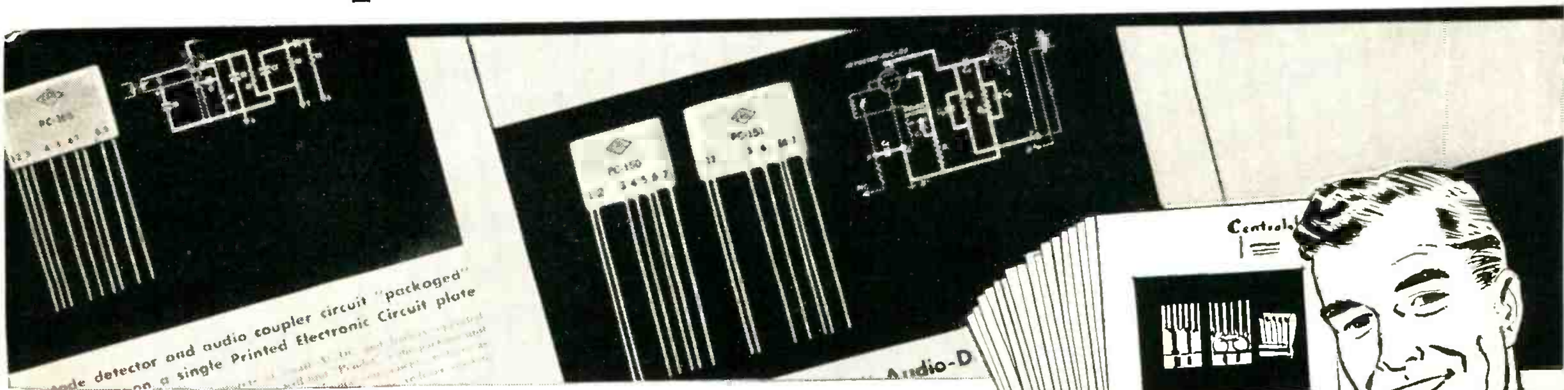

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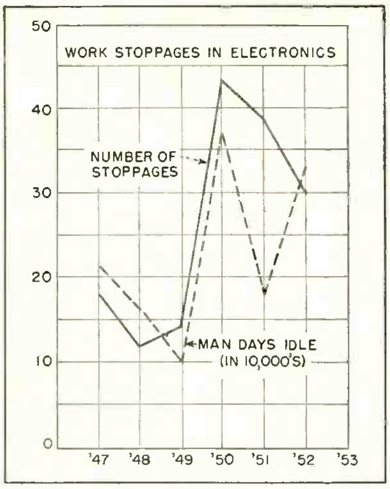

1950, big sales year for manufacturers, man-days idle were highest. Then as business slumped in 1951 and regained in 1952, man-days idle followed the same course.

▶ **1953**—There have been a number of work stoppages in the electronics industry so far this year but only one of any severity. It involves more than 10,000 workers and several weeks duration. But there are rumblings of more wage disputes in the steel industry that could affect electronics.

Television Highlights NARTB Show

Broadcasters see 3-D telecast; remote control and low-budget operation also discussed

THEME of the recent NARTB convention seemed to be "What else can you do with television?" The 1,500 conventioneers who crowded Los Angeles' Biltmore Hotel heard reports on three-dimensional tv, color tv, intercontinental tv and tv in a can. Low-budget operation of small-city television stations and remote control of a-m and f-m broadcast transmitters were discussed in several papers. Fifty-odd suppliers of broadcast equipment and services exhibited.

▶ **Three-D**—An experimental telecast over KECA-TV ABC-Paramount's L. A. outlet showed delegates how the illusion of depth may be achieved in television. Special receivers at the Biltmore using two picture tubes resolved their images on a 3 by 4-ft viewing screen. Viewers needed Polaroid glasses.

The emphasis was also on 3-D at the Statler where 1,000 SMPTA members concurrently held their annual confab.

▶ **Color**—Discussing the future of color television, RCA's General Sarnoff prognosticated that once the FCC authorizes color it will take industry nine to 12 months to tool up and produce. Sarnoff also predicted the failure of subscription television on a national scale.

Features of the NTSC color television system were discussed in a paper by Dr. W. R. G. Baker of GE.

▶ **Around the World**—Intercontinental television may be just over the horizon according to Neal McNaughten, NARTB's engineering manager. High-powered microwave relays and submarine cables with transistor amplifiers would do the trick.

▶ **Low Budgets**—Reflecting television's post-freeze trek to the hinterland, low-budget operation of a small-city station was the subject of a panel discussion. In the same vein, Federal engineers presented a paper on how to set up a television station with two technicians while GE demonstrated a packaged tv station designed for one-man operation.

Low-budget operations, it developed, are still not low enough for stations serving markets under 100,000 population. Tab for essential equipment comes to $300,000 with yearly operating cost running between $175,000 and $300,000.

▶ **Canned TV**—Importance of canned entertainment in post-freeze television was attested to by at least six equipment makers. General Precision, Standard Electronics, Federal and RCA exhibited small cameras especially suited for film reproduction. Philco and DuMont both introduced continuous-motion film scanners.

Reporting on his company's sys-

(Continued on page 16)

Three-Dimensional Television Lens

Wide-angle lens giving 142-degree field of view, as used at the Navy's Special Devices Center, Sands Point, N. Y. in a gunnery trainer. A television system using this wide-angle lens and a spherical-screen projection receiver to provide three-dimensional television is presently under development at RCA

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tem for recording tv programs on tape, John T. Mullin of Bing Crosby Enterprises claimed the tape would record both sound and picture with the quality of a live telecast.

Movies Triple Audio Facilities

NEWCOMER in the 3D field is CinemaScope, which uses a 65-foot wide screen, a single projector and no glasses. Behind the screen are three speakers, each with its separate amplifying system and sound track, to produce a stereophonic sound effect.

Installation costs big theaters about $10,000, little theaters less, according to Twentieth Century-Fox. The company expects 12,000 installations to be made by the end of next year.

Expansion Plans for Puerto Rico Plants

Subassembly and parts plants plow back tax-exempt profits; many new plants are under way

PRACTICALLY all of the electronic plants established in Puerto Rico in the last two years are actively expanding. Business is good down there, because most of this expansion money comes from profits inflated by tax-exemption.

Figures tell the story; present total square-footage of operating plants is about 115,000 and goes to an estimated 350,000 by year-end for expanded and new plants combined. Total present employment of 875 correspondingly jumps to about 3,500. The accompanying tabulation gives the present picture in detail, as derived by combining latest figures of Puerto Rico's Economic Development Administration (New York City office: 600 Fifth Ave.) with observations made during editorial visits to operating plants.

ELECTRONIC PLANTS IN PUERTO RICO

Name of Firm	Location	Started	Sq Ft	Empl	Chief Products
Ben Ida Electronics	Hato Rey	Jan. '52	3,500	—	Amplifiers & record players
Borinquen Radio Components Corp.	Rio Piedras	Future	—	—	Radio hardware & structural parts
Caribe Aircraft Radio Corp. (Related to Lavoie Labs)	Coamo	May '52	10,800	80	Radar subassemblies, coils & filters
Coradel Mfg. Co.	Caguas	June '52	5,000	—	Lightning arresters & lead-ins
Diversified Products Corp.	Carolina	May '53	—	—	Ceramic insulators
Empire Industries Inc.	Bayamon	Future	—	—	Transformers
John Hackes & Siegler	Hato Rey	Future	—	—	Quartz crystals
Hemisphere Corp. (Related to National Moldite Co.)	Rio Piedras	July '53	11,000	30	Molded coil forms & ferrite cores
Hermetic Seal Products Co. of Puerto Rico Inc.	Hato Rey	Aug. '51	10,000	110	Feed-through insulators
Hycor Co., Inc.	Vega Baja	Nov. '52	1,500	35	Precision resistors & toroids
Interamerica Electronics Corp.	Santurce	Future	—	—	Hearing aids & components
Pamcor Inc.	Rio Piedras	May '53	11,500	—	Terminals & connectors
Phillips Control Corp.	San Juan	June '52	8,000	50	Aircraft relays, coils & solenoids
Port Electric Corp.	Catano	Future	—	—	Radio tuning devices
Radell Corp.	San Juan	Jan. '52	3,250	70	Deposited carbon resistors & vhf coils
Rectifier Corp. of Puerto Rico	Fajardo	May '53	—	—	Components
Rico Electronics Inc. (Related to National Video Corp.)	Vega Alta	Jan. '53	11,500	—	TV picture-tube guns
Statham Instruments Inc.	Hato Rey	Future	—	—	Scientific instruments
Sylvania Electric of P. R. Inc.	Rio Piedras	Oct. '51	37,000	400	Mica punchings, tube parts & components
Triplett Electric Co. of P. R. Inc.	Bayamon	Apr. '52	8,000	65	Meters and multimeters
Weller Mfg. Co.	Bayamon	Dec. '50	8,000	60	Soldering guns

▶ **Profits**—There are two methods of showing a high profit on electronic operations in Puerto Rico:

Method 1. Produce a product having high labor content and low transportation cost (practically everything in electronics field), placing emphasis on a topnotch labor training program, on good management and on an incentive program that rewards labor for extra effort. This method takes maximum advantage of the island's 45-cent labor rate.

Method 2. Operate as a small, new firm which has a low base for U. S. excess profits tax but is expanding rapidly because of good management or because of a secret process or successful new product. Such a firm can take maximum advantage of tax exemption.

▶ **Wages**—Minimum wages for labor in electronic plants are set by a committee of nine representing management, labor and the public interest equally. Applicable U. S. laws are ambiguous in specifying that wages on the island must not be so low as to constitute unfair competition with U. S. labor, yet not so high as to diminish employment in Puerto Rico. The commit-

(Continued on page 18)

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tee meets about every two years, and it takes another year to put a wage change into effect.

For the electronics industry, the present minimum is 45¢ an hour. In well-established plants, merit raises may bring this as high as 58¢ an hour for assembly-line workers, with group leaders (supervising about 12 workers) making \$150 to \$325 a month. Machine-shop and maintenance electrician rates are 75¢ to 80¢ an hour.

▶ **Taxes**—Present laws provide complete exemption from insular taxes until 1959. A new law now under consideration will give each new plant 10 full years of exemption. To show maximum untaxed profit, business transactions must be completed in Puerto Rico. Most firms achieve this by pricing their products FOB San Juan.

▶ **Productivity** — A government survey of five electronic plants indicated that after an average of 8½ months of operation, worker productivity was 95 percent of that in mainland plants and quality of output was 88 percent of U. S. standards. Most of the workers involved had not worked in a factory before, but had high manual dexterity. Individual firms have achieved as high as 120 percent of mainland productivity on repetitive high-speed manual operations. Temperature and humidity are more comfortable than around New York City even in summer, hence do not affect production.

Productivity of native workers is a function of training, management and choice of human material, just as anywhere else. One firm uses with excellent success a modified piecework incentive program based on three-month output rather than daily output. If a worker attains the norm at the end of three months, he gets a raise; if not, he gets fired.

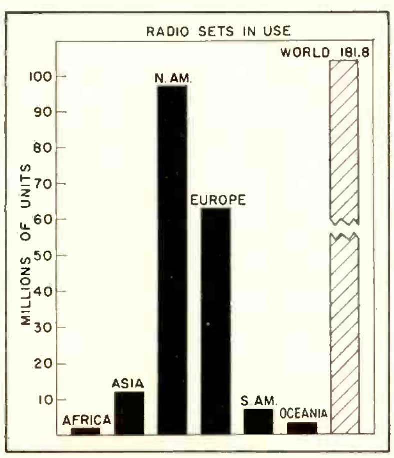
Germany gets set to tap the European bicycle market with this \$11.40 bike radio. Loudspeaker is built into the lamp housing. Two dry cells fit under the saddle

World Radio Output Increases

RADIO receivers are still the number one electronic product throughout the world despite substantial gains made by tv abroad. The statistics from the United Nations show that more than 181 million radio sets are in use today, a probable retail value of over 9 billion dollars. By continents, as indicated in the chart, North America has more radio sets in use than the rest of the world combined.

In terms of receivers per 1,000 inhabitants, the U. S. again leads with 620, followed by Sweden with 301 and the Falkland Islands in South America with 300. Two countries where set saturation is of no concern are French Equatorial Africa and Tanganyika, each with 0.2 radios per 1,000 inhabitants.

▶ **Production**—Although 17 countries in the world produced radios in the past 4 years only 11 reported complete production figures to the UN. Excluding the U. S., the rest of the world produced 4.5 million radios in 1949, 5.7 million in 1950 and 6.3 million in 1951, the latest reported year. U. S. production of radios during these years was nearly double the rest of the world's output in each year.



Germany was second biggest producer in 1951 with 2.2 million receivers that year, almost double its production of 1.1 million in 1949.

The United Kingdom followed Germany with an output of 2.1 million sets in 1951 compared to 1.3 million in 1950 when she was the world's second place producer.

Of 11 countries reporting, only Canada, Japan, Norway and Yugoslavia experienced a decline in set production between 1949 and 1951. India, Austria, Denmark, Germany, Iceland, United Kingdom and Australia were all on the upswing.

Loudspeaker Business Follows New Trends

Volume this year is expected to reach 22.5 million units, a 3.2 million gain over 1952

RTMA RECENTLY estimated in a report to NPA that 1953 loudspeaker production would total 22.5 million units compared with 18.8 produced in 1952. The average weight of an Alnico 5 magnet per speaker is 1½ oz, so this year the industry will need approximately 2.1 million pounds of Alnico 5 material.

The increase over 1952 production is believed due to the opening

(Continued on page 20)

of new tv areas and a lack of finished set inventory in the hands of the industry.

▶ **Market**—Approximately 7 million units will go to tv set producers and about 8 million to radio manufacturers, if predictions hold true. Remaining sales will be split up among hi-fi, industrial, military and replacement markets.

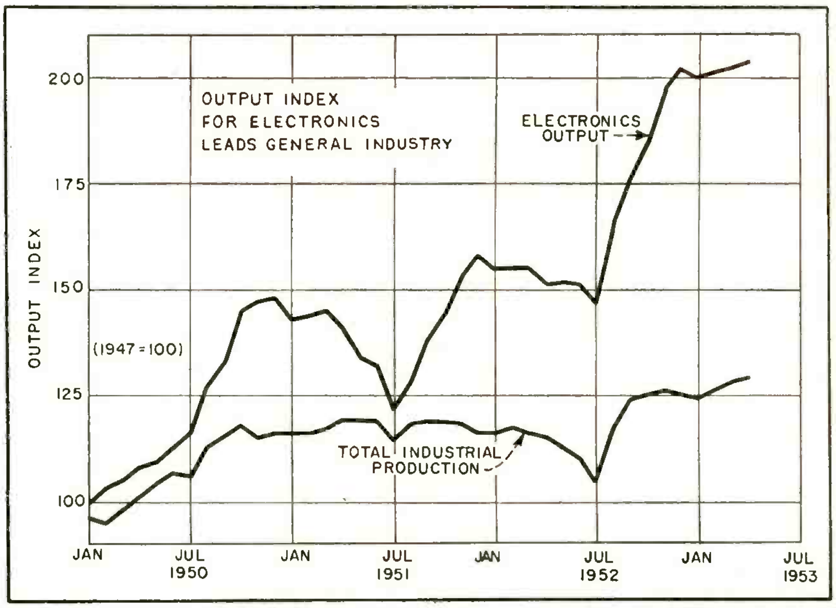
▶ **Product**—Some manufacturers see an increasing trend in radio and tv set design toward smaller sets, fewer combinations, more table models. This means smaller loud speakers and smaller dollar volume per unit for companies.

However, other loudspeaker manufacturers are optimistic because of the accelerating hi-fi trend which has made the public more fidelity conscious and has resulted in a noticeable increase in sales of heavier and larger units. It had also caused some set manufacturers to equip combination sets with larger cones, the 12 inch instead of the 10 inch, despite higher cost.

Manufacturers are now using larger loundspeakers in their portable lines. Motorola, with its new design that incorporates the magnet and associated components within the cone, now is able to use a 7-inch loud speaker in place of a 4 inch (ELECTRONICS, p 8, May, 1953).

Meters Fluid Flow

Flowability of a fluid is measured instantly and continuously with this new instrument for industry and the medical profession. A small ultrasonic sensing probe is applied to a blood sample while an electronic computer and recorder chart how fast a clot is formed



PLOT of output indexes shows electronics out in front. On page 4 of each issue . . .

New 'Figures' Show Business Trends

Cumulative totals on page 4 of each issue compare current and previous year's output

RECENTLY added to the regular 'Figures of the Month' page of ELECTRONICS is a new subdepartment called 'Figures of the Year'. The statistics printed each month under this heading show at a glance cumulative monthly conditions in the electronics business as compared to the same time last year.

This month's totals show a significant increase in general production and sales for the first quarter of '53 as compared to '52. Cathode-ray tube production almost tripled, with an increase of 168.91 percent over last year. Radio and television set production remained high.

▶ **Output Index**—The 'Electronics Output Index' (also on page 4) continues to reflect a healthy situation in the industry. As shown in the accompanying chart comparing the electronics index with similarly compiled statistics on industry in general, output of electronics goods has increased about 100 percent since 1947, while increase in general industry amounts to around 25 percent.

Computed largely from Bureau of Labor Statistics, the Output Index shows activity in both military and commercial electronics. A slight drop-off may be expected during summer months as the American public turns to trout lines.

Financial Roundup

OUTSTANDING gains for the first 3 months of 1953 compared to the same period last year were registered by companies in the electronics field. National City Bank of New York reports that total net income in the first quarter for 23 companies was $78.3 million compared to $54.4 million in 1952, a 44-percent increase. Profit reports by individual companies in the first 3 months of this year are as follows:

Company	Net Profit (3 mos.) 1953	1952
Admiral	$3,056,878	$1,515.506
CBS	2,404.935	1.522.796
Hoffman	476,646	401.675
IBM	7,520,105	6.797.876
Magnavox	1,782,000	558.000
Minn. Honeywell	2,332,770	1.294.583
Motorola	3,174,208	2.238.135
RCA	9,293,141	7,076.520
Raytheon	1,355,000	408.000
Sylvania	3,679.243	1,953.771
TelAutograph	44,856	47,443
Tung Sol	552,318	492.241
Zenith	2,109,461	1,083.242

▶ **Securities**—Computer Manufacturing Corp. filed with SEC cover-

(Continued on page 22)

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Midland CRYSTALS Play a Vital Role

Midland Crystals are entrusted with the exacting job of frequency control in the Collins 51R-3. Thirty-four crystals provide complete 280-channel coverage. In such critical service, there can be no compromise with quality, precision, and undeviating performance under every operating stress.

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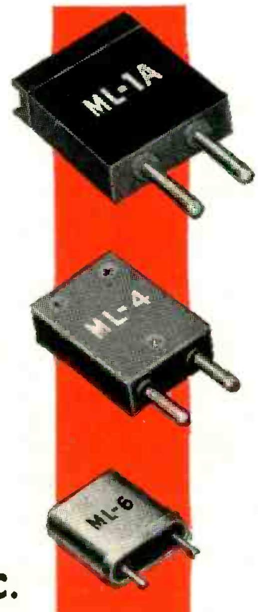

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ing 150,000 shares of common stock par 10 cents to be offered at $1 per share. Net proceeds will be used for working capital and for general corporate purposes.

General Electric proposed a stock option plan for key employees. Participants selected will be given the right to purchase GE common stock of no par value at 100 percent of the fair market value on the date the option is granted.

Restricted stock options may be granted by GE to from 700 to 1,200 employees for the purchase of not more in grand total of 1.4 million shares of common stock. The stocks would be taken from unissued common stock of which there are 6,154,073 shares. Proceeds of the sales will go into general funds.

RCA placed privately with a group of institutional investors $10 million in 3¾-percent promissory notes due May 1, 1977, bringing to $40 million the amount borrowed under a $50 million credit set up in February, 1952. Proceeds are to be used for working capital and to take care of increased volume of defense business.

Weston Electrical Instrument Corp. registered with SEC covering 107,055 shares of its capital stock, $12.50 par, to be offered for subscription by stockholders at the rate of one new share for each 3 shares held on the record date. The company will use $2 million of the proceeds to reduce bank loans. The balance will be added to general funds of the company.

Hedging Plan Bolsters Lean Years

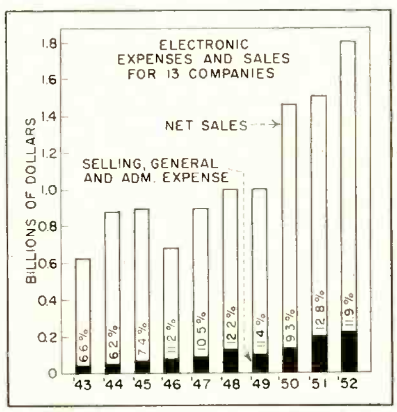
Electronic manufacturers evaluate selling costs and plans to increase sales effectiveness

ANALYSIS of the selling, general and administrative expenses of 13 electronic manufacturers for the past ten years indicates that companies are spending more for total sales, the expenditure last year reaching the highest point since 1943. But in 1952, as a percentage of net sales, which also reached record highs, sales expenses declined.

▶ **Strategy**—Selling costs have followed a fairly stable path since World War II because many electronic manufacturers allocate sales budgets by a set percentage of sales and spend more for sales when they are at a peak.

With defense cuts and tougher competition just ahead, electronic manufacturers are taking another look at this concept of tying expenditures to sales, in an effort to get more effective use out of their funds.

▶ **New Approach**—One plan for better sales spending was recently advanced by Gwilym A. Price, president of Westinghouse. He proposes a tax law that will permit companies to set up funded promotional reserves as tax-exempt costs in good years, for spending in lean years.



▶ **Price Plan**—"The tax deduction-reserve plan would overcome this normal tendency to reduce sales budgets when sales were low. Under such a plan, the Treasury would allow a company with a past history of spending on sales and market development to deduct tax-free a certain percentage of its gross. The company would spend this money for defined objectives, under approved conditions within a certain period."

Station Power Gains Extend TV Markets

IMPORTANT to televison receiver sales are existing tv markets in which stations have upped their power and increased coverage. Since June 1, 1951, over 60 tv stations have improved their facilities affecting over half the country's markets. NBC alone reports that 41 of its tv affiliates have boosted power since then.

▶ **Markets**—Although extension of coverage in terms of homes and audience is difficult to ascertain, set manufacturers agree that in old markets improved transmission by tv stations has provided a stimulant to business and has increased fringe sales just as improved tv receivers did in the past. It is estimated coverage increased 5 to 10 miles in many markets.

▶ **Future**—A number of tv stations plan power increases in the near future and have FCC okays. Applications by 19 other stations are pending approval. Markets expected to get power boosts in the near future are: Boston, WNAC-TV; Cincinnati, WLWT; Columbus, WLWC; Buffalo, WBEN-TV; Austin, Texas, KTBC-TV.

Transistor Improvement Promises Bright Future

Hermetic sealing and use of new materials may eliminate moisture and temperature bugs

STEADY PROGRESS is being made toward solving the moisture problem and other troublesome factors in transistors. In an announcement by Zenith it was revealed that that company had been unable to make transistors stand up under hearing-aid conditions. It was reported that the transistors they tried failed rapidly in service, evidently due to high moisture conditions prevalent near the body where hearing aids are normally worn.

Hermetic sealing promises to be a virtual cure-all for the moisture problem. One company, CBS-Hy-

(Continued on page 24)

Bendix Radio

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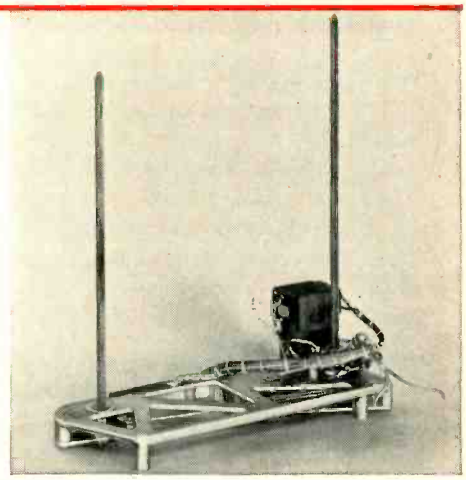

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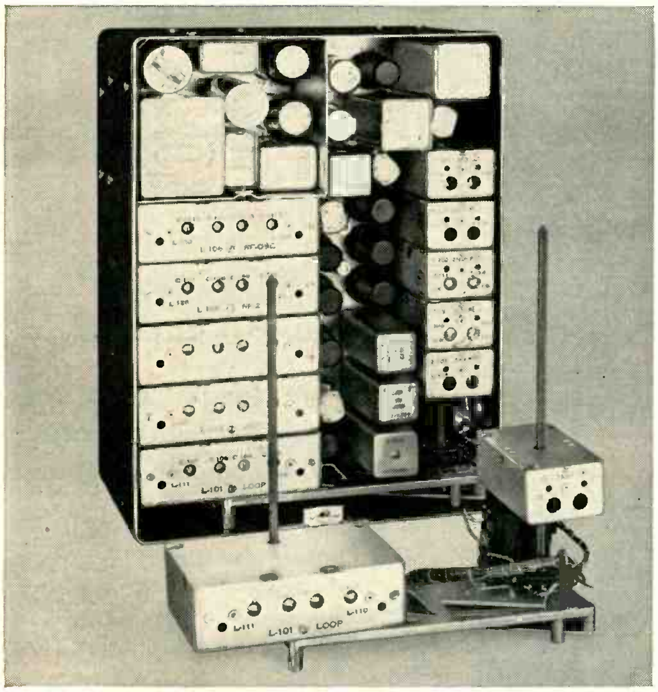

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Bendix selected Panelyte—12″ shafts made of Grade 170 Continuous Glass Cloth. This phenolic laminate withstands high torque loads—is stable under varying changes of temperature and humidity. Moisture absorption is only 0.1%. Electrical properties are excellent.

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GRADE 120, Staple glass cloth, phenolic resin, heat resistance.

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GRADE 140, Continuous glass cloth, melamine resin, arc resistance, high strength.

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tron, has already announced hermetically-sealed transistors, and several of the larger transistor makers indicate plans to do likewise in the very near future. The sealing process involves potting the transistor in a tiny (but so far costly) can equipped with a glass seal.

▶ **Other Developments**—Better and less expensive transistor materials appear to be the goal of numerous research programs, some of which are bearing fruit. Battelle Memorial Institute announced successful tests on a compound of aluminum and antimony for transistors. Preliminary tests show possibility of characteristics superior to germanium and silicon where operation at high temperatures is contemplated. A further advantage lies in the low cost of AlSb—a half ton costs about as much as a pound of germanium.

Transistor-pure silicon may also become cheaper and available in greater quantities as a result of a new manufacturing process developed by du Pont. This new source will also help raise power and temperature limits for transistors, because silicon functions as a semiconductor as high as 400 F.

Defense Contract Rules Revised

Administration jettisons broad-base procurement policy; electronics may be exception

FUTURE defense contracts will be awarded to the companies that can handle them best and cheapest and not necessarily to the firms or areas that need them most. Thus Deputy Secretary Roger M. Kyes announced a reversal of the Defense Department policy of spreading the work thin. Concurrently, the department announced that procurement would be placed in the hands of management men from industry. Presumably the Small Defense Plants Administration will expire quietly

▶ **Loophole**—Electronics manufacturers will probably not be affected greatly by the new policy. Kyes stated that marginal producers may still get contracts when the item manufactured is hard to get, in short supply or where the Defense Department wishes to keep the line open. Electronic equipment generally falls into these categories.

More significant is that the former broad-base policy had little effect on the electronics industry. Much lip service was paid to aiding small business but a small business was defined as one employing 500 workers or less, scarcely called small in the electronics industry.

▶ **Broad Base**—Figures supplied by the New York office of the Signal Corps Supply Agency show that from August 1952 until March 1953 this office let $780,903.17 worth of contracts, each under $1,000. Small business received a little more than half the work.

During the same period, the small business specialist at the Signal Corps' New York office serviced 8,947 firms and assisted small business in obtaining $6,372,855 worth of contracts over $1,000.

Aviation Weather Broadcasts Save Talk

Forecaster at La Guardia Field reads latest information onto magnetic tape (right) which repeats five-sector forecasts endlessly via relay transmitter (left) until next hourly forecast is recorded. Main transmitter in Manhattan broadcasts data on 162.55 mc from 6 am to 6 pm, KW035

Radio Networks Continue to Expand

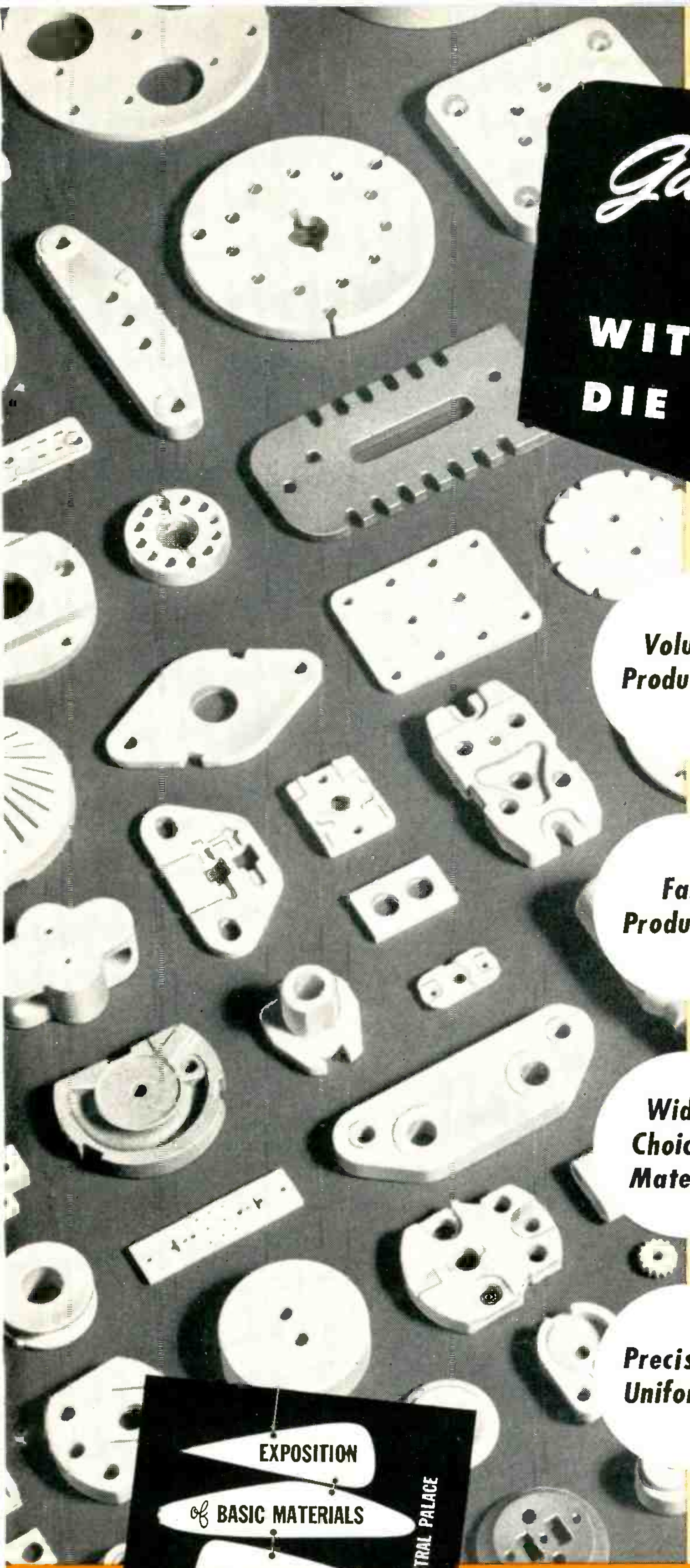
Webs are bigger than ever despite inroads of television; local sponsorship a boon

A GLANCE at the chart (next page) proves network radio is bigger than ever and apparently still growing. Latest figures give total outlets as follows: NBC, 206; CBS, 217; ABC, 355 and MBS, 562.

One reason advanced for the growth of network radio in the face of television's inroads against the listening audience is that the networks are acquiring a-m outlets primarily for television CP's. Independent a-m stations in new tv areas have found network affiliation essential. Another powerful inducement to independents is network policy of making national shows available for local sponsorship. Mutual has expanded heavily in non-tv areas and has found big-league baseball especially world-series coverage an attractive feature.

Radiomen in general seem con-

(Continued on page 26)



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electronics

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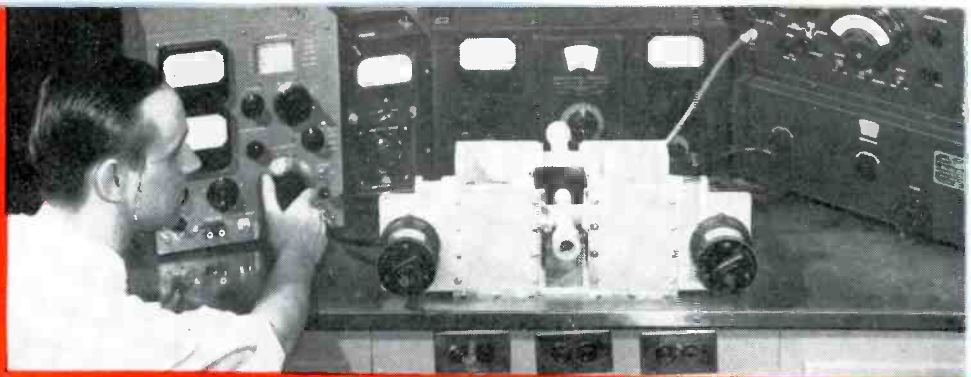
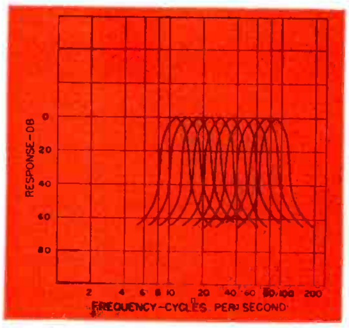
FOUL DETECTOR AND
AUTOMATIC PINSPOTTER

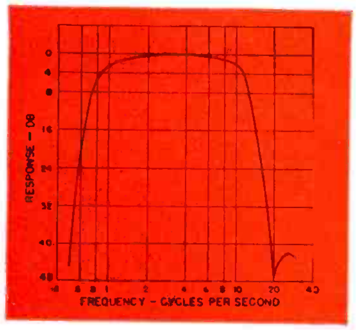
for SPECIALIZED FILTERS



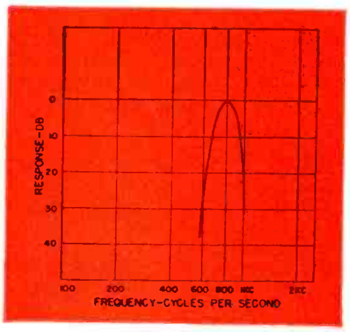
Decades of experience in the design and production of specialized filters have resulted in UTC being a first source for difficult filters. Fifteen years ago UTC was already the largest user of permalloy dust toroids in the world (exclusive of the telephone system). Present designs include a wide variety of core materials, structures, and winding methods to provide maximum performance in electrical requirements and stability. Illustrated below are a few of the thousands of special filter designs in present production.



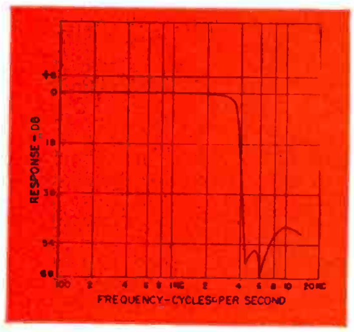
These low frequency band pass filters are held to 1 DB tolerance at the 3 DB crossover . . . 600 ohm . . . 4 filters per 7½" rack panel.



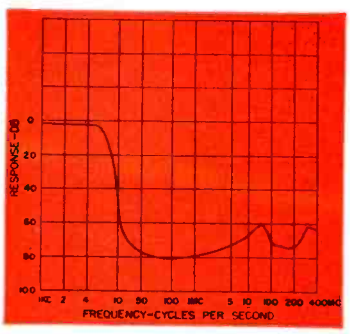
This ultra low frequency filter has a band pass range of one cycle to 10 cycles . . . 50,000 ohms . . . 700 cubic inches.



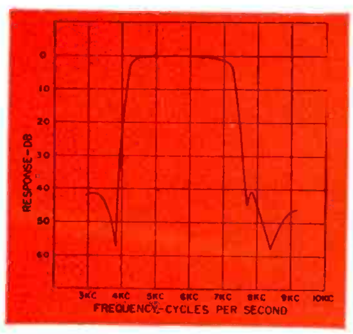
This 600 ohm miniaturized 1 KC band pass filter is housed in a case only 1" x 1¾" x 2½".



This 600 ohm miniaturized low pass filter is housed in a case only 1" x 1¾" x 2½".



This power line filter provides correct output voltages from sources of 50 to 400 cycles . . . noise attenuation is from 14 KC to 400 MC . . . 29 cubic inches.



This band pass filter is designed for sharp cut-off at both ends of the range . . . 10,000 ohms . . . case dimensions 1⅝" x 2½" x 3¼".

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FOUL DETECTOR AND AUTOMATIC PINSPOTTER—Action views of American Machine and Foundry's electronically controlled equipment. Photos by Syd Karsen at Farragut Pool Bowling Center, Brooklyn, N. Y. For details see p 148 .... COVER

June, 1953 ELECTRONICS Vol. 26, No. 6

Member ABC and ABP

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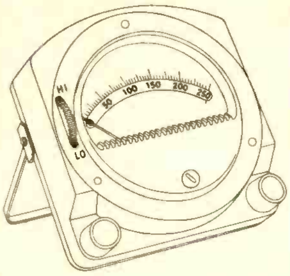

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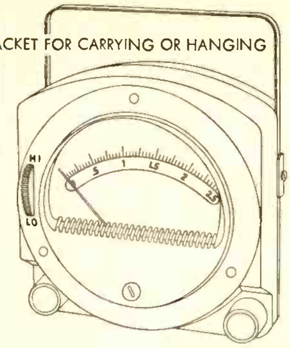

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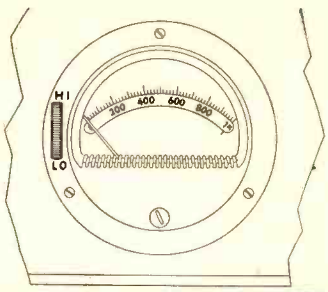

The Marion Multi-Dialer Model MD-1 shown here (ruggedized movement) is available with five self-contained ranges in volts, milliamperes, microamperes and amperes. It is also available custom-engineered to your end-product so that it may be installed on your panel and when appropriate scale is selected it will automatically insert the instrument with appropriate accessories into five separate measuring circuits and/or ranges in your equipment.

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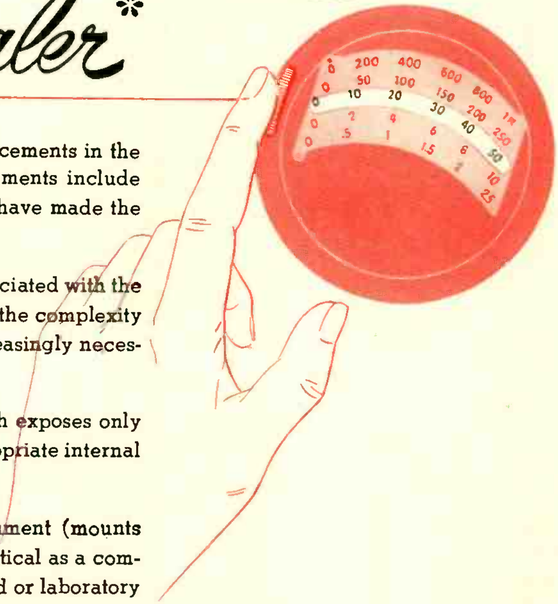

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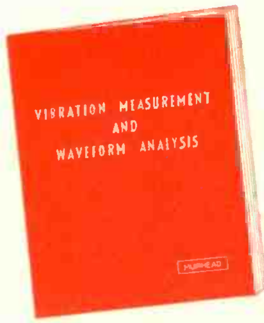

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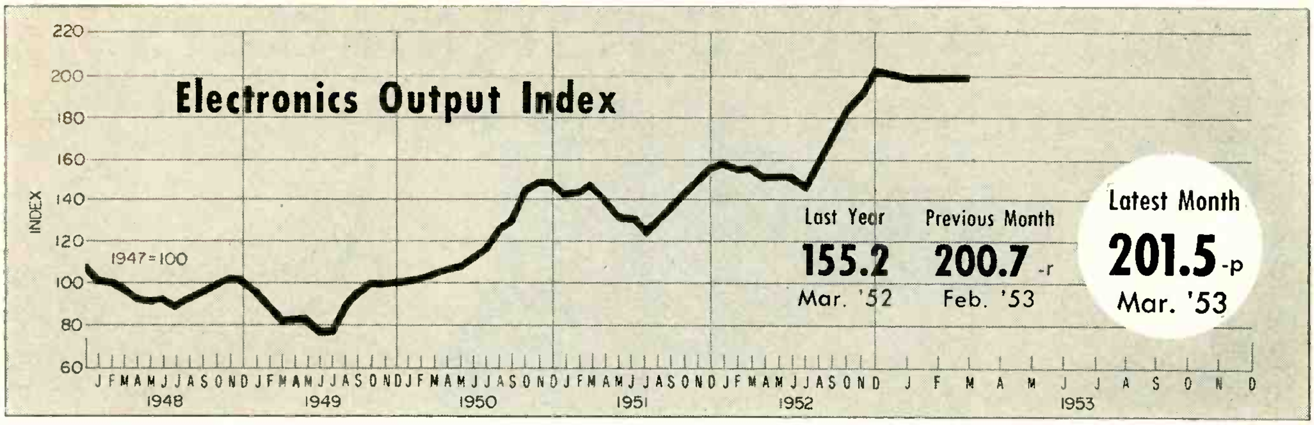


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago	Previous Month	**Latest Month**
	Mar. '52	Feb. '53	Mar. '53
Television sets	510,561	730,597	810,112
Home sets	357,689	402,742	442,101
Clock Radios	175,169	210,924	275,079
Portable sets	99,720	87,711	177,656
Auto sets	343,314	491,062	654,367

RECEIVER SALES

(Source: RTMA)		Feb. '53	Mar. '53
Television sets, units	......	537,122	603,704
Radio sets (except auto)	......	507,527	516,618

RECEIVING TUBE SALES

(Source: RTMA)	Mar. '52	Feb. '53	Mar. '53
Receiv. tubes, total units	30,935,220	40,024,475-r	44,691,200
Receiving tubes, new sets	19,513,454	27,730,235	31,367,831
Rec. tubes, replacement	7,231,186	9,217,982-r	9,949,321
Receiving tubes, gov't.	2,776,796	1,393,962-r	1,449,857
Receiving tubes, export	1,413,784	1,682,296	1,924,191
Picture tubes, to mfrs.	370,206	699,411	974,154

SEMICONDUCTOR SALES

(Source: RTMA)		Feb. '53	Mar. '53
Germanium Diodes	......	1,466,421	1,172,475

INDUSTRIAL EQUIPMENT ORDERS

(Source: NEMA)	Quarterly Figures: Year Ago	Previous Quarter	**Latest Quarter**
	4th '51	3rd '52	4th '52
Dielectric Heating	$620,000	$320,000	$440,000
Induction Heating	$3,400,000	$1,760,000	$2,420,000
Welding Control	$1,430,000	$1,810,000	$1,390,000
Other Electronic Control	$860,000	$920,000	$970,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	4th '51	3rd '52	4th '52
Vacuum (non-receiving)	$14,300,000	$10,580,000	$12,790,000
Gas or vapor	$3,170,000	$2,950,000	$3,480,000
Phototubes	$390,000	$570,000	$760,000
Magnetrons and velocity modulation tubes	$6,670,000	$8,500,000	$10,510,000
Gaps and T/R boxes	$2,120,000	$1,700,000	$2,090,000

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago	Previous Month	**Latest Month**
	Apr. '52	Mar. '53	Apr. '53
Sets in Use—total	16,939,100	22,551,500	23,256,000

BROADCAST STATIONS

(Source: RTMA)	Apr. '52	Mar. '53	Apr. '53
TV Stations on Air	108	164-r	179
TV Stns CPs—not on air	0	255	264
TV Stns—Applications	536	639-r	612
AM Stations on Air	2,347	2,424	2,430
AM Stns CPs—not on air	68	133	135
AM Stns—Applications	324	250	249
FM Stations on Air	632	607	600
FM Stns CPs—not on air	14	21	21
FM Stns—Applications	9	7	9

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Mar. '52	Feb. '53	Mar. '53
Aeronautical	32,176	37,825	38,822
Marine	34,843	39,001	39,425
Police, fire, etc.	10,592	12,482	12,682
Industrial	12,475	16,002	16,232
Land Transportation	4,847	5,636	5,660
Amateur	106,832	116,697	112,666
Citizens Radio	878	1,924	1,980
Disaster	29	101	189
Experimental	458	529	415
Common carrier	922	1,070	1,094

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Feb. '52	Jan. '53	Feb. '53
Prod. workers, comm. equip.	273,100	410,900-r	418,700-p
Av. wkly. earnings, comm.	$65.14	$67.23-r	$65.93-p
Av. wkly. earnings, radio	$61.28	$63.74-r	$64.40-p
Av. weekly hours, comm.	41.2	41.5-r	40.7-p
Av. weekly hours, radio	40.8	40.6-r	40.5-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Apr. '52	Mar. '53	Apr. '53
Radio—TV & Electronics	292.5	310.7	298.9
Radio Broadcasters	286.2	294.3	290.7

p—provisional; r—revised

FIGURES OF THE YEAR

	1952 Total	First Quarter Totals 1952	1953	Percent Change
Television set production	6,096,279	1,324,831	2,259,943	+ 70.58%
Radio set production	10,934,872-r	2,367,800	3,834,784	+ 61.96
Television set sales	6,144,990	1,279,783	1,780,899	+ 39.16
Radio set sales (except auto)	6,878,547	1,505,883	1,438,871	— 4.45
Receiving tube sales	368,519,243	85,934,322	122,058,756	+ 42.04
Cathode-ray tube sales	6,120,292	1,040,829	2,798,921	+ 168.91

INDUSTRY REPORT

International Hookup Televises Coronation

BBC marshals resources, picks up $171,500 tab to telecast ceremony

AN INTERNATIONAL television network will bring scenes of the June 2 coronation of Queen Elizabeth II to viewers in Great Britain, France, Holland, Belgium and Germany. The British Broadcasting Corporation will use 20 cameras manned by 101 engineers and eight commentators to give complete coverage of the ceremonies.

Cameras will be installed at several locations within Westminster Abbey and at four vantage points along the route of the procession. The complete program will last seven hours. Extra cost involved in televising the coronation will be $171,500.

▶ **Network**—Besides feeding the British television network, the signal will be transmitted by microwave to Paris where it will be used to feed the French 441 and 819-line transmitters after conversion from the British 405-line signal.

The French will also provide a microwave link from Cassel, on the London-Paris route to Lille. Here a Belgium-Dutch relay will carry the signal to Lopik in Holland via Breda. Conversion to the 625-line standard will take place at Breda and Dutch transmitters at Lopik and Eindhoven will broadcast the program to Belgian and Dutch viewers.

From Breda the 625-line signal will also go via microwave to Cologne where it will feed the NWDR television network linking seven German cities.

HYDROGEN THYRATRONS ranging from a few kilowatts to 40 megawatts produced from emergency development program led by Signal Corps engineers. Rapid expansion on M-Day is possible because . . .

Keyer Tube Resources Are Pooled

In a crash program, new tubes and machines to build and test them were evolved together

TO MEET an extreme emergency military demand, normal development and production procedures were short-circuited to get keyer tubes for vital defense equipment.

Late in 1950 a review of production against requirements showed hydrogen thyratrons, needed chiefly to pulse magnetrons in radars, were in short supply. The problem was presented to the Signal Corps, and a round-the-clock program was initiated at the Signal Corps Procurement Agency, Philadelphia.

▶ **Authority**—Anticipating future needs, the Signal Corps group decided to establish multiple sources for the production of hydrogen thyratrons in the shortest possible time. To cover possible anti-trust violation suits, authority was obtained from the Attorney General to allow pooling engineering know-how among competitive companies.

At integration committee meetings, representatives from all branches of the armed forces met with engineers from all the companies involved. According to B. D. Aaron, Signal Corps project engineer, "the most difficult problem at first was to get them to ask the right questions. Once we got past that, production and testing information and advice were freely swapped." Engineers from some companies toured other companies' plants, to learn how to make the equipment and tubes that grew as the program went along.

▶ **Ad Lib**—There were few specifications to guide the program and practically no prototypes. Small tubes were scaled up to big ones; interim types were made and finalized. Samples were flown to

Signal Corps Engineering Laboratories for aging and engineering evaluation. Heavy equipment to heat, treat and test the tubes was built from whatever parts could be found. Components were flown to a plant in the middle west where 35-kva aging units were designed, rushed into production and shipped to tube producers. Other units were built in California and air-shipped to reduce hazards of transportation damage and attendent delays.

▶ **Cooperation**—When a company worked the bugs out of its production problems, complete engineering specifications were made of findings, and copies were sent to every other company in the program. Engineering time for the crash program, and for future production programs, was thereby cut from several years to several months.

Pilot plant production runs were established and contracts were written specifying that companies involved maintain production know-how and tooling for a minimum of six years. "In case M-day comes," Aaron said, "production can be expanded immediately, without waiting for contracts to be negotiated, bids to be given and orders placed. The machinery is all there, all ready and working."

Thousands of type-approved thyratrons now roll off the lines, for use in the services' Skysweeper AA gun, among other things, and a precedent for similar future problems has been established.

▶ **Companies**—Among those manufacturers involved in the hydrogen thyratron program were, for equipment production: American Television Mfg. Corp., Kip Electronics, Chatham Electronics, Douglas Laboratories, General Electric, Girdler Corp., Manson Laboratories, Marchant Research, Westinghouse.

For tube production: Amer. Television Mfg. Corp., Amperex Electronics, Bomac Laboratories, Chatham Electronics, General Electric, Kuthe Laboratories, Machlett Laboratories, Penta Laboratories, Radio Corp. of America, Sylvania Electric, Westinghouse.

The companies included stretch cross country from New England to California.

Business Briefs

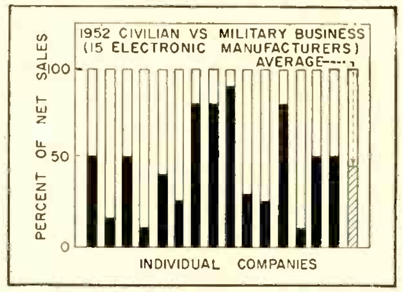
Controls—Last of price controls have been dropped in accord with Eisenhower's 'orderly decontrol of prices'. OPS plans June 30 exit.

Depreciation — Treasury is giving more liberal treatment of regulations on how fast plant and equipment can be written off for tax purposes.

Labor—End of price and wage controls brought some price rises, rumbles of reopening wage contract negotiations. Unemployment is about 1.8 million, near last year's 1.7 million, but employment is 1.8 million higher, which makes the labor market tight. Midsummer record of 63 million employed is expected.

Buy American—Enacted in 1933 under outgoing Hoover, the Buy American Act was upheld by Defense Secretary Wilson who turned down British low bid on Army contract. President Eisenhower backed Wilson, bucked Dulles and Stassen. The law's '25-percent under' interpretation, broken last June, is holding again.

Copper—Price is down to 30 cents per pound. It's a buyer's market now; National Production Authority has stopped allocating the metal because of 'favorable developments in the overall supply.' Imports and scrap production are up.



DEFENSE volume shows as . . .

Electronic Companies Size Up Military Sales

As defense spending cuts loom ahead, manufacturers look at military sales percentages

ELECTRONIC manufacturers, both large and small, will do well to prepare for an increase in their commercial business and a decline in their military production, Glen McDaniel, RTMA general counsel, told west coast electronic manufacturers recently. He declared it appears likely that military expenditures will be reduced or stretched out, "but how fast I don't know. Of one thing we can be sure, electronics and aircraft will remain paramount in whatever armament program is decided upon for the years ahead."

▶ **Ratios**—A survey of 15 manufacturers in the field reveals that defense sales in 1952 (black columns) ranged from 10 to 90 percent of total net sales, with an average for the companies of 45 percent. This is lower than an estimate made last year by the Defense Department who set military sales at 53.3 percent of total sales in 1952. (ELECTRONICS, p 6, Aug. 1952) The percentage was expected to be lower as the defense delivery schedule "stretch out" went into effect last year.

▶ **Companies**—In 1951, smaller electronic companies reported proportionately more military business than did large firms. But major electronic manufacturers indicate they increased their defense business substantially in 1952.

Shipments of electronic apparatus

(Continued on page 8)

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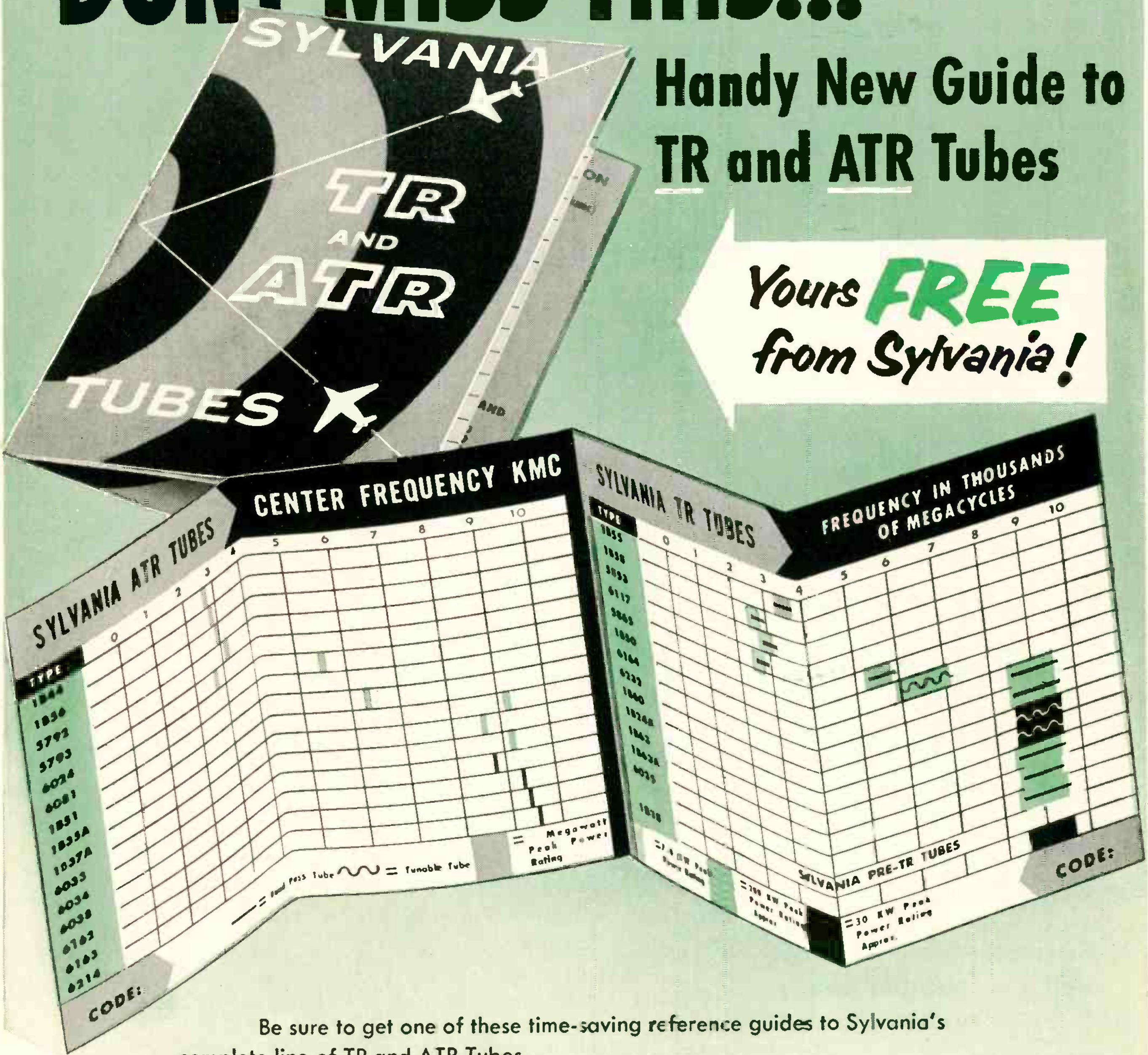

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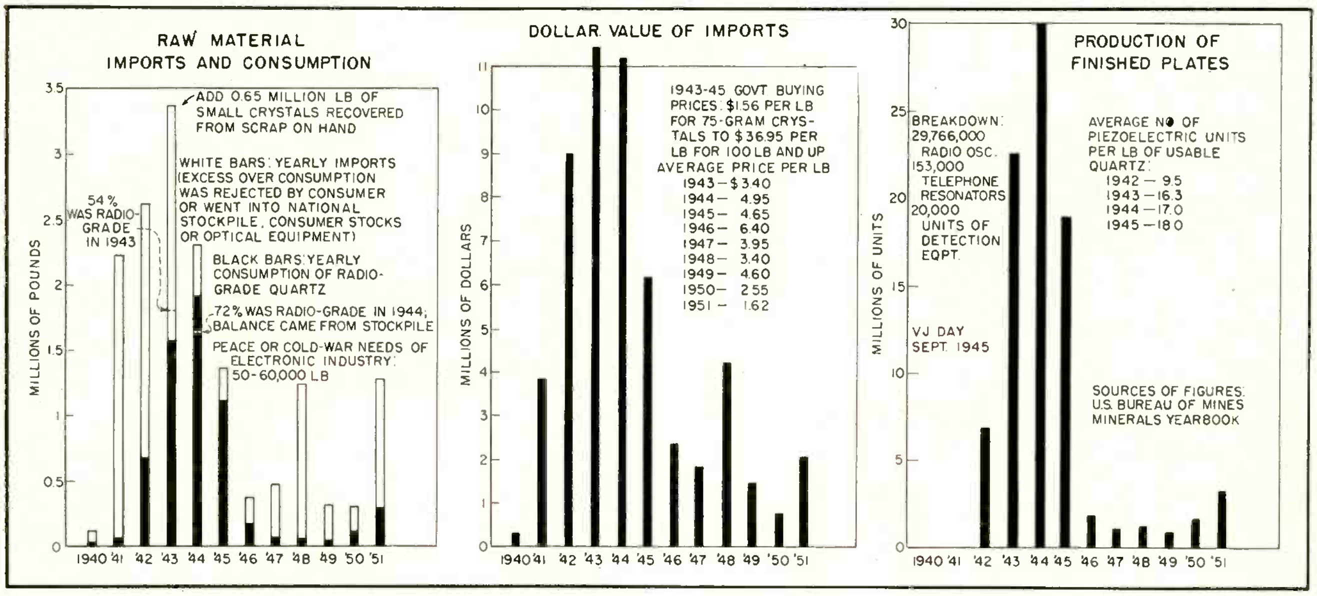
for the armed forces by RCA were approximately double those of 1951. Sylvania estimates that 28.5 percent of its net sales in 1952 were accounted for by defense products, nearly double 1951's volume. Zenith also reported that production and shipment of material for the military services, at a low level in 1951, increased materially in 1952 and amounted to approximately 10 percent of the company's net sales.

▶ **Future**—Although electronic manufacturers are concerned about the effect of a military cut-off on the industry, many would welcome the return to full civilian production. Profits are higher and the commercial sales outlook for 1953 is very promising. Already most companies have experienced record first quarters. But even without top civilian sales the present electronic defense backlog, which is at a peak, could carry the industry's big volume well into 1954.

ELECTRONIGRAPH—Natural Quartz Crystals



Status of Quartz Crystal Growing Plants in U.S.

Industry changeover to small crystals, in plentiful supply from Brazil, eases needs

PRODUCTION plants for growing synthetically the wartime needs of radio-grade quartz crystals could be built and equipped within a year if necessary. It may be assumed that military stockpiling of natural crystals has been geared to this time figure, hence there should be no shortages even if the Brazilian supply were cut off today.

Brazilian domination of the quartz market has been a bugaboo for a nation geared to the philosophy of always having a second source of supply. Most critical years were 1942 and 1943, when U-boats were sinking supply ships in the Caribbean. An air lift solved this problem. Tension eased further, after the war, with the announcement that Signal Corps sponsored research on quartz crystal growing had paid off.

▶ **Change in Demand**—Crystals under 200 grams, considered as scrap early in World War II, now serve because the industry has become adapted to use of finished plates approximately ½ inch square or round. Small natural crystals cost only $1.25 to $4 a pound, as contrasted to $15 and up for the pound-size and larger crystals considered necessary heretofore.

Small crystals usually have much less twinning, hence give an even greater yield per pound despite increased geometric losses. With larger crystals, only 30 to 40 percent of the weight ordinarily is usable because of defects.

▶ **Growing Costs**—Under developmental conditions at Bell Telephone Laboratories and at Brush Laboratories, costs have approximated $50 per pound for synthetic crystals. With organized mechanized handling of the heavy autoclaves for loading and unloading, this cost may be better than halved in full production.

A further reduction in net cost per finished plate is possible because synthetic crystals are relatively free from flaws and hence may approach 100-percent usability except for geometric losses in cutting. By varying growing time and

(Continued on page 10)

Batch of 11 perfect 160-gram quartz crystals being unloaded by A. C. Walker after growing 48 days in 4-foot autoclave at Bell Telephone Labs in Murray Hill, N. J. Threaded cap is removed with huge wrench and chain hoist, after which welded-steel inner liner is sawed open. Project is sponsored by Signal Corps Engineering Labs of Fort Monmouth

choosing the right angle for the quartz seed plate, the synthetics can be made almost exactly the optimum size and orientation for cutting a particular type of plate with minimum cutting waste. Despite all this, the present cost of the synthetic product is way more than the current rate for radio-grade Brazilian quartz. However, it is reasonable to believe that large-scale commercial production eventually will be feasible because of a greater potential yield from synthetic quartz.

In the military picture, cost of raw quartz is secondary to availability. This is partly why the Signal Corps sponsors crystal-growing research at both BTL and Brush.

▶ **Process Details**—Both labs grow the crystals by suspending seed plates in an alkaline solution between 350C and 400C and high pressure, with scrap natural quartz at the bottom. BTL uses a welded autoclave at 15,000 lb per sq inch (ELECTRONICS, p 96, April 1951), and gets about 5 lb of quartz per month per cu ft of autoclave space.

Brush uses a continuously-rocked double-chamber autoclave at 5,000 lb per sq inch (ELECTRONICS, p 238, April 1953), and gets about the same output per cu ft.

Broadcasters Made Money In '52

Station revenues for 1952 are 5 percent higher than total dollar take in 1951

TOTAL revenue of the radio-broadcasting industry in 1952 amounted to $473.1 million, 5 percent above the previous year. Figures are from a preliminary FCC report. While 7 networks, including owned stations, estimated total revenues of $101.0 million or 2.9 percent below 1951, more than 2,300 radio stations estimated total revenues of $372.1 million, an increase of 7.4 percent above 1951. Thus radio income for networks and individual stations followed the same pattern as did tv income for networks and individual stations in 1952. (ELECTRONICS, p 22, May, 1953)

Added to the estimated $336.3 million total revenues of tv broadcasters, the combined industry revenues in 1952 reached $809.4 million showing a marked increase of 18 percent above 1951.

▶ **Income vs Revenue**—Radio industry income before federal income taxes rose to $62.6 million in 1952 after having dropped to $57.5 million in 1951 from a peak of $68.2 million in 1950. Networks, including owned and operated stations, estimated 1952 income at $11.2 million or 11 percent above 1951. Total income of 2,300 radio stations was estimated at $51.4 million or 8.4 percent above 1951. The 814 a-m stations licensed in 1941 and prior years, comprising slightly more that ⅓ of all a-m stations, accounted for almost ⅔ of the total revenues and ¾ of the total income of all a-m stations.

▶ **TV vs Radio**—A total of 470 a-m stations in tv markets estimated their 1952 revenues at $171.5 million or 2 percent above 1951. In non-tv markets, 1,629 a-m stations estimated their total revenues at $199.6 million, almost 11 percent above 1951. Increased total revenues in 1952 were reported by about three out of five a-m stations in the tv markets and by four out of five a-m stations in the non-tv markets. Overall, 74 percent of the total stations reported increased revenues in 1952.

Losses were reported by 15.9 percent of the 2,276 a-m stations. This is the smallest number since 1946 when 11 percent of the 1,015 then operating were unprofitable.

U.S. Surveys Labor Picture

Number of stoppages has declined sharply since 1950 but total man-days idle have risen

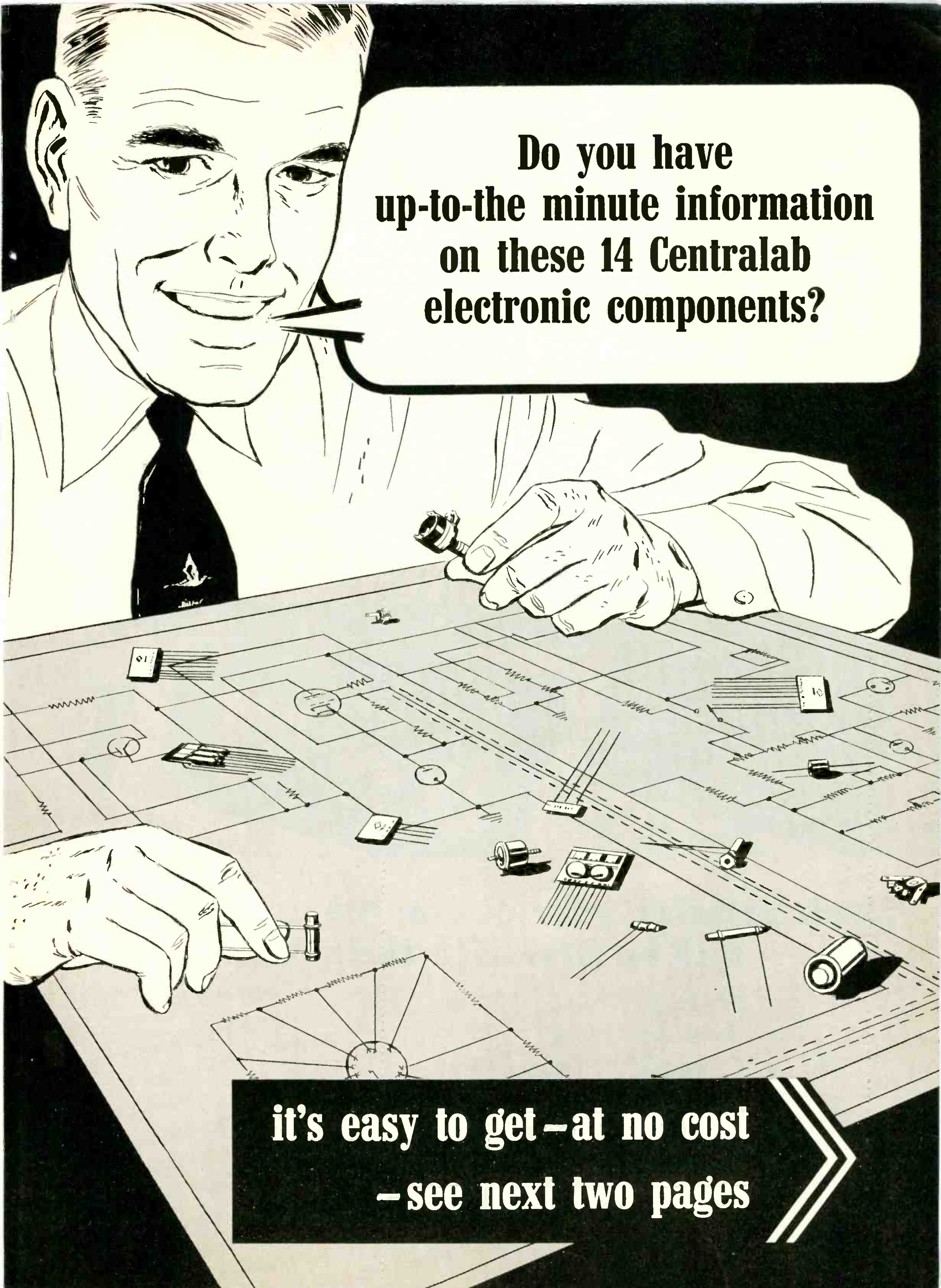
TREND in work stoppages involving six or more workers and lasting for a full shift or longer shows up in a report by the Labor Department. Last year there were 30 such stoppages in the communications equipment field, radio, tv, equipment and parts manufacturers. This was the lowest number of disputes to be recorded since 1949. However, man-days idle as a result of the 30 stoppages totalled 327,000, the largest number since 1950 when total reached 368,000.

Although the number of disputes was lower, the stoppages evidently affected larger companies for longer periods of time. In 1952, two companies in the electronics field had strikes involving 10,000 or more workers, while in 1951 there was only one such stoppage.

▶ **Pattern**—According to the Labor Department, the largest number of work stoppages have been caused by disputes over wages and shorter hours. Other prevalent reasons are: union organization, working conditions, interunion and intraunion matters.

Fluctuation, as seen in total man-days idle, seems to follow the sales pattern of the radio-tv industry. In

(Continued on page 14)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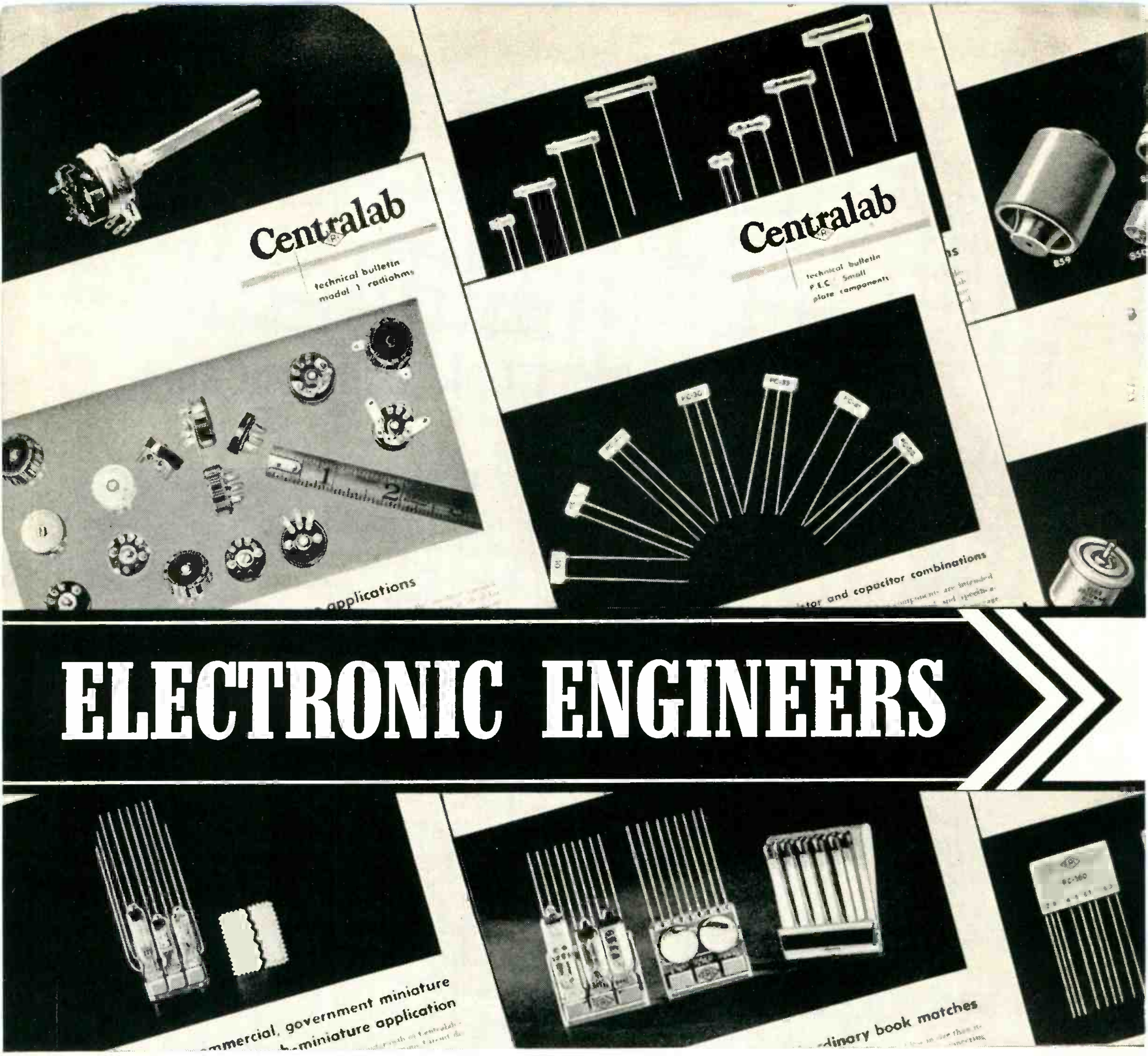
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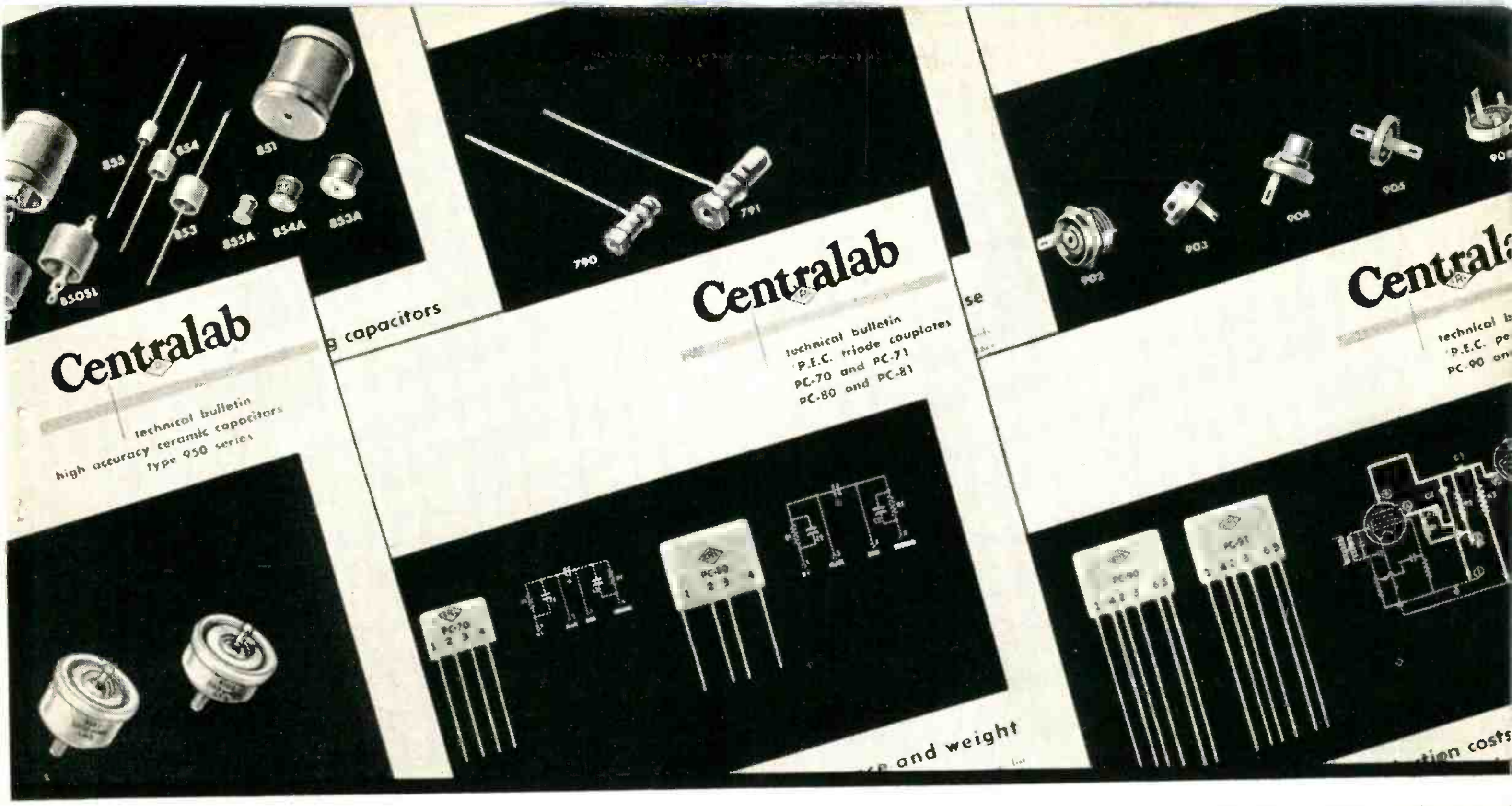

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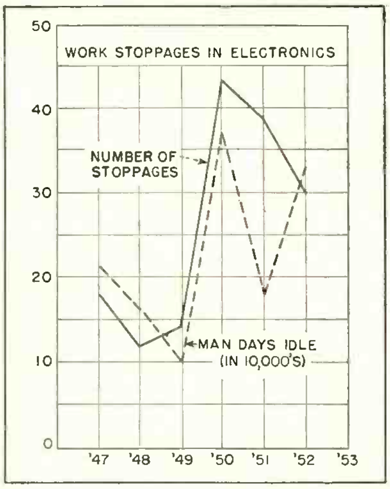

1950, big sales year for manufacturers, man-days idle were highest. Then as business slumped in 1951 and regained in 1952, man-days idle followed the same course.

▶ **1953**—There have been a number of work stoppages in the electronics industry so far this year but only one of any severity. It involves more than 10,000 workers and several weeks duration. But there are rumblings of more wage disputes in the steel industry that could affect electronics.

Television Highlights NARTB Show

Broadcasters see 3-D telecast; remote control and low-budget operation also discussed

THEME of the recent NARTB convention seemed to be "What else can you do with television?" The 1,500 conventioneers who crowded Los Angeles' Biltmore Hotel heard reports on three-dimensional tv, color tv, intercontinental tv and tv in a can. Low-budget operation of small-city television stations and remote control of a-m and f-m broadcast transmitters were discussed in several papers. Fifty-odd suppliers of broadcast equipment and services exhibited.

▶ **Three-D**—An experimental telecast over KECA-TV ABC-Paramount's L. A. outlet showed delegates how the illusion of depth may be achieved in television. Special receivers at the Biltmore using two picture tubes resolved their images on a 3 by 4-ft viewing screen. Viewers needed Polaroid glasses.

The emphasis was also on 3-D at the Statler where 1,000 SMPTA members concurrently held their annual confab.

▶ **Color**—Discussing the future of color television, RCA's General Sarnoff prognosticated that once the FCC authorizes color it will take industry nine to 12 months to tool up and produce. Sarnoff also predicted the failure of subscription television on a national scale.

Features of the NTSC color television system were discussed in a paper by Dr. W. R. G. Baker of GE.

▶ **Around the World**—Intercontinental television may be just over the horizon according to Neal McNaughten, NARTB's engineering manager. High-powered microwave relays and submarine cables with transistor amplifiers would do the trick.

▶ **Low Budgets**—Reflecting television's post-freeze trek to the hinterland, low-budget operation of a small-city station was the subject of a panel discussion. In the same vein, Federal engineers presented a paper on how to set up a television station with two technicians while GE demonstrated a packaged tv station designed for one-man operation.

Low-budget operations, it developed, are still not low enough for stations serving markets under 100,000 population. Tab for essential equipment comes to $300,000 with yearly operating cost running between $175,000 and $300,000.

▶ **Canned TV**—Importance of canned entertainment in post-freeze television was attested to by at least six equipment makers. General Precision, Standard Electronics, Federal and RCA exhibited small cameras especially suited for film reproduction. Philco and DuMont both introduced continuous-motion film scanners.

Reporting on his company's sys-

(Continued on page 16)

Three-Dimensional Television Lens

Wide-angle lens giving 142-degree field of view, as used at the Navy's Special Devices Center, Sands Point, N. Y. in a gunnery trainer. A television system using this wide-angle lens and a spherical-screen projection receiver to provide three-dimensional television is presently under development at RCA

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tem for recording tv programs on tape, John T. Mullin of Bing Crosby Enterprises claimed the tape would record both sound and picture with the quality of a live telecast.

Movies Triple Audio Facilities

NEWCOMER in the 3D field is CinemaScope, which uses a 65-foot wide screen, a single projector and no glasses. Behind the screen are three speakers, each with its separate amplifying system and sound track, to produce a stereophonic sound effect.

Installation costs big theaters about $10,000, little theaters less, according to Twentieth Century-Fox. The company expects 12,000 installations to be made by the end of next year.

Expansion Plans for Puerto Rico Plants

Subassembly and parts plants plow back tax-exempt profits; many new plants are under way

PRACTICALLY all of the electronic plants established in Puerto Rico in the last two years are actively expanding. Business is good down there, because most of this expansion money comes from profits inflated by tax-exemption.

Figures tell the story; present total square-footage of operating plants is about 115,000 and goes to an estimated 350,000 by year-end for expanded and new plants combined. Total present employment of 875 correspondingly jumps to about 3,500. The accompanying tabulation gives the present picture in detail, as derived by combining latest figures of Puerto Rico's Economic Development Administration (New York City office: 600 Fifth Ave.) with observations made during editorial visits to operating plants.

ELECTRONIC PLANTS IN PUERTO RICO

Name of Firm	Location	Started	Sq Ft	Empl	Chief Products
Ben Ida Electronics	Hato Rey	Jan. '52	3,500	—	Amplifiers & record players
Borinquen Radio Components Corp.	Rio Piedras	Future	—	—	Radio hardware & structural parts
Caribe Aircraft Radio Corp. (Related to Lavoie Labs)	Coamo	May '52	10,800	80	Radar subassemblies, coils & filters
Coradel Mfg. Co.	Caguas	June '52	5,000	—	Lightning arresters & lead-ins
Diversified Products Corp.	Carolina	May '53	—	—	Ceramic insulators
Empire Industries Inc.	Bayamon	Future	—	—	Transformers
John Hackes & Siegler	Hato Rey	Future	—	—	Quartz crystals
Hemisphere Corp. (Related to National Moldite Co.)	Rio Piedras	July '53	11,000	30	Molded coil forms & ferrite cores
Hermetic Seal Products Co. of Puerto Rico Inc.	Hato Rey	Aug. '51	10,000	110	Feed-through insulators
Hycor Co., Inc.	Vega Baja	Nov. '52	1,500	35	Precision resistors & toroids
Interamerica Electronics Corp.	Santurce	Future	—	—	Hearing aids & components
Pamcor Inc.	Rio Piedras	May '53	11,500	—	Terminals & connectors
Phillips Control Corp.	San Juan	June '52	8,000	50	Aircraft relays, coils & solenoids
Port Electric Corp.	Catano	Future	—	—	Radio tuning devices
Radell Corp.	San Juan	Jan. '52	3,250	70	Deposited carbon resistors & vhf coils
Rectifier Corp. of Puerto Rico	Fajardo	May '53	—	—	Components
Rico Electronics Inc. (Related to National Video Corp.)	Vega Alta	Jan. '53	11,500	—	TV picture-tube guns
Statham Instruments Inc.	Hato Rey	Future	—	—	Scientific instruments
Sylvania Electric of P. R. Inc.	Rio Piedras	Oct. '51	37,000	400	Mica punchings, tube parts & components
Triplett Electric Co. of P. R. Inc.	Bayamon	Apr. '52	8,000	65	Meters and multimeters
Weller Mfg. Co.	Bayamon	Dec. '50	8,000	60	Soldering guns

▶ **Profits**—There are two methods of showing a high profit on electronic operations in Puerto Rico:

Method 1. Produce a product having high labor content and low transportation cost (practically everything in electronics field), placing emphasis on a topnotch labor training program, on good management and on an incentive program that rewards labor for extra effort. This method takes maximum advantage of the island's 45-cent labor rate.

Method 2. Operate as a small, new firm which has a low base for U. S. excess profits tax but is expanding rapidly because of good management or because of a secret process or successful new product. Such a firm can take maximum advantage of tax exemption.

▶ **Wages**—Minimum wages for labor in electronic plants are set by a committee of nine representing management, labor and the public interest equally. Applicable U. S. laws are ambiguous in specifying that wages on the island must not be so low as to constitute unfair competition with U. S. labor, yet not so high as to diminish employment in Puerto Rico. The commit-

(Continued on page 18)

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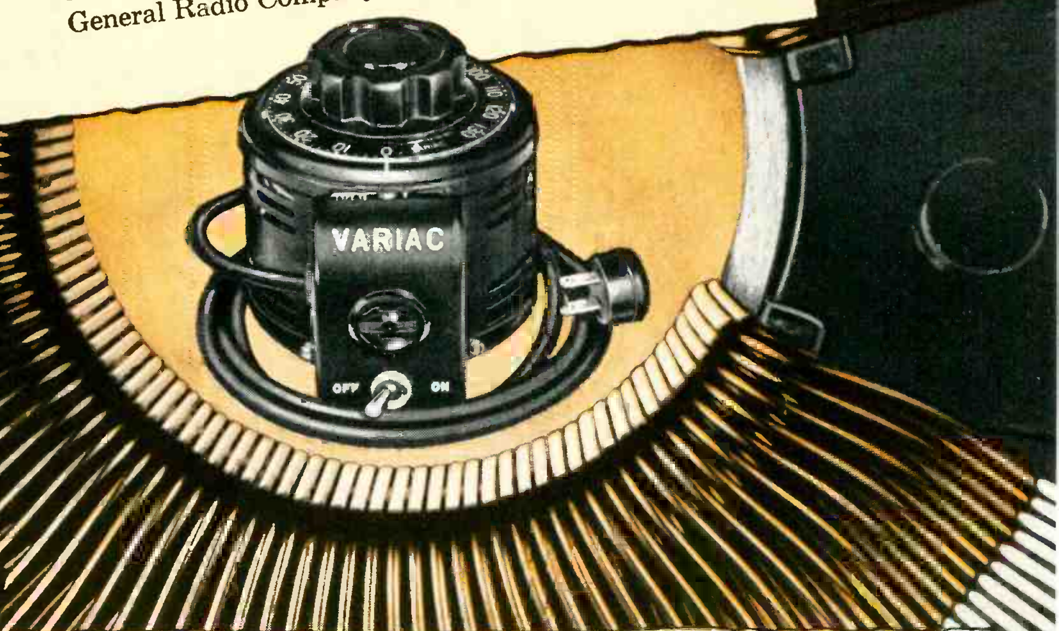

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tee meets about every two years, and it takes another year to put a wage change into effect.

For the electronics industry, the present minimum is 45¢ an hour. In well-established plants, merit raises may bring this as high as 58¢ an hour for assembly-line workers, with group leaders (supervising about 12 workers) making $150 to $325 a month. Machine-shop and maintenance electrician rates are 75¢ to 80¢ an hour.

▶ **Taxes**—Present laws provide complete exemption from insular taxes until 1959. A new law now under consideration will give each new plant 10 full years of exemption. To show maximum untaxed profit, business transactions must be completed in Puerto Rico. Most firms achieve this by pricing their products FOB San Juan.

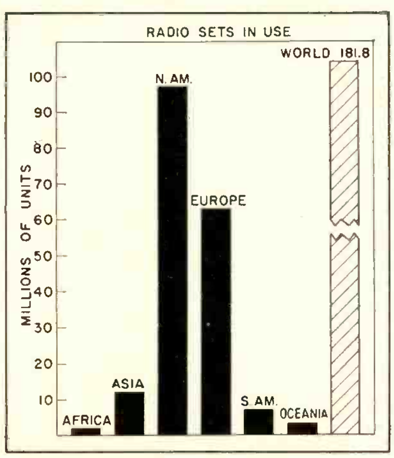
▶ **Productivity** — A government survey of five electronic plants indicated that after an average of 8½ months of operation, worker productivity was 95 percent of that in mainland plants and quality of output was 88 percent of U. S. standards. Most of the workers involved had not worked in a factory before, but had high manual dexterity. Individual firms have achieved as high as 120 percent of mainland productivity on repetitive high-speed manual operations. Temperature and humidity are more comfortable than around New York City even in summer, hence do not affect production.

Productivity of native workers is a function of training, management and choice of human material, just as anywhere else. One firm uses with excellent success a modified piecework incentive program based on three-month output rather than daily output. If a worker attains the norm at the end of three months, he gets a raise; if not, he gets fired.

Germany gets set to tap the European bicycle market with this $11.40 bike radio. Loudspeaker is built into the lamp housing. Two dry cells fit under the saddle

World Radio Output Increases

RADIO receivers are still the number one electronic product throughout the world despite substantial gains made by tv abroad. The statistics from the United Nations show that more than 181 million radio sets are in use today, a probable retail value of over 9 billion dollars. By continents, as indicated in the chart, North America has more radio sets in use than the rest of the world combined.



In terms of receivers per 1,000 inhabitants, the U. S. again leads with 620, followed by Sweden with 301 and the Falkland Islands in South America with 300. Two countries where set saturation is of no concern are French Equatorial Africa and Tanganyika, each with 0.2 radios per 1,000 inhabitants.

▶ **Production**—Although 17 countries in the world produced radios in the past 4 years only 11 reported complete production figures to the UN. Excluding the U. S., the rest of the world produced 4.5 million radios in 1949, 5.7 million in 1950 and 6.3 million in 1951, the latest reported year. U. S. production of radios during these years was nearly double the rest of the world's output in each year.

Germany was second biggest producer in 1951 with 2.2 million receivers that year, almost double its production of 1.1 million in 1949.

The United Kingdom followed Germany with an output of 2.1 million sets in 1951 compared to 1.3 million in 1950 when she was the world's second place producer.

Of 11 countries reporting, only Canada, Japan, Norway and Yugoslavia experienced a decline in set production between 1949 and 1951. India, Austria, Denmark, Germany, Iceland, United Kingdom and Australia were all on the upswing.

Loudspeaker Business Follows New Trends

Volume this year is expected to reach 22.5 million units, a 3.2 million gain over 1952

RTMA RECENTLY estimated in a report to NPA that 1953 loudspeaker production would total 22.5 million units compared with 18.8 produced in 1952. The average weight of an Alnico 5 magnet per speaker is 1½ oz, so this year the industry will need approximately 2.1 million pounds of Alnico 5 material.

The increase over 1952 production is believed due to the opening

(Continued on page 20)

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25 KW AT 220 MC!

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Two GL-6251's in your new v-h-f circuit will boost E. R. P. to the *full authorized 316 kw!*

Here's a plus: only 5 kw is needed to drive a pair of these high-gain tetrodes! Low-power TV transmitters now on the air—by adding an amplifier stage with two GL-6251's—can increase signal strength to top levels at moderate cost.

Manufacture and sale of these amplifier circuits to TV stations, is a profit opportunity for you second only to that from applying GL-6251's in new high-power v-h-f transmitters, where your customers require maximum E. R. P. from the start.

GL-6251 is the *big* new tube for your *big* jobs! Get complete information about this SUPER-POWER tetrode from *Tube Department, General Electric Company, Schenectady 5, New York.*

163-IA6

GENERAL ELECTRIC

of new tv areas and a lack of finished set inventory in the hands of the industry.

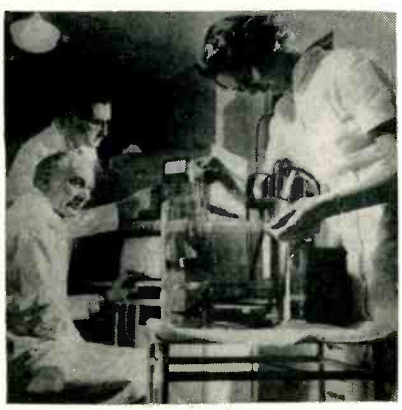
▶ **Market**—Approximately 7 million units will go to tv set producers and about 8 million to radio manufacturers, if predictions hold true. Remaining sales will be split up among hi-fi, industrial, military and replacement markets.

▶ **Product**—Some manufacturers see an increasing trend in radio and tv set design toward smaller sets, fewer combinations, more table models. This means smaller loud speakers and smaller dollar volume per unit for companies.

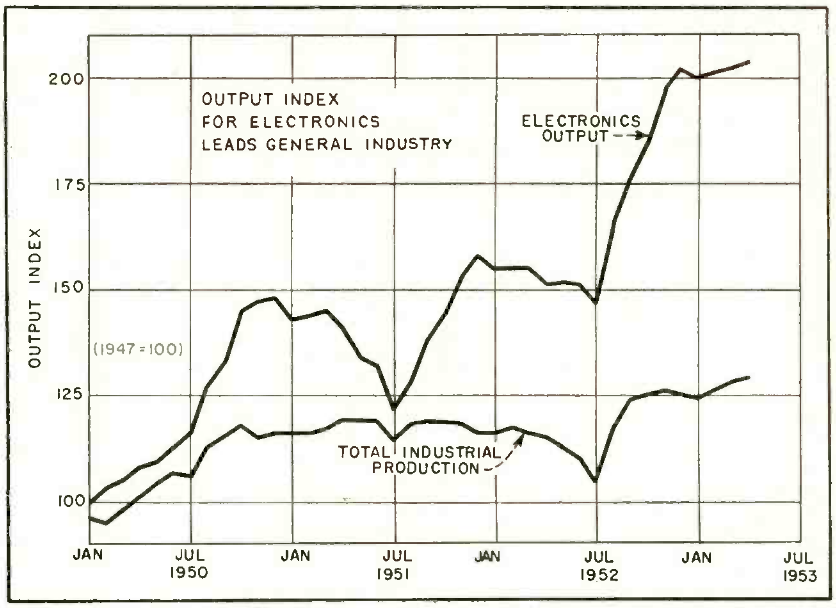
However, other loudspeaker manufacturers are optimistic because of the accelerating hi-fi trend which has made the public more fidelity conscious and has resulted in a noticeable increase in sales of heavier and larger units. It had also caused some set manufacturers to equip combination sets with larger cones, the 12 inch instead of the 10 inch, despite higher cost.

Manufacturers are now using larger loundspeakers in their portable lines. Motorola, with its new design that incorporates the magnet and associated components within the cone, now is able to use a 7-inch loud speaker in place of a 4 inch (ELECTRONICS, p 8, May, 1953).

Meters Fluid Flow



Flowability of a fluid is measured instantly and continuously with this new instrument for industry and the medical profession. A small ultrasonic sensing probe is applied to a blood sample while an electronic computer and recorder chart how fast a clot is formed



PLOT of output indexes shows electronics out in front. On page 4 of each issue . . .

New 'Figures' Show Business Trends

Cumulative totals on page 4 of each issue compare current and previous year's output

RECENTLY added to the regular 'Figures of the Month' page of ELECTRONICS is a new subdepartment called 'Figures of the Year'. The statistics printed each month under this heading show at a glance cumulative monthly conditions in the electronics business as compared to the same time last year.

This month's totals show a significant increase in general production and sales for the first quarter of '53 as compared to '52. Cathode-ray tube production almost tripled, with an increase of 168.91 percent over last year. Radio and television set production remained high.

▶ **Output Index**—The 'Electronics Output Index' (also on page 4) continues to reflect a healthy situation in the industry. As shown in the accompanying chart comparing the electronics index with similarly compiled statistics on industry in general, output of electronics goods has increased about 100 percent since 1947, while increase in general industry amounts to around 25 percent.

Computed largely from Bureau of Labor Statistics, the Output Index shows activity in both military and commercial electronics. A slight drop-off may be expected during summer months as the American public turns to trout lines.

Financial Roundup

OUTSTANDING gains for the first 3 months of 1953 compared to the same period last year were registered by companies in the electronics field. National City Bank of New York reports that total net income in the first quarter for 23 companies was $78.3 million compared to $54.4 million in 1952, a 44-percent increase. Profit reports by individual companies in the first 3 months of this year are as follows:

Company	Net Profit (3 mos.) 1953	1952
Admiral	$3,056,878	$1,515.506
CBS	2,404.935	1.522.796
Hoffman	476,646	401.675
IBM	7,520,105	6.797.876
Magnavox	1,782,000	558.000
Minn. Honeywell	2,332,770	1.294.583
Motorola	3,174,208	2.238.135
RCA	9,293,141	7.076.520
Raytheon	1,355,000	408.000
Sylvania	3,679.243	1.953.771
TelAutograph	44,856	47,443
Tung Sol	552,318	492.241
Zenith	2,109,461	1.083.242

▶ **Securities**—Computer Manufacturing Corp. filed with SEC cover-

(Continued on page 22)

THE COLLINS

OMNIRANGE NAVIGATION RECEIVER

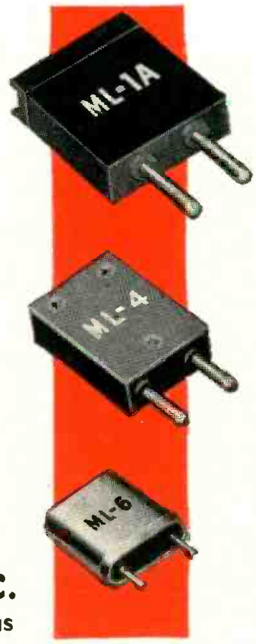
Is the Heart of the Famous Collins Navigation System

The Collins 51R-3 Navigation Receiver is typical of the outstanding developments of the Collins Radio Company for aviation, navigation, and communication. It is in wide use among airlines, private, and military planes. With accessories, it is the heart of the Collins navigation system to which is entrusted the efficient and safe operation of every type aircraft.

Midland CRYSTALS Play a Vital Role

Midland Crystals are entrusted with the exacting job of frequency control in the Collins 51R-3. Thirty-four crystals provide complete 280-channel coverage. In such critical service, there can be no compromise with quality, precision, and undeviating performance under every operating stress.

Midland Crystals measure up to Collins' strict standards because every one of the millions of Midland Crystals in use today is a product of Midland Quality Control. This is the system by which every crystal is constantly checked and tested at every step in processing. Midland employs the highest technical skill and finest production facilities known to the industry. It is your assurance of completely dependable crystal performance.



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ing 150,000 shares of common stock par 10 cents to be offered at $1 per share. Net proceeds will be used for working capital and for general corporate purposes.

General Electric proposed a stock option plan for key employees. Participants selected will be given the right to purchase GE common stock of no par value at 100 percent of the fair market value on the date the option is granted.

Restricted stock options may be granted by GE to from 700 to 1,200 employees for the purchase of not more in grand total of 1.4 million shares of common stock. The stocks would be taken from unissued common stock of which there are 6,154,073 shares. Proceeds of the sales will go into general funds.

RCA placed privately with a group of institutional investors $10 million in 3⅝-percent promissory notes due May 1, 1977, bringing to $40 million the amount borrowed under a $50 million credit set up in February, 1952. Proceeds are to be used for working capital and to take care of increased volume of defense business.

Weston Electrical Instrument Corp. registered with SEC covering 107,055 shares of its capital stock, $12.50 par, to be offered for subscription by stockholders at the rate of one new share for each 3 shares held on the record date. The company will use $2 million of the proceeds to reduce bank loans. The balance will be added to general funds of the company.

Hedging Plan Bolsters Lean Years

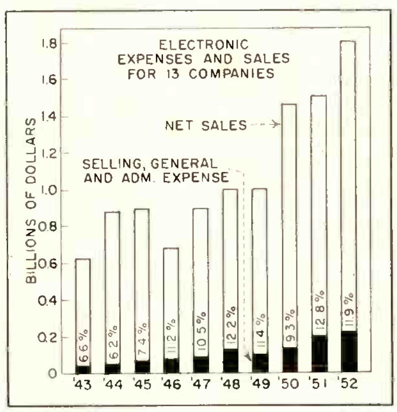
Electronic manufacturers evaluate selling costs and plans to increase sales effectiveness

ANALYSIS of the selling, general and administrative expenses of 13 electronic manufacturers for the past ten years indicates that companies are spending more for total sales, the expenditure last year reaching the highest point since 1943. But in 1952, as a percentage of net sales, which also reached record highs, sales expenses declined.

▶ **Strategy**—Selling costs have followed a fairly stable path since World War II because many electronic manufacturers allocate sales budgets by a set percentage of sales and spend more for sales when they are at a peak.

With defense cuts and tougher competition just ahead, electronic manufacturers are taking another look at this concept of tying expenditures to sales, in an effort to get more effective use out of their funds.

▶ **New Approach**—One plan for better sales spending was recently advanced by Gwilym A. Price, president of Westinghouse. He proposes a tax law that will permit companies to set up funded promotional reserves as tax-exempt costs in good years, for spending in lean years.



▶ **Price Plan**—"The tax deduction-reserve plan would overcome this normal tendency to reduce sales budgets when sales were low. Under such a plan, the Treasury would allow a company with a past history of spending on sales and market development to deduct tax-free a certain percentage of its gross. The company would spend this money for defined objectives, under approved conditions within a certain period."

Station Power Gains Extend TV Markets

IMPORTANT to televison receiver sales are existing tv markets in which stations have upped their power and increased coverage. Since June 1, 1951, over 60 tv stations have improved their facilities affecting over half the country's markets. NBC alone reports that 41 of its tv affiliates have boosted power since then.

▶ **Markets**—Although extension of coverage in terms of homes and audience is difficult to ascertain, set manufacturers agree that in old markets improved transmission by tv stations has provided a stimulant to business and has increased fringe sales just as improved tv receivers did in the past. It is estimated coverage increased 5 to 10 miles in many markets.

▶ **Future**—A number of tv stations plan power increases in the near future and have FCC okays. Applications by 19 other stations are pending approval. Markets expected to get power boosts in the near future are: Boston, WNAC-TV; Cincinnati, WLWT; Columbus, WLWC; Buffalo, WBEN-TV; Austin, Texas, KTBC-TV.

Transistor Improvement Promises Bright Future

Hermetic sealing and use of new materials may eliminate moisture and temperature bugs

STEADY PROGRESS is being made toward solving the moisture problem and other troublesome factors in transistors. In an announcement by Zenith it was revealed that that company had been unable to make transistors stand up under hearing-aid conditions. It was reported that the transistors they tried failed rapidly in service, evidently due to high moisture conditions prevalent near the body where hearing aids are normally worn.

Hermetic sealing promises to be a virtual cure-all for the moisture problem. One company, CBS-Hy-

(Continued on page 24)

Bendix Radio

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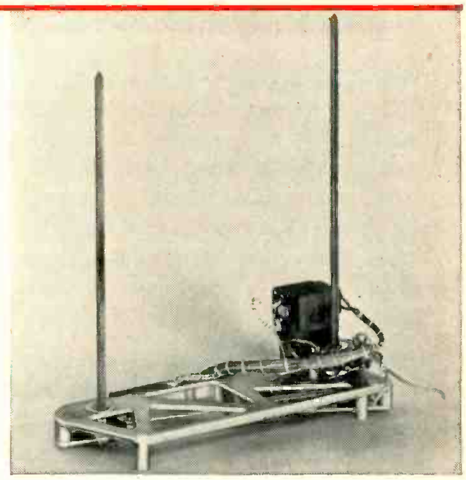

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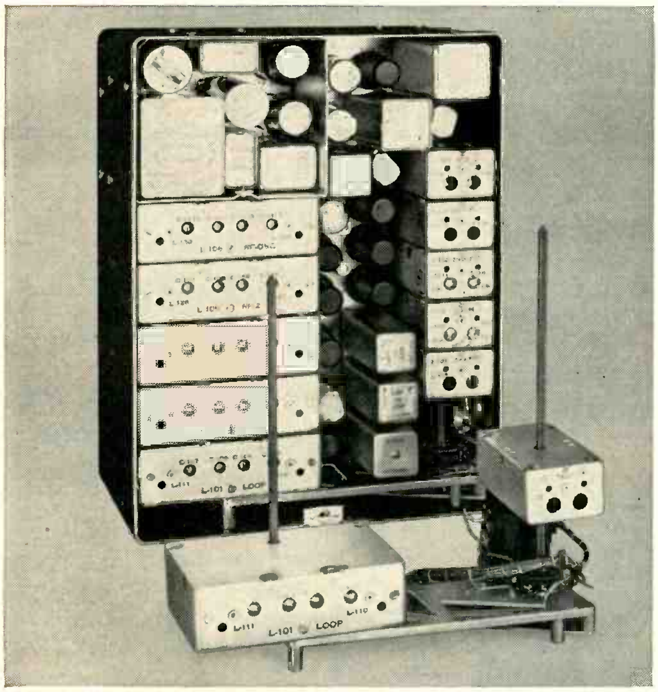

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Other Panelyte Glass Base grades include the following:

GRADE 120, Staple glass cloth, phenolic resin, heat resistance.

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GRADE 135, Staple glass cloth, silicone resin, high heat resistance.

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GRADE 601, Glass mat, polyester resin (reinforced plastic).

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tron, has already announced hermetically-sealed transistors, and several of the larger transistor makers indicate plans to do likewise in the very near future. The sealing process involves potting the transistor in a tiny (but so far costly) can equipped with a glass seal.

▶ **Other Developments**—Better and less expensive transistor materials appear to be the goal of numerous research programs, some of which are bearing fruit. Battelle Memorial Institute announced successful tests on a compound of aluminum and antimony for transistors. Preliminary tests show possibility of characteristics superior to germanium and silicon where operation at high temperatures is contemplated. A further advantage lies in the low cost of AlSb—a half ton costs about as much as a pound of germanium.

Transistor-pure silicon may also become cheaper and available in greater quantities as a result of a new manufacturing process developed by du Pont. This new source will also help raise power and temperature limits for transistors, because silicon functions as a semiconductor as high as 400 F.

Defense Contract Rules Revised

Administration jettisons broad-base procurement policy; electronics may be exception

FUTURE defense contracts will be awarded to the companies that can handle them best and cheapest and not necessarily to the firms or areas that need them most. Thus Deputy Secretary Roger M. Kyes announced a reversal of the Defense Department policy of spreading the work thin. Concurrently, the department announced that procurement would be placed in the hands of management men from industry. Presumably the Small Defense Plants Administration will expire quietly

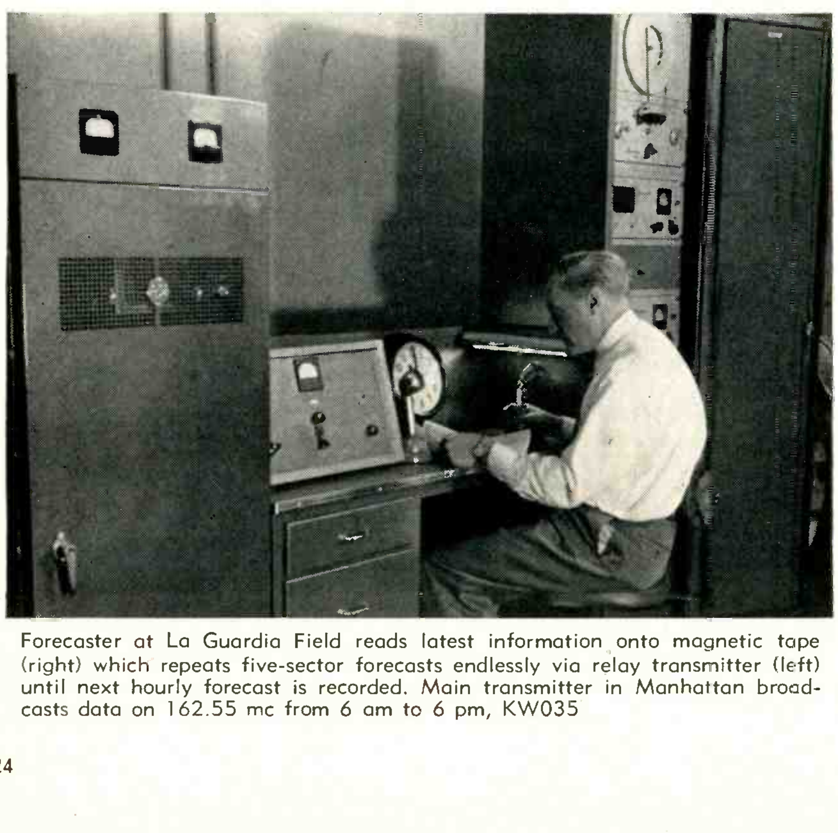
▶ **Loophole**—Electronics manufacturers will probably not be affected greatly by the new policy. Kyes stated that marginal producers may still get contracts when the item manufactured is hard to get, in short supply or where the Defense Department wishes to keep the line open. Electronic equipment generally falls into these categories.

More significant is that the former broad-base policy had little effect on the electronics industry. Much lip service was paid to aiding small business but a small business was defined as one employing 500 workers or less, scarcely called small in the electronics industry.

▶ **Broad Base**—Figures supplied by the New York office of the Signal Corps Supply Agency show that from August 1952 until March 1953 this office let $780,903.17 worth of contracts, each under $1,000. Small business received a little more than half the work.

During the same period, the small business specialist at the Signal Corps' New York office serviced 8,947 firms and assisted small business in obtaining $6,372,855 worth of contracts over $1,000.

Aviation Weather Broadcasts Save Talk



Forecaster at La Guardia Field reads latest information onto magnetic tape (right) which repeats five-sector forecasts endlessly via relay transmitter (left) until next hourly forecast is recorded. Main transmitter in Manhattan broadcasts data on 162.55 mc from 6 am to 6 pm, KW035

Radio Networks Continue to Expand

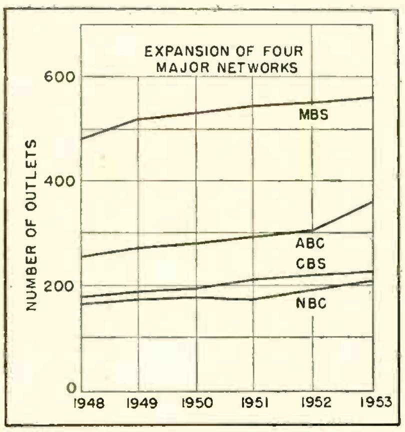
Webs are bigger than ever despite inroads of television; local sponsorship a boon

A GLANCE at the chart (next page) proves network radio is bigger than ever and apparently still growing. Latest figures give total outlets as follows: NBC, 206; CBS, 217; ABC, 355 and MBS, 562.

One reason advanced for the growth of network radio in the face of television's inroads against the listening audience is that the networks are acquiring a-m outlets primarily for television CP's. Independent a-m stations in new tv areas have found network affiliation essential. Another powerful inducement to independents is network policy of making national shows available for local sponsorship. Mutual has expanded heavily in non-tv areas and has found big-league baseball especially world-series coverage an attractive feature.

Radiomen in general seem con-

(Continued on page 26)



fident that radio and television can coexist. They point to sold-out daytime radio, increased away-from-home listening and continued popularity of several night-time shows.

Electron Art Advances Abroad

ELECTRONICS as an industry is global in its scope. No one country has a monopoly on research talent or engineering ingenuity.

▶ **International**—In a test of facilities for covering Queen Elizabeth's coronation, the British Broadcasting Company beamed a London tv show simultaneously to four European countries. Good reception was reported in West Germany, Belgium, Holland and France.

France uses both 441- and 819-line pictures, Belgium uses 819 and 625 lines while Holland and West Germany both use 625 lines.

▶ **England**—Pluggable packaged circuits are building blocks for the model-401 electronic digital computer built by Elliott Brothers, London, for the National Research and Development Corp. Packaged circuits are mass produced and computers built to order from stock.

▶ **Czechoslovakia**—Communist Czechoslovakia's first television transmitter will soon be erected near Prague. Authorities stress that the Tesla-built transmitter uses only Czech-made components. Concurrently a plant in Strasnice has announced the first line of Czech television receivers.

MEETINGS

MAY 6-JUNE 1: International Telecommunications Union Conference, Palais Wilson, Geneva, Switzerland.
JUNE 9-11: International Aviation Trade Show, Hotel Statler, New York, N. Y.
JUNE 10-20: Automation, Servomechanism and Instrumentation Exhibition, Oslo, Norway.
JUNE 11-12: IRE Professional Group On Communications Systems Symposium, AT&T Long Line Auditorium, New York, N. Y. on June 11 and Overseas Transmitting and Receiving Stations of AT&T, Lawrenceville and Netcong, N. J. on June 12.
JUNE 15-19: Exposition of Basic Materials for Industry, Grand Central Palace, N. Y. C.
JUNE 16-24: International Electro-Acoustics Congress, The Netherlands.
JUNE 20-OCT. 11: German Communication and Transport Exhibition, Munich, Germany.
JUNE 29-JULY 3: ASTM Annual Meeting, Atlantic City, N. J.
AUG. 19-21: WESCON (Western Electronic Show & Convention), IRE (7th Region) and WCEMA (West Coast Electronic Manufacturers' Association cosponsors, Municipal Auditorium, San Francisco, Calif.
AUG. 29-SEPT. 6: West German Radio and Television Exhibition, Duesseldorf, Germany.
SEPT. 1-3: International Sight and Sound Exposition, Palmer House, Chicago. Ill.
SEPT. 1-12: British 20th National Radio & Television Exhibition 1953, Earlscourt, London, England.
SEPT. 21-25: Eighth National Instrument Exhibit, Sherman Hotel, Chicago, Ill.
SEPT. 28-30: Ninth annual National Electronics Conference, Sherman Hotel, Chicago, Ill.
NOV. 9-12: Conference on Radio Meteorology, Austin, Texas.

Industry Shorts

▶ **More** than 1,000 stations now operate on CONELRAD according to FCC Commissioner Sterling.

▶ **Yakima** to Spokane microwave relay system advanced another step as Pacific Telephone Co. awarded construction contracts for buildings at 4 of the 6 relay points on the $3 million route. The system is slated for completion in December.

▶ **Radio** telescope built at Cambridge University, England, can penetrate to a distance of 6 billion light years into space, 3 times further than the 200-inch Hale telescope of the Mount Palomar Observatory in California.

▶ **Yugoslavia** is buying underwater tv equipment, for dock and harbor inspection in its Adriatic ports, from Marconi's of England.

▶ **Antenna** masts of glass-fiber reinforced plastic are under study at the Signal Corps as possible replacement for metal and plywood towers.

▶ **Digital** computer that was ordered by Armour Research Foundation of Illinois Institute of Technology from International Business Machines to supplement other computers at the Foundation's computer center has been installed and is now in operation there.

▶ **All-channel** 17-inch tv table model recently introduced by Emerson, will retail for $199.95, lowest price so far.

▶ **India's** first electronics plant is to be built by the government with the cooperation of French Compagnie Generale de Telegraphic Sans Fil.

▶ **Spain's** first television station, operated by Government-owned Radio-Nacional de Espana in Madrid, starts experimental telecasts. The tests are being transmitted to 65 receiving sets, of which 15 are owned by official government agencies. Regular daily broadcasts will begin as soon as technical problems are ironed out. Plans are for a second station in Barcelona and a third in Bilbao.

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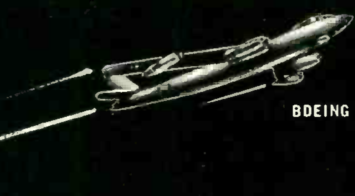

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FILTRON'S production facilities are suppying more RF Interference Filters for use in military electronic equipment than ever before, to meet the nation's requirements.

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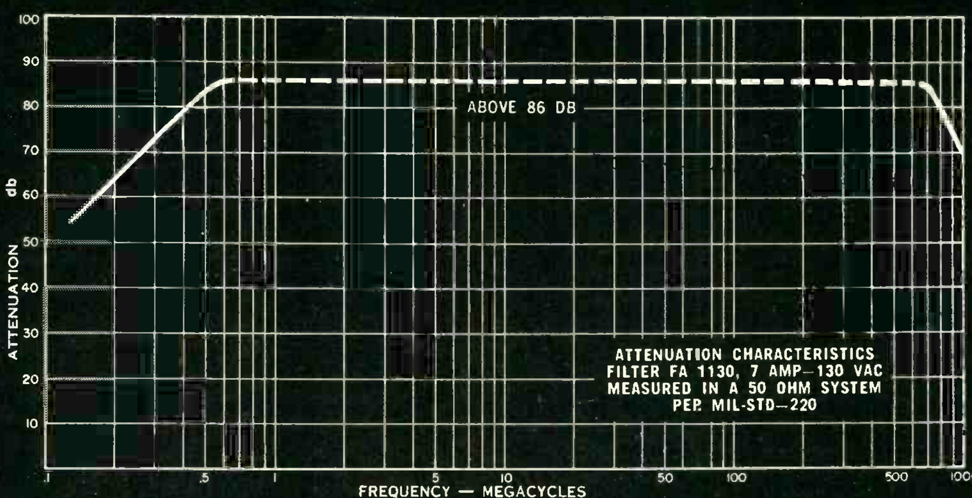

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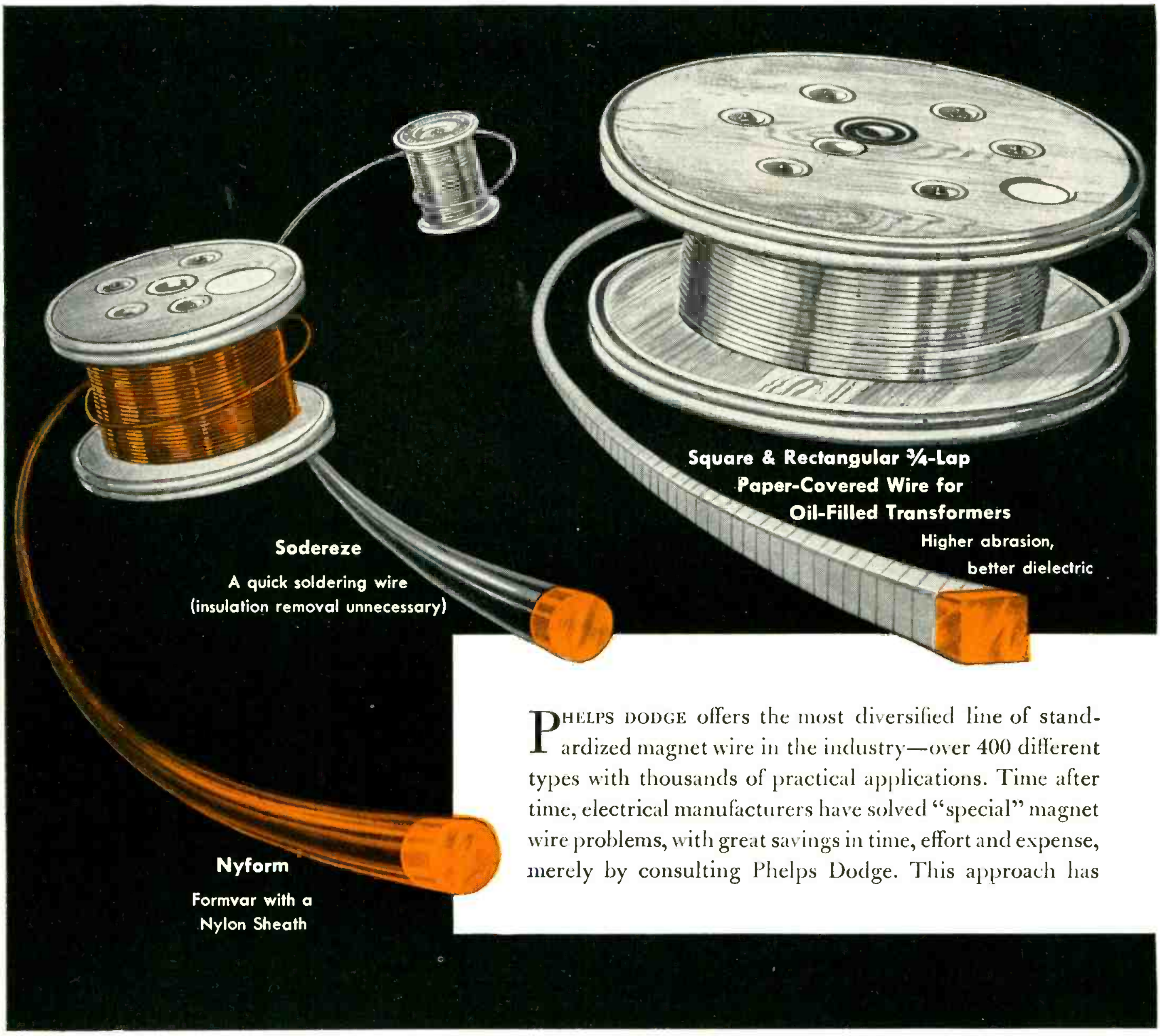

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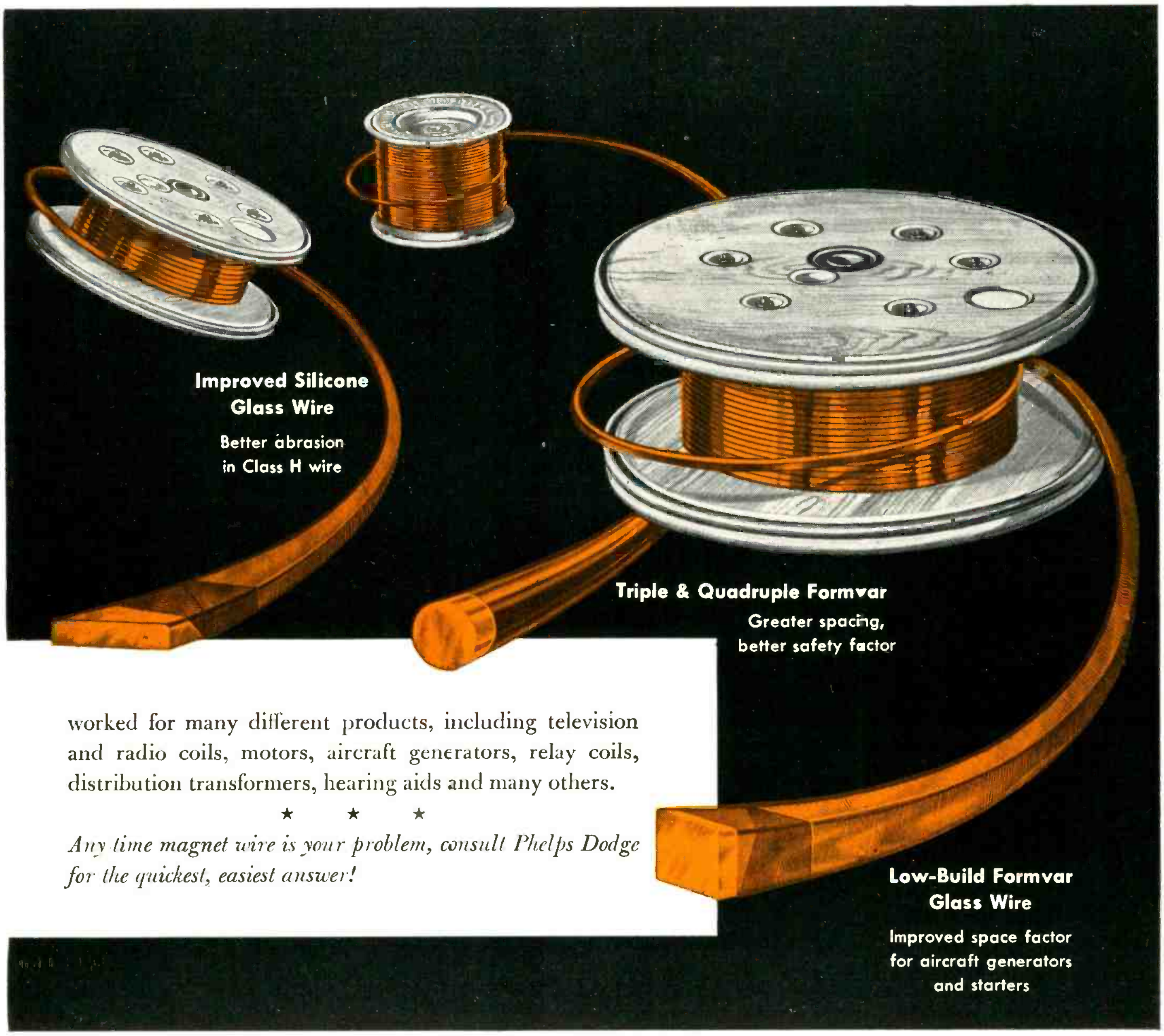

worked for many different products, including television and radio coils, motors, aircraft generators, relay coils, distribution transformers, hearing aids and many others.

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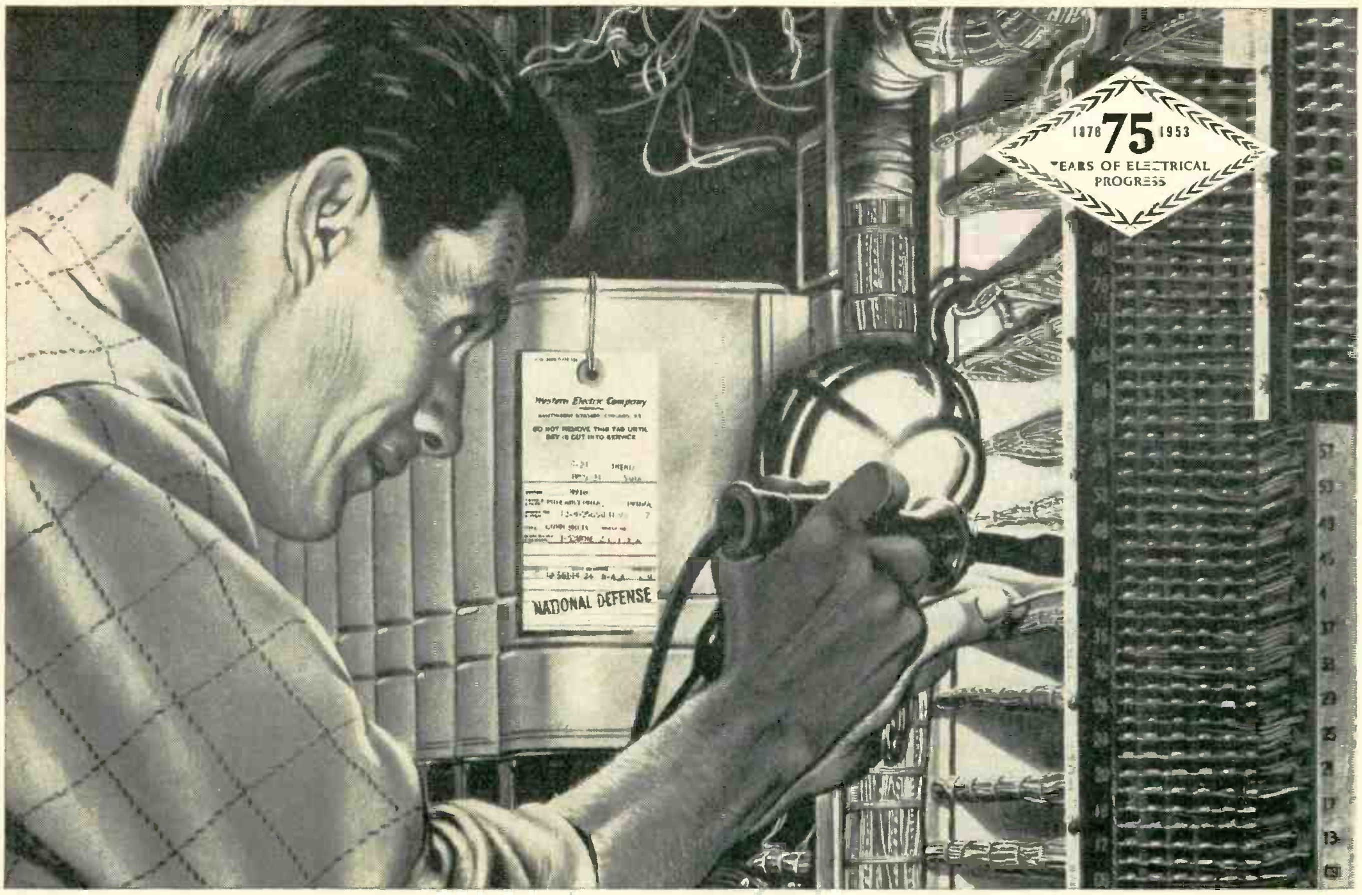

Western Electric installer in an aircraft plant connecting telephone equipment with a G-E soldering iron.

Western Electric Uses G-E Soldering Irons to Speed Vital Telephone Installations

For efficient soldering of millions of connections during the installation of telephone equipment, Western Electric uses G-E industrial soldering irons. Repeat orders testify to this company's satisfaction with G-E irons.

No matter what *your* soldering operation—intermittent or high-speed repetitive work—General Electric has the iron to meet your particular requirements. You'll find that G-E irons, equipped with the famous long-life Calrod* heating element, give you lower maintenance costs. You can choose durable, interchangeable calorized copper tips or, for even longer maintenance-free tip life, sturdy Ironclad copper tips. Ratings range from 25 to 1250 watts, tip sizes from ⅛-inch to two inches.

Give G-E industrial soldering irons a chance to prove their lower over-all costs to you. Buy a few through your nearest G-E Sales Office or Apparatus Distributor, and keep cost comparison records on their performance. You will see for yourself that these irons will save you money. General Electric Company, Schenectady 5, N. Y.

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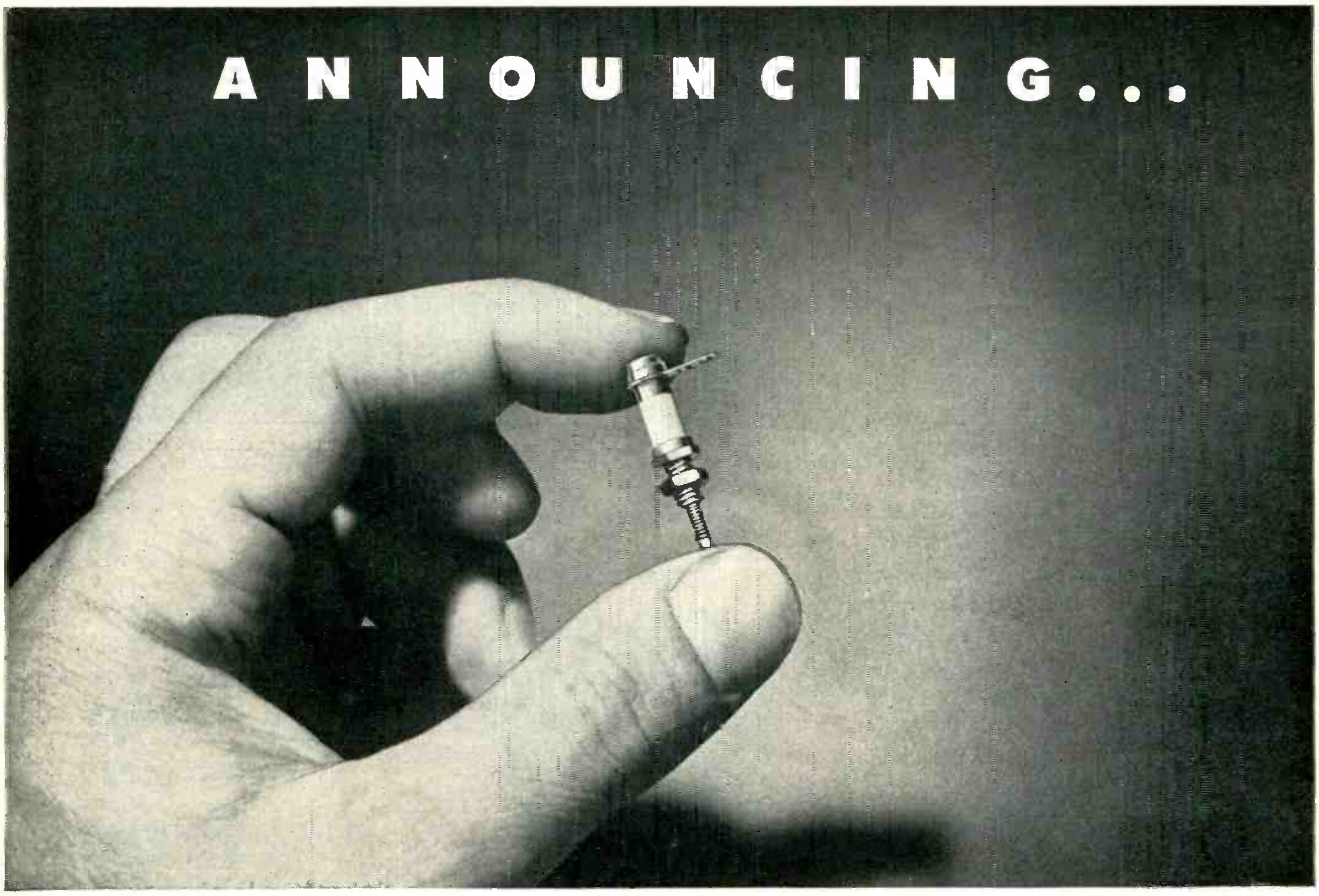
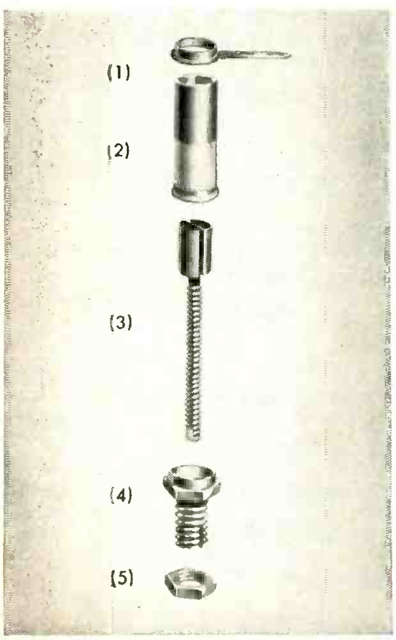


Shown approximately full size.

C.T.C.'s new CST-50 capacitor

with greatly increased range, greater stability



Exploded view of the CST-50 capacitor shows: (1) ring terminal with two soldering spaces; (2) metallized ceramic form; (3) spring-type S-shaped tuning sleeve*; (4) split mounting stud; (5) locking nut.

*Patent Applied For

Surpasses the range of capacitors many times larger in physical size.

The new CST-50 variable ceramic capacitor embodies a tunable* element of such unusual design it practically eliminates losses due to air dielectric. As a result, a large minimum to maximum capacity range (1.5 to 12 MMFD) is realized — despite the small physical size of the capacitor. This tunable* element is a spring-type, S-shaped tuning sleeve* which maintains constant maximum pressure against the inside wall of the ceramic form.

Other Design Features

The CST-50 stands only 19/32" high when mounted, is less than ¼" in diameter and has an 8-32 threaded mounting stud. The mounting stud is split so that the tuning sleeve* can be securely locked without causing an unwanted change in capacity. The tuning sleeve* is at ground potential. The CST-50 is provided with a ring terminal which has two soldering spaces.

All C.T.C. materials, methods and processes meet applicable government specifications. For further information on C.T.C. components and C.T.C.'s consulting service (available without extra charge) write us direct. Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles and 988 Market St., San Francisco, California.

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DESIGN and PRODUCTION NEWS

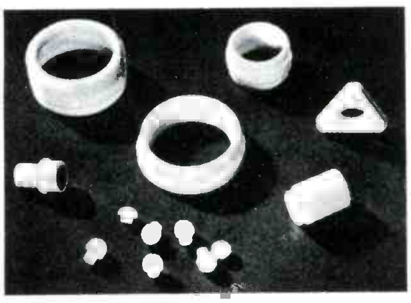
FOR ELECTRICAL AND ELECTRONIC ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company JUNE 1953

Corrosion, Moisture Interference Eliminated in Immersion Gauge

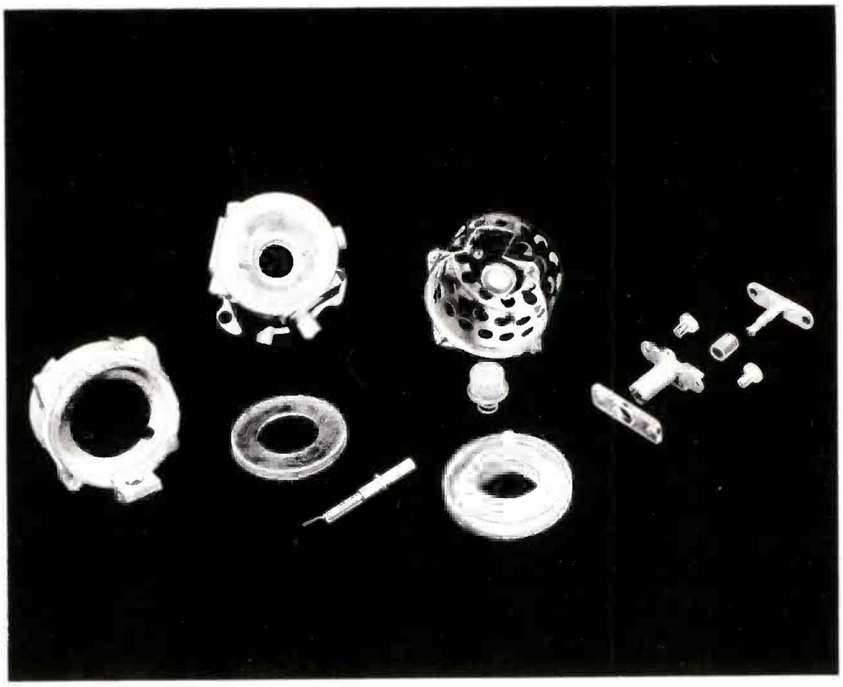
The difference between dependable "laboratory" accuracy or complete breakdown for a rugged immersion-type electronic fuel gauge may be attributed in part to its 59 machined Kel-F polymer parts, samples of which are shown here. Used primarily as dielectric insulators to isolate each of the three "probe" tubes which act as capacitor surfaces, the plastic parts are also subjected to constant vibration, corrosion from aircraft sludges and fuels, wear, and random concentrations of moisture.

The three-tube probe of the instrument which senses the weight of fuel in an aircraft tank may be completely or partially immersed at all times in volatile aircraft or jet fuel at temperatures ranging from minus 60° to 200°F. The unusual chemical inertness of the Kel-F—resisting corrosion or erosion of machined surfaces by the fuel or sludge—prevents any change in the critical spacing of .1″ between the capacitor tubes essential to accuracy in the instrument readings. Electrical isolation of each capacitor tube surface is complete due to the excellent dielectric strength of Kel-F plastic. Dependable insulation, free from surface shorting or grounding caused by moisture or residues found in the fuel, is assured by the zero water absorption and non-stick characteristics of Kel-F.



The precision insulating parts required for this electronic instrument are produced by the Tri Point Manufacturing Company of Brooklyn, N.Y. Tri Point uses rod and tubing extruded from Kel-F polymer and then machines the necessary parts on standard automatic screw machines. The ready machinability of Kel-F permits this company to maintain tolerances within .001″ on all parts supplied to the Aviation Engineering Corporation of Woodside, N.Y., manufacturers of this aircraft instrument.

Refer to Report E-108



KEL-F® in UHF Pulse Cavity Insulates Against 3500 V, Under High Shock and Vibration Loads...100% Humidity

The UHF pulse cavity assembly, shown above, utilizes insulating parts and circuit supports of Kel-F polymer to increase cavity efficiency in radar and other communications equipment. The excellent dielectric strength of Kel-F at low and high frequencies prevents both leakage of 3500 V pulses and radiation of RF signals from the unit. Efficiency is further boosted by the high arc resistance of the polymer.

Both ultimate operation and assembly phases of this cavity benefited because of the unusual mechanical properties of Kel-F trifluorochloroethylene polymer. The toughness—resiliency and high compressive strength—of the plastic allowed standard mounting methods to be used without danger of the plastic cracking or chipping. The exceptionally low "cold flow" of Kel-F assures that mounted parts will remain firmly in position, preventing misalignment. During operation, at temperatures from minus 60° to 200°F., molded parts effectively withstand shock loads of 1200 foot pounds without failure. Additional stress from sustained vibration of 10 G's, encountered in certain services, is taken in stride by the plastic without development of brittleness or loosening of mounts.

Shelley Products Limited, custom molders of Huntington Station, N.Y., supplied the Kel-F polymer parts illustrated to the Radio Receptor Company, Inc. of New York, N.Y. the firm which manufactures this cavity unit for the Armed Services. Using Kel-F trifluorochloroethylene polymer molding powders, Shelley Products readily injection-molded the required parts to specified tolerances. The use of Kel-F polymer for these parts resulted in a lower unit cost, as compared to similar materials, due to the ease with which Kel-F could be fabricated.

In addition to the excellent dielectric and mechanical properties of Kel-F, this polymer's unusual zero water absorption and "non-stick" properties serve to extend the application of this unit. The zero water absorption of Kel-F precludes efficiency loss through surface shorting, leaks or "tracking" caused by moisture. This property, combined with the "non-stick" characteristic of the polymer, prevents the accumulation of conductive residues or fungus growths, cause of shorting in tropic climates.

Refer to Report E-109

(SEE REVERSE SIDE)

® Registered trademark of The M. W. Kellogg Company's trifluorochloroethylene polymers.

KEL-F
TRIFLUORO CHLORO ETHYLENE POLYMERS
KEL-F
MOLDING POWDERS
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FLUORO CHLORO CARBON PLASTIC
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KEL-F
OILS WAXES GREASES

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

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MOLDING POWDERS

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DISPERSION COATINGS

KEL-F

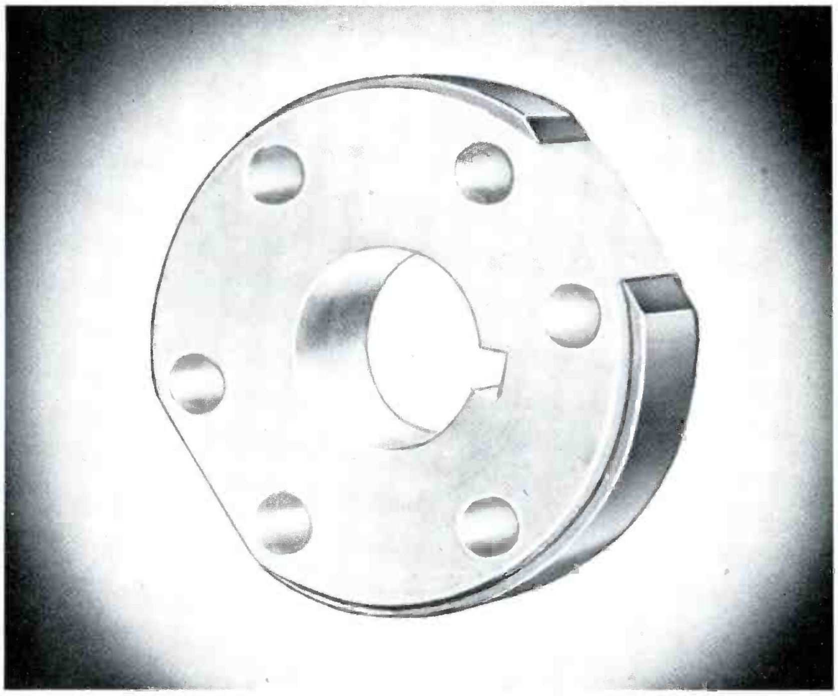
TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

OILS WAXES GREASES

DESIGN and PRODUCTION NEWS

CONTINUED FROM PRECEDING PAGE



Switch Rotor of KEL-F® Takes Rough Handling, 75 Amp Current Surges, Ignores Oils and Greases!

This injection-molded Kel-F polymer switch rotor with copper pole pieces withstands the impact of 75 amp. starting currents needed to propel electrically-powered heavy duty plant trucks. Because of the high dielectric strength of Kel-F, insulation is complete, and full power is transmitted to the drive-motor. Even after countless starts and stops during the course of a working day, positive switching action is assured. At the elevated temperatures generated, the excellent dimensional stability of Kel-F prevents the rotor from softening and allowing the pole pieces to loosen or part from the switch shaft . . . and the polymer's high heat resistance eliminates any chance of plastic breakdown or carbonization which cause arcing.

The high impact resistance and compressive strength of Kel-F are responsible for the rotor's ability to withstand the heavy pounding given by over-zealous operators . . . without chipping, cracking or embrittlement of the plastic. Leakage of lubricating oils and grease also caused by rough handling has no visible effect on the chemically inert plastic. Shorting of the 75 amp. current across the insulation, common with other materials during periods of high humidity, can not occur with Kel-F because of the zero water absorption of the polymer. This latter property also precludes the formation of fouling fungus growths when trucks are stored in damp locations.

Electronic Mechanics, Inc., of Clifton, N.J. injection molds the rotor, with its two copper poles, in a single operation on a standard molding machine, supplying the complete switch rotors to a major producer of materials handling equipment. Maximum bonding surface between the copper pole pieces and the plastic rotor body is provided by grooving the inner surface of each metal part. Provisions are made in the mold for the shaft hole and key way, so that the only finishing required prior to use is removal of the sprue.

Refer to Report E-110

Get the Whole Kel-F Story at the Basic Materials Show!

The largest and most complete exhibit of Kel-F polymers and finished products ever displayed—that's Kellogg's Booth 56 at the Basic Materials For Industry Exposition, June 15 through 19 in New York City. At the new exhibit you will be able, in a few moments, to acquaint yourself with the extremely wide scope of application of Kel-F molding powders, waxes, greases, oils and dispersion coatings. And, you'll be able to obtain the latest technical data on Kel-F as well as examine more than 125 Kel-F polymer products on display.

Make a point to visit the Kel-F polymer exhibit . . . June 15-19.

Molders of the Month

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

American Molding Company
San Francisco, Calif.
Injection Molding
Electronic Components

Federal Telecommunication Laboratories, Inc.
Nutley, N. J.
Insulated Wire, Tubing

Garlock Packing Company
Palmyra, N. Y.
Gaskets, Packings, "O" Rings
Injection, Compression Molding

H. & R. Industries
Nazareth, Pa.
Extruded Rod, Tubes, Shapes
Injection Molding

Kurz-Kasch, Incorporated
Dayton, Ohio
Compression Molding
Plunger Molding

W. S. Shamban & Company
Culver City, Calif.
Extrusions, Rods
Injection Molding
Compression Molding, "O" Rings
RF Sealing of Film

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

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Announcing

for UHF-TV EIMAC 15 kw KLYSTRONS

Easily handled, this 3K50,000LK klystron weighs only 37 pounds.

● TOP POWER
● EASY TUNING
● LIGHT WEIGHT
● THREE TUBES COVER ALL UHF-TV CHANNELS

EIMAC TYPE 3K50,000L KLYSTRONS give UHF-TV a transmitting tube with high power and light weight, high performance and economy along with the advantages that go with mass production, external tuning and ceramic cavities. In typical UHF-TV operation the new klystrons have a linear peak sync output of 12 kw.

3K50,000LA — channels 14-32
3K50,000LF — channels 33-55
3K50,000LK — channels 56-83

Eimac REG. U.S. PAT. OFF. TUBES

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

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PLASTIC TAPE ends breakdowns on this vital nervous system!

Men's lives may depend on it— that's why "Scotch" Plastic Electrical Tape No. 33 harnesses this wiring for precision Naval equipment. And the contractors for the job, Belock Instrument Corp., College Point, N. Y., find the tape gives them *more* than dependable results—*more* than complete protection against moisture, fungus and abrasion.

They find "Scotch" 33 easier and faster to apply. Personnel can be quickly trained. Harnessing time is cut one third.

Try it yourself and see! See how it sticks tight right off the roll, how it conforms smoothly to odd shaped joints and fittings, how so little goes so far. In several standard widths and lengths. Order "Scotch" 33 from your supplier today!

FREE! **POCKET TAPE CALCULATOR** quickly figures total quantity of "Scotch" Electrical Tape needed for production operations. Includes data on 23 "Scotch" Brand tapes. Write Minnesota Mining & Mfg. Co., Dept. ES-63, St. Paul 6, Minnesota.

SCOTCH BRAND
Electrical Tape No. 33

FLAT PRESS

HEATER-CATHODE TUBE NEWS

RAYTHEON

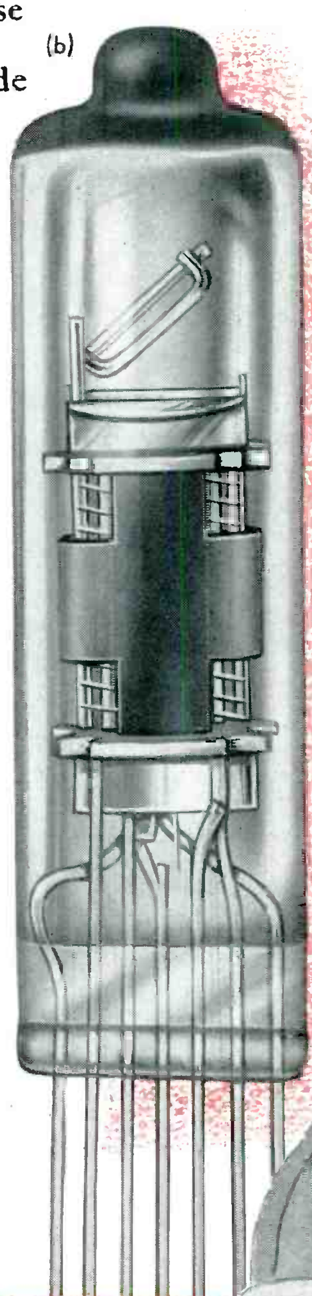
RAYTHEON

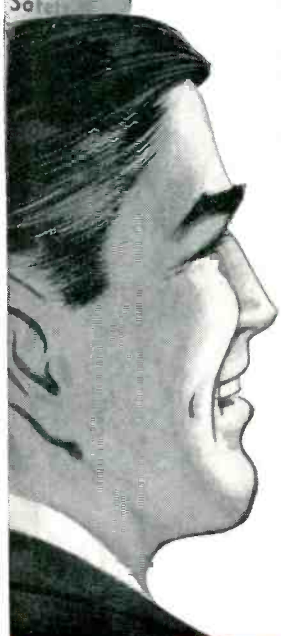
EXTRA

EXTRA

You get all these "extras" when you use Raytheon Flat Press Heater-Cathode Subminiature Tubes:

1. Higher Plate Voltage Ratings
2. Wider Heater Voltage Ratings
3. Superior Low Heater Voltage Performance
4. Lower Thermal and Shot Noise
5. Higher Ambient and Bulb Temperature Ratings
6. Lower Vibrational Noise Output
7. Longer Shelf Life
8. Reduced Air Leakers — Longer Dumet Seal (a)
9. Molded Tips (b)





Data sheets for these Tubes and information on other Raytheon Subminiature Tubes may be obtained from your nearest Raytheon Tube Distributor or from any of the Raytheon offices listed below.

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Receiving Tube Division — for application information call

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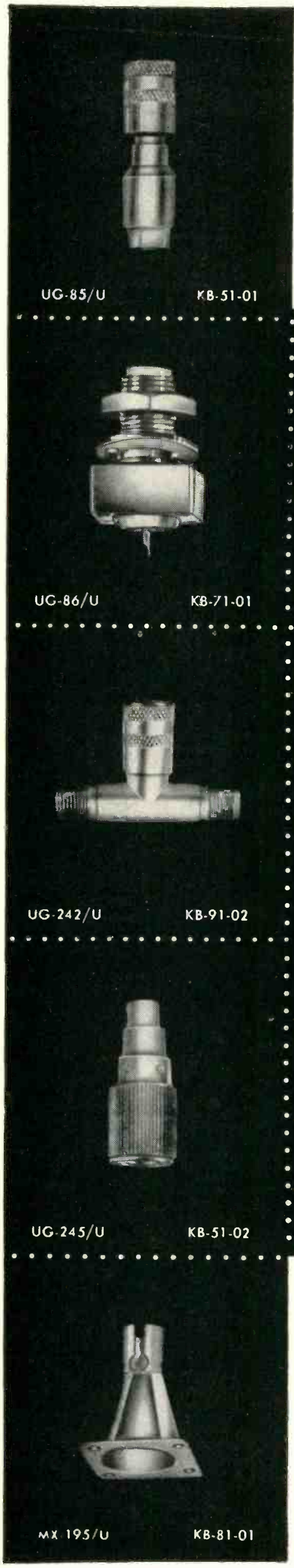
BN
CONNECTORS BY KINGS



BN Connectors are small, lightweight connectors designed for use with small cables such as RG-55/U, RG-58/U and RG-62/U. They are widely used for Video, I. F., Trigger Pulse and Low-Power R. F. applications.

During its many years of collaboration with our Armed Forces, Kings has developed engineering skills and production know-how that have won them "top-priority" with radio and electronic engineers everywhere. Constant research and rigid quality control are responsible for the increasing demand for Connectors by Kings.

Our fully-staffed engineering department is ready to serve you promptly and skillfully. You'll be glad you called on Kings first.

KINGS Electronics CO., INC.

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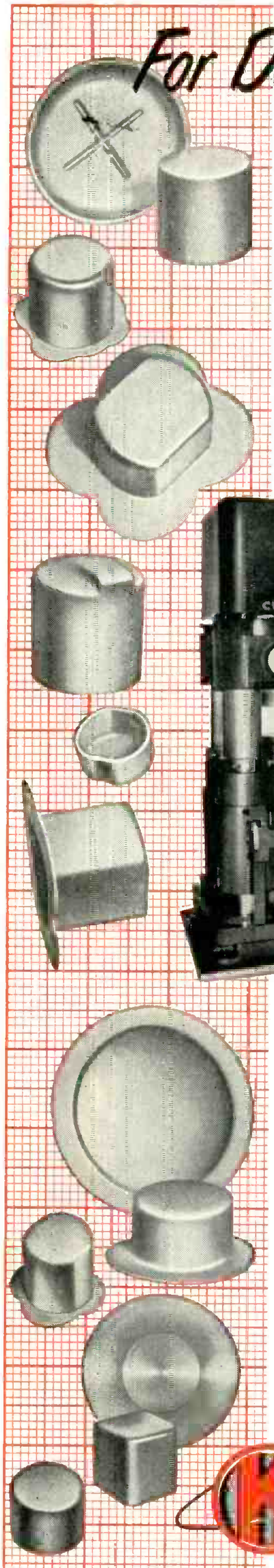

–on "short run" metal forming and drawing

HYDROFORMING sharply reduces tooling time...costs—new process speeds delivery

Kaupp provides design and project engineers an economical and quick method of obtaining short run development pieces. Punch and nest ring are the only tools required . . . rubber diaphragm backed by hydraulic oil acts as the die member of the tool. Perfect surfaces are assured. Less time is consumed in tool making, therefore tooling costs are considerably lower. Contact us on your next short run order . . . hydroforming by Kaupp will save you time and money!

Punch and nest ring are the only tool requirements as hydraulic oil functions as the die member.

PRECISION FORMING AND DRAWING OF STAINLESS STEEL, INCONEL, ALUMINUM, COLD ROLLED STEEL, COPPER, BRASS, AND OTHER ALLOYS IN 1/32 SHEETS TO 3/8 PLATES.

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Ferramics offer many outstanding advantages. These widely adopted magnetic core materials have reduced assembly time by eliminating laminations in inductive components, cut costs and reduced space requirements by replacing tubes in digital computers, and revolutionized microwave transmission design by use of gyrator effect. Ferramics have improved designs in numerous other equipments, and have resulted in the development of basically new techniques in still others. Current research indicates still greater gains to come. The complete story on Ferramics is available without obligation.

TABLE OF MAGNETIC PROPERTIES OF FERRAMICS

PROPERTIES	UNIT	A-106	B-90	C-159	D-216	E-212	G-254	H-419	H1-1102	I-141	J-4[illegible]
Initial Perm. at 1 mc/sec	—	20	95	250	410	[illegible]	415	850	550	900	[illegible]
*Max. Perm.	—	100	133	1100	1033	[illegible]	3360	[illegible]	3800	3000	[illegible]
*Sat. Flux Density	Gauss	[illegible]	[illegible]	[illegible]	3100	3300	3200	[illegible]	2800	2000	[illegible]
*Residual Mag.	Gauss	1063	330	2700	[illegible]	[illegible]	1650	[illegible]	1500	700	[illegible]
*Coercive Force	Oersted	[illegible]	3.0	2.1	[illegible]	.65	.25	.18	.35	.30	.80
Temp. Coef. of initial perm.	%/°C	[illegible]	.04	.40	.30	.25	13	.66	.80	.30	.22
Curie Point	°C	[illegible]	240	330	165	[illegible]	160	150	125	70	180
Vol. Resistivity	ohm-cm.	[illegible]	[illegible]	2x10⁶	5x10⁷	4x10⁵	[illegible]	1x10⁴	2x10⁴	[illegible]	5x10⁷
Loss Factor: At 1 mcs/sec	—	.0005	.00016	.00037	.00005	.00008	[illegible]	.00030	.0004	[illegible]	.000055
At 5 mcs/sec	—	[illegible]	.0011	.0008	[illegible]	.002	[illegible]	.00155	.001	[illegible]	.0004

*Measurements made on D.C. Ballistic Galvanometer with Hmax = 25 oersteds. Above data based on nominal values

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The General Ceramics technical staff will be happy to consult with you. Just call or write Sales Engineer, Ferramics Division.

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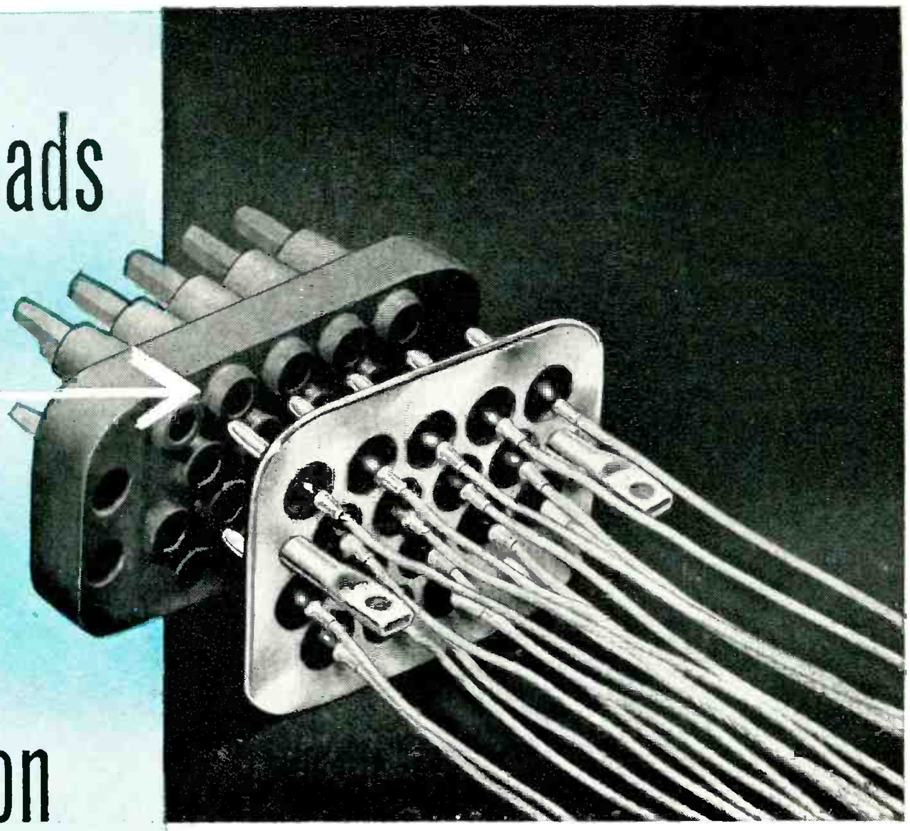
flexible leads built into multiple headers by Sealtron



NOW—eliminate difficult soldering in "close quarters"—save space

Sealtron welds flexible lead wires right into multiple-pin "Header" connectors to eliminate the "close-quarters" soldering operation formerly needed to connect leads. Now all you do is slip "spaghetti" sleeving over the flexible lead and connect directly into your electronic assembly.

Sealtron "built-in" leads meet AN specifications—eliminate space-taking mechanical attachments required with soft-soldered connections. This means the flexible leads take up as little as 3/32″ on the back of the panel (see drawing), save valuable space where miniaturization is essential.

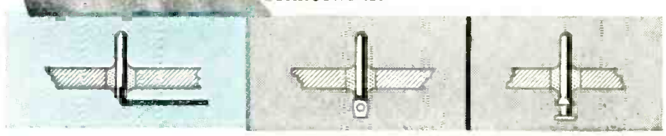
Sealtron Multiple Headers can be incorporated into any panel or chassis requiring multiple connections, fit standard receptacles. Supplied cadmium, tin or silver-plated; available with any number of pins. If required, Sealtron engineers will design and build special multiple headers to suit your needs.

Write today for full information.

"Here's how Sealtron 'builds-in' leads to **SAVE SPACE**"

First, lead wire is permanently butt-welded to pin. Then electrode with lead wire attached is "fired" directly into header plate forming a hermetically perfect seal.

RESULT — weld is imbedded in glass so that wire can be bent at sharp right angles. Uses 1/16″ less space than FP connections, 3/32″ less space than TH connections.



"Built-in" welded connection—showing lead wire bent at sharp right angle.

FP or Flattened-Pierced Connection

TH or Turret Head Connection

(Mechanical connections required with soft-soldered leads)

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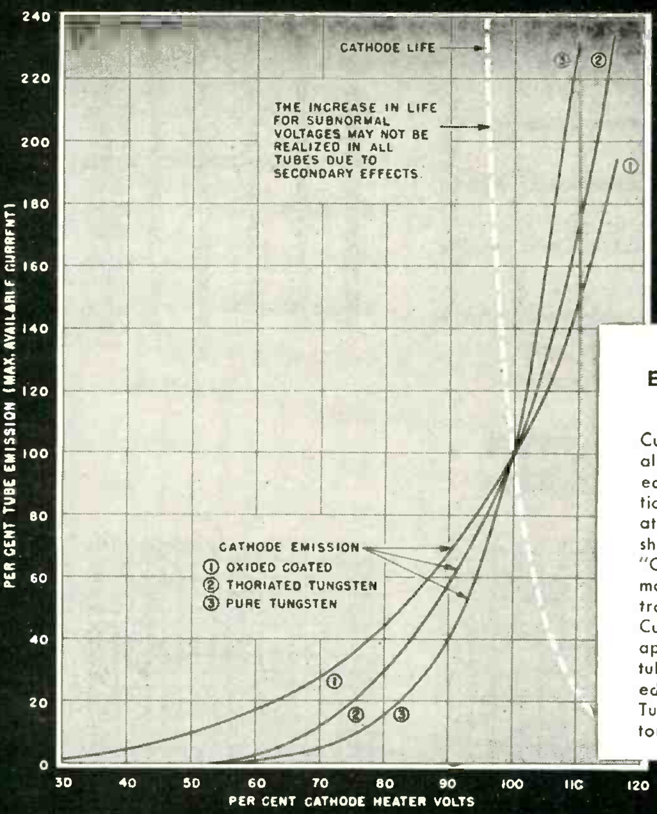
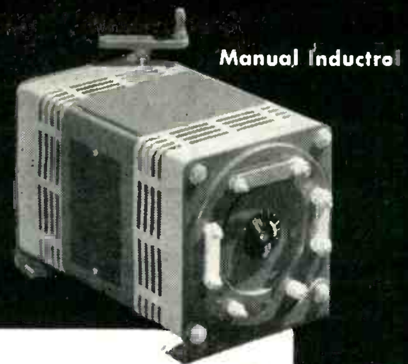
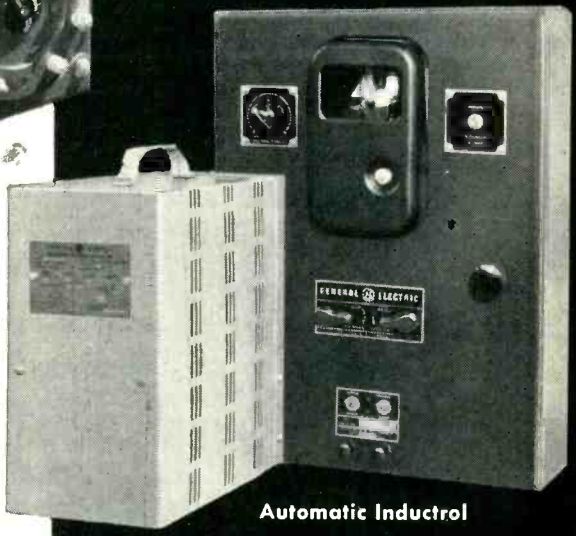




1878 75 1953 YEARS OF ELECTRICAL PROGRESS

ELECTRONIC TUBE-LIFE VS. VOLTAGE

Current-carrying ability of all electronic tubes is affected seriously by voltage deviation. The loss of emission at undervoltage results in shorter tube life. Curve 1 "Oxide Coated" applies to most of the thyratrons, pliotrons and receiving tubes. Curve 2 "Thoriated Tungsten" applies to small transmitter tubes and some battery-heated tubes. Curve 3 "Pure Tungsten" applies to oscillator tubes.



For maximum tube life and performance, include G-E Inductrols as "original equipment"

Automatic voltage regulation provides an effective and economical means of avoiding losses in power capacity

The life and efficiency of the electronic equipment you manufacture depends, to a large extent, on the performance of the electronic tubes. Tube life is adversely affected by over- or under-voltage conditions *that can easily be prevented.*

G-E dry-type induction voltage regulators, called Inductrols, offer you an effective and economical means of maintaining correct operating voltage. Two types are available for indoor service on circuits 600 volts and below, single-phase 3 to 240 kva; three-phase 9 to 520 kva.

1. **Automatic** Inductrols maintain a closely regulated output voltage from a varying supply voltage with a bandwidth of ±1%. The standard range of regulation is plus and minus 10%.
2. **Hand-operated or manually controlled motor-operated** Inductrols provide a variable output voltage from a relatively constant supply voltage. They supply 100% raise and 100% lower regulation.

You can put your confidence in—

GENERAL ELECTRIC

Typical applications for G-E Inductrols that have proved highly effective include: radar equipment, induction heating equipment, medical and industrial x-ray equipment, TV and radio transmitters.

For further information, contact your nearest G-E sales office, agent or distributor...or return the attached coupon.

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For full details on dry-type induction voltage regulators, return this coupon . . . today!

Single-phase INDUCTROLS, indoor service 600 volts and below on circuits 3 to 240 kva—GEC-795A ☐

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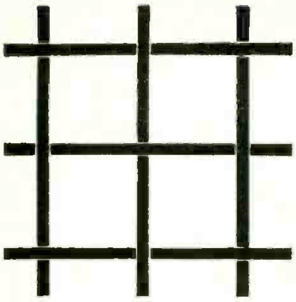
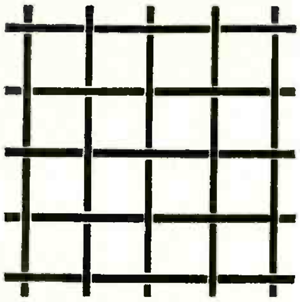
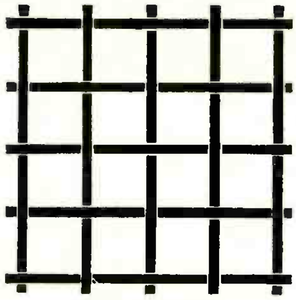


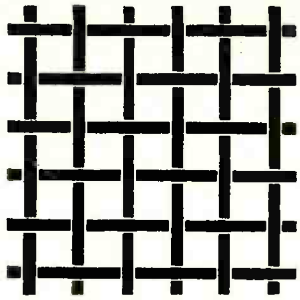
2 Mesh .063″
76.4% Open Area



3 Mesh .041″
76.7% Open Area

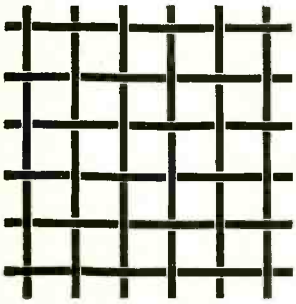


3 Mesh .054″
70.1% Open Area

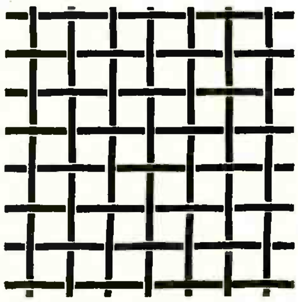


4 Mesh .063″
56.0% Open Area

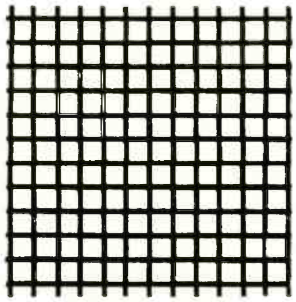
CALL CHASE



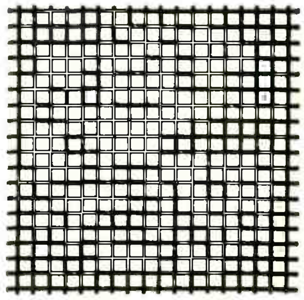
4 Mesh .047″
65.9% Open Area



5 Mesh .041″
63.2% Open Area

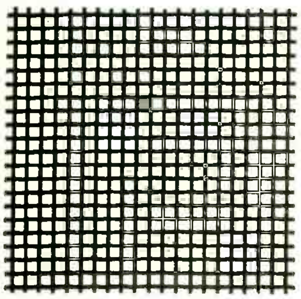


8 Mesh .028″
60.2% Open Area

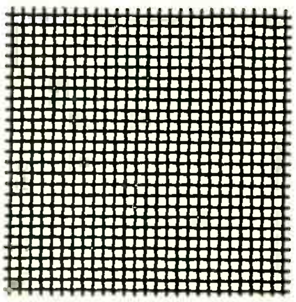


12 Mesh .023″
51.8% Open Area

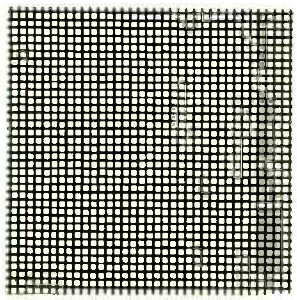
FOR INDUSTRIAL WIRE CLOTH



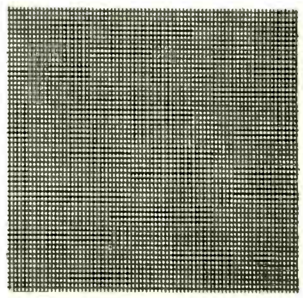
14 Mesh .020″
51.0% Open Area



18 Mesh .017″
48.3% Open Area



24 Mesh .0135″
45.8% Open Area



50 x 40 Mesh .009″
35.7% Open Area

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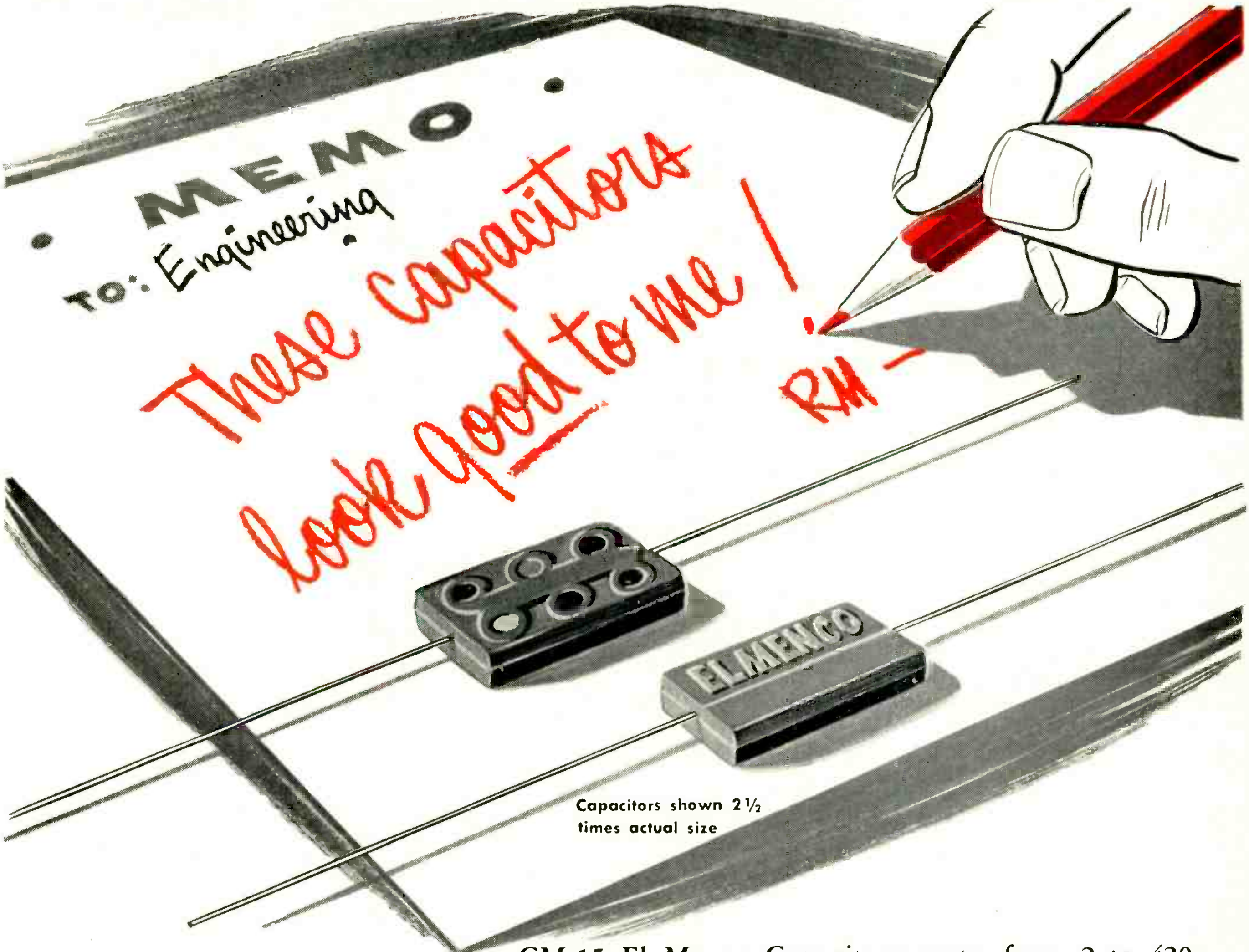

Capacitors shown 2½ times actual size

CM-15 El Menco Capacitors range from 2 to 420 mmf. at 500 vDCw . . . measure only 9/32″ x ½″ x 3/16″ . . . but they're

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ALL fixed mica El Menco Capacitors are *factory-tested at double their working voltage.* So, you can be sure they'll stand up. They also meet all significant JAN-C-5 specifications. This means that you can specify them with confidence for all military or civilian electronic applications.

Our Type CM-15 silvered mica capacitors reach 525 mmf. at 300 vDCw. Our other types — silvered and regular — provide capacities up to 10,000 mmf. Want samples for testing? *The Electro Motive Manufacturing Co., Inc., Willimantic, Conn.*

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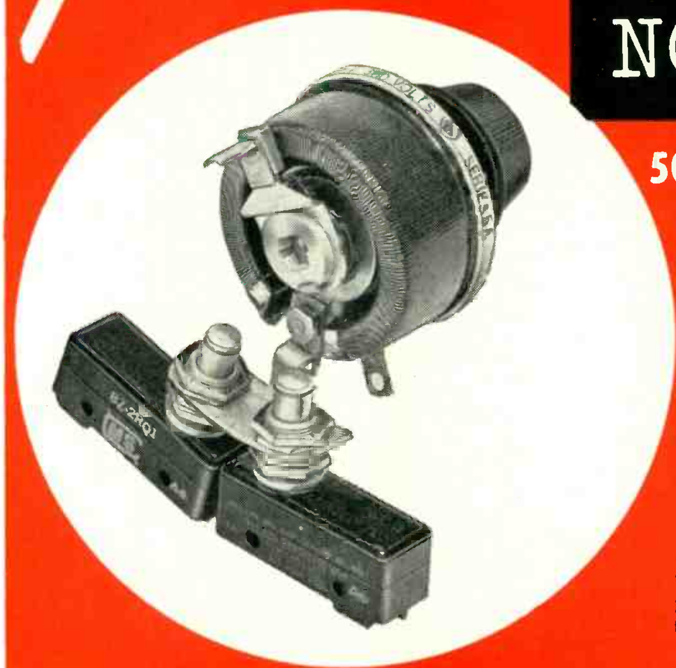

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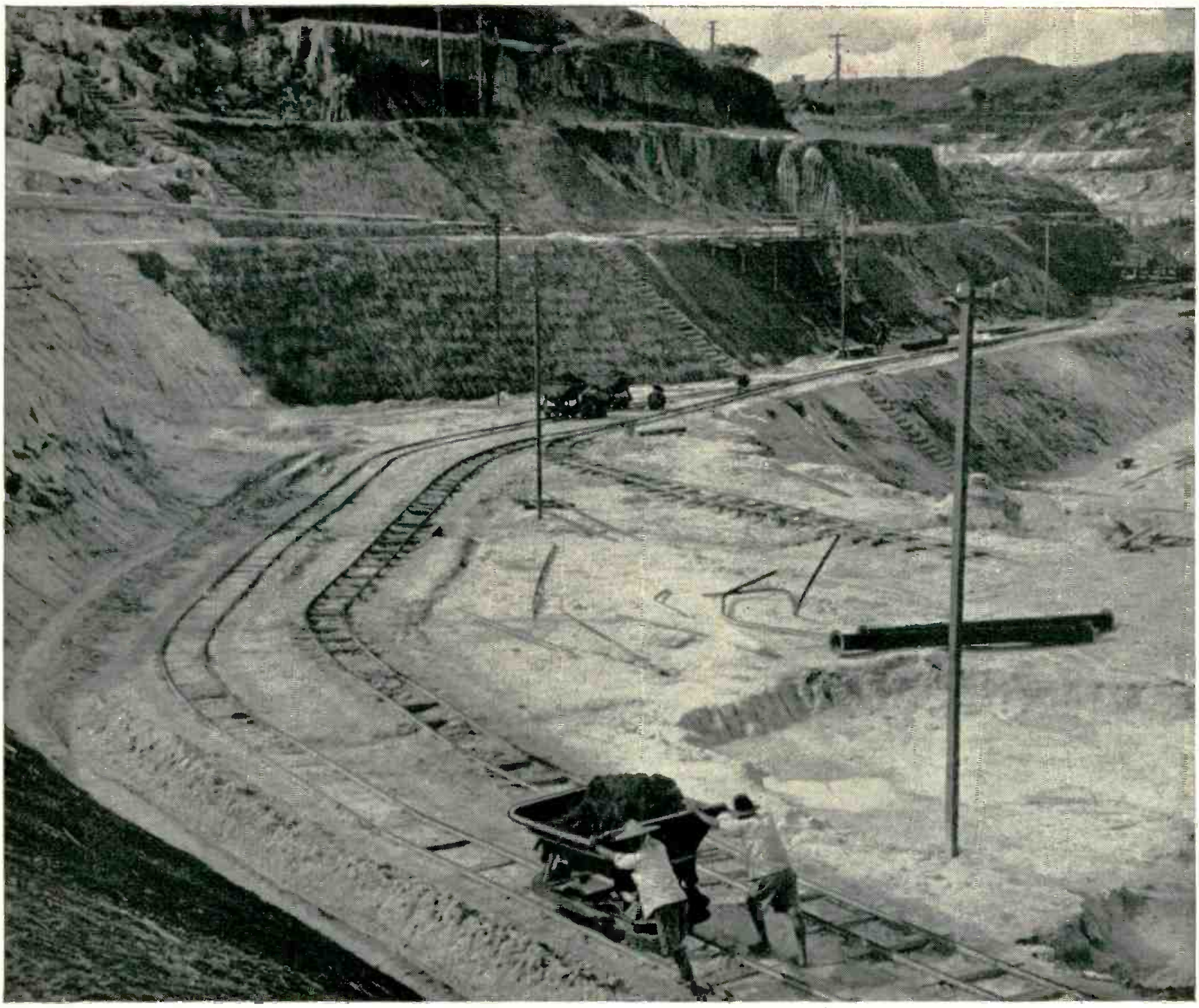

They're starting to make a TV set

You're looking at a picture of a Malayan open-pit tin mine—one of the world's largest.

Next time you look at the picture on your TV screen, remember it wouldn't be there without tin from mines like this.

Without tin for solder, most electrical and electronic equipment would be useless tangles of disconnected wires.

Without tin for cans and closures, much of the nation's food supply for our rapidly growing population would be lost.

Without tin for bearing metals, the wheels of industry could not turn so smoothly and efficiently.

And in new alloys and chemical compounds tin is becoming continually more valuable as an industrial material.

Over a third of the world's tin is mined in Malaya. No end is in sight, geologists say, to Malaya's important reserves. And now that U.S. Government controls on tin have ended, this time-tested metal is again freely available in this country to *any* user, in *any* quantity, for *any* purpose, and an adequate supply for the future is assured.

A free and stable market for tin is important to the economy and security of the United States, Malaya and, in fact, the entire Free World. And by steadily winning its war against Communist guerrillas, Malaya has materially strengthened its position as the world's most important supplier of tin for the needs of the United States.

Remember, no other metal combines all the properties of tin. Tin is inert, nontoxic, friction and corrosion resistant. Tin is highly malleable, second only to gold. Above all, tin is economical to use. A little tin can do a lot of work.

This is the time to investigate thoroughly the ways it can work for you.

TIN NEWS, issued monthly, covers noteworthy current developments in the production, marketing and use of tin. Write for free copy.

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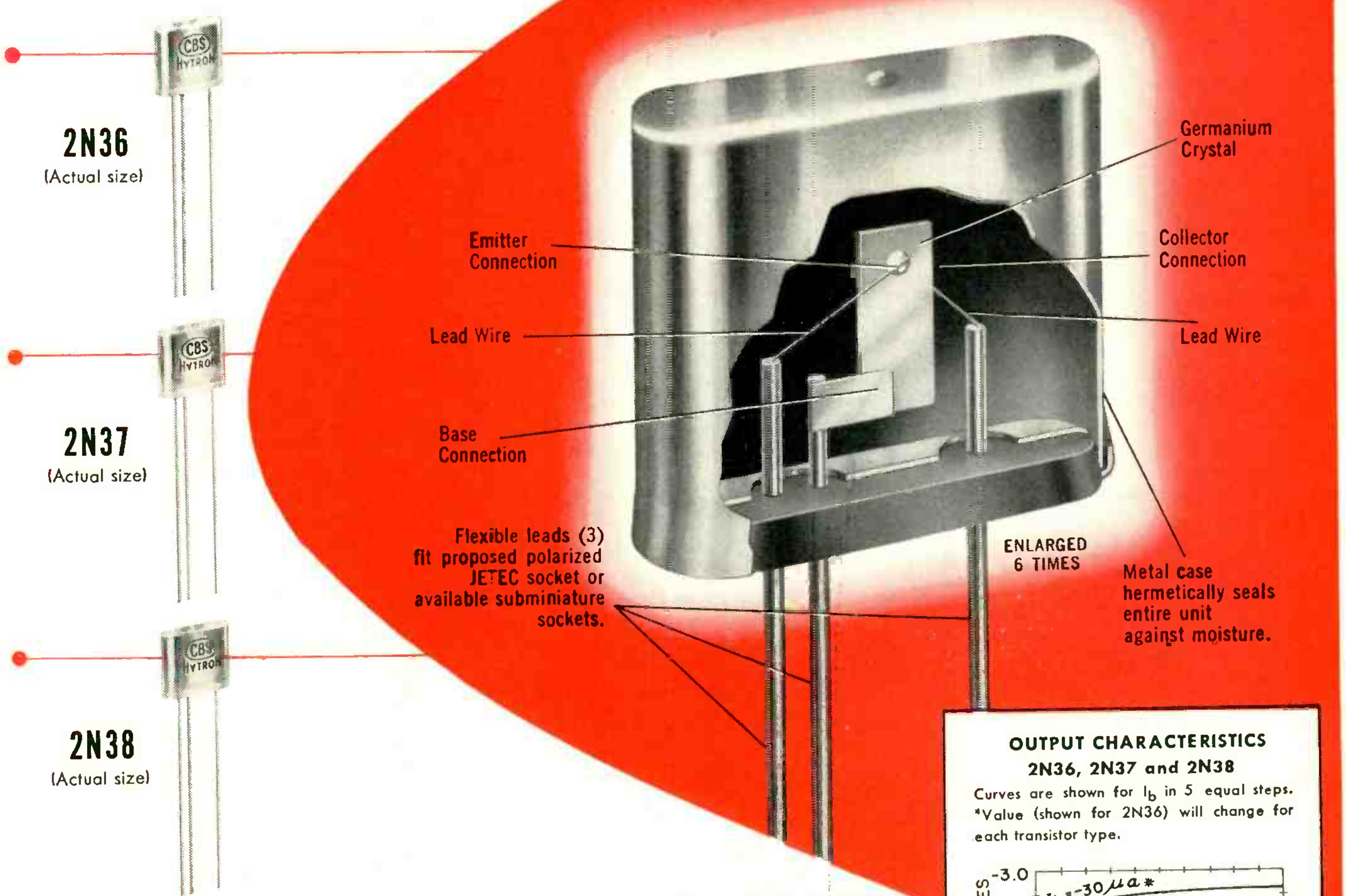
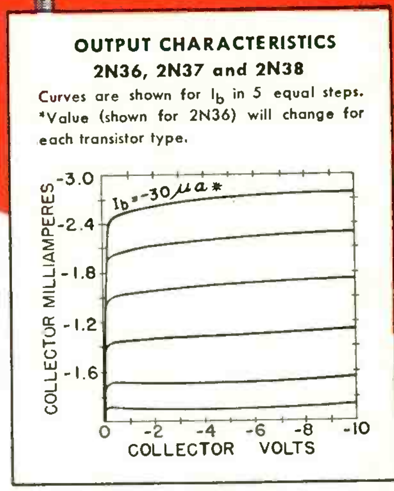




NOW...HERMETICALLY SEALED CBS-HYTRON JUNCTION TRANSISTORS

In junction transistors, the surfaces are extremely sensitive to moisture. For dependability, they must be completely moisture-proofed. CBS-Hytron, recognizing this, is the first to offer you the new *hermetically sealed* 2N36, 2N37, and 2N38 junction transistors. Each is uniquely sealed in a metal case . . . moisture-proof, contamination-proof, light-proof. (See drawing.)

You can buy these new hermetically sealed P-N-P junction types immediately. All are amplifier types. Have similar characteristics, except for current amplification and power gain. You may operate the 2N36, 2N37, 2N38 up to 55°C. Their in-line design gives you: Compact, flat mounting . . . easily identified polarity . . . solder-in or plug-in (with clipped leads) convenience.

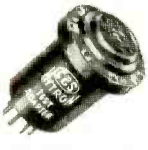
In addition to their unique moisture-proof feature, these CBS-Hytron junction types offer: (1) High gain. (2) Low noise figure. (3) Operation at low voltages. As well as other advantages characteristic of transistors: Compactness . . . light weight . . . ruggedness . . . instantaneous operation . . . and long life.

Remember, CBS-Hytron hermetically sealed 2N36, 2N37, 2N38 transistors are available at once. Write for complete data. Or order now for prompt delivery.

ELECTRICAL CHARACTERISTICS†
CBS-Hytron P-N-P Junction Transistors

Characteristic	2N36	2N37	2N38	
Collector voltage	—6	—6	—6	v
Collector current	—1	—1	—1	ma.
Current amplification factor #	45	30	15	
Power gain #	40	36	32	db

†Typical values at 25°C. #Grounded emitter connection.



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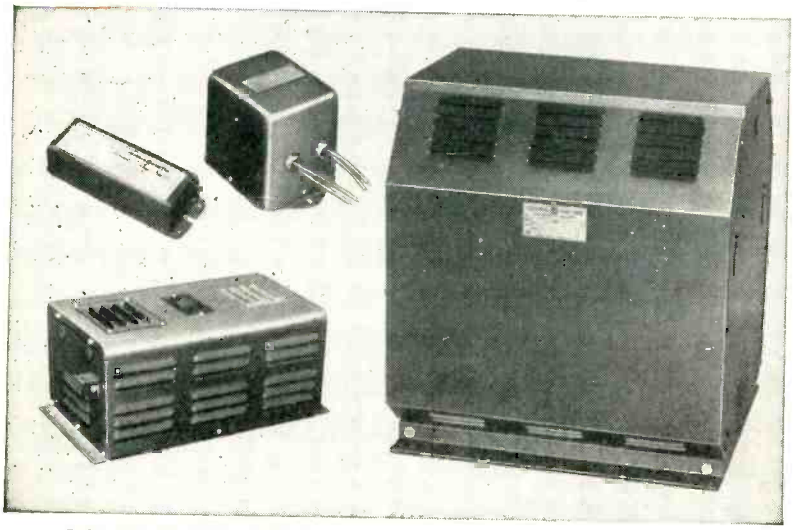
DESIGNER'S

New line of G-E voltage stabilizers features flexibility



G-E STABILIZER LINE has output ratings from 15- to 5000-va.

Now, to help you iron out voltage ups and downs, General Electric offers a new line of standard automatic voltage stabilizers that offers greater design flexibility at no extra cost. These compact, lightweight units can be a key feature in your design of sensitive electronic equipment where precision performance depends on accurate voltage stabilization.

Output ratings of 1000, 2000, 3000 and 5000 volt-amperes are available, with 115 and 230 volts on both input and output, to give you a wide variety of operating combinations. Fluctuations between 95 and 130, or 190 and 260 volts are corrected to a stable 115 or 230 volts within ±1 per cent — in less than two cycles. Single-core construction completely isolates input circuit from output circuit. For more information see Bulletin GEA-5754.

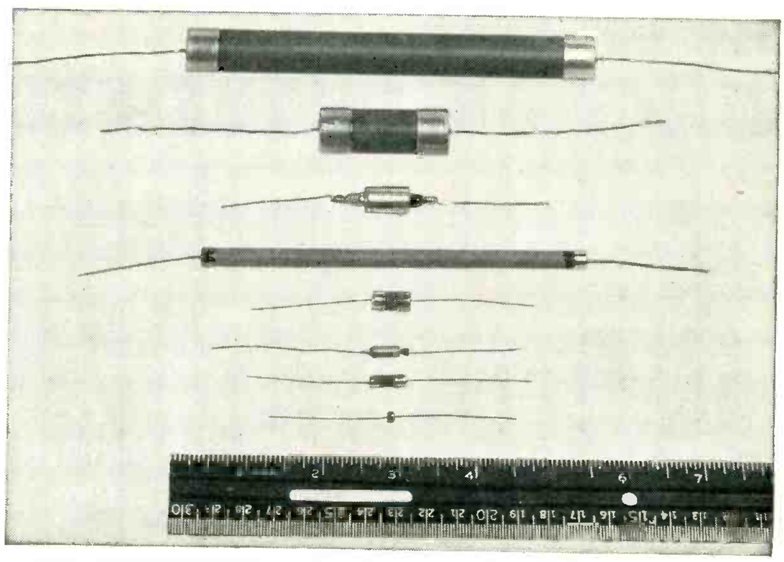
Miniature selenium rectifiers resist severe operating conditions

Two types of totally enclosed casings are available: Textolite* tubes for normal operating conditions; hermetically sealed, metal-clad casings to meet severe government specifications.

These small-size selenium cell assemblies have long life, high reverse resistance, good regulation and low heat rise. Their ambient temperature range is broad—from −55C to +100C. Lead mounting is standard, but they may also be bracket-mounted.

This new G-E line of rectifiers may be used for blocking, electronic computer, signal, magnetic amplifier, communication or control circuits; for operating small relays, solenoids, precipitators. Cell sizes range from 3/32 in. to 15/32 in. diameter, d-c current ratings 0.050 milliamperes to 25 milliamperes. For further information, write for Bulletin GEA-5935.

*Reg. Trade-mark of General Electric Co.



FOR COMPACTNESS, washers between cells have been eliminated

You can put your confidence in—

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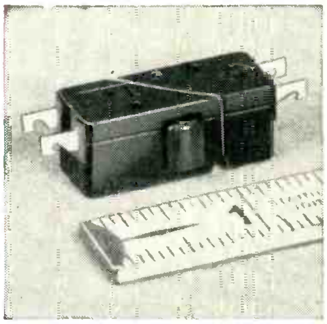
DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS



Switchettes are versatile, have high current rating

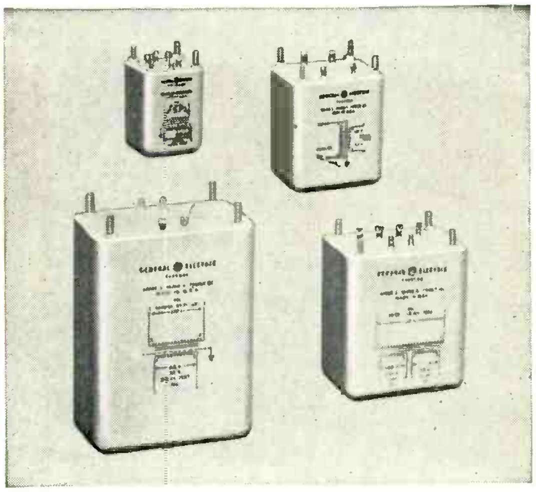
A wide range of design problems can be solved by G-E general-purpose switchettes. They are corrosion-proof, vibration-resistant, small, lightweight. Efficient at sea level or at 50,000 feet, in ambient temperatures from 200F to −70F. Ratings up to 230 volts, 25 amp. a-c; 250 volts, 25 amp. d-c. See Bulletin GEC-796.

Inductrols—for automatic or manual voltage regulation

Compact design of G-E inductrols lets you fit them into any location. They offer micrometer-fine control, autotransformer efficiency. Hand-operated and automatically operated models are available for indoor service 600 v and below on circuits 3 to 520 kva. Bulletin GEC-795 covers single-phase inductrols; GEA-5824, 3-phase models.

New iron weighs only 8½ oz.

The new 120-v, 60-w G-E lightweight iron is designed for high-speed, production-line soldering on electronic, instrument, and communications equipment. Thin, 5/16-inch diameter shank gets the ¼-inch tip into places a regular iron can't reach. Balanced design allows the soldering of more joints per minute. Long-lasting Iron-clad tip needs no filing or dressing. See Bulletin GED-1583.



COMPLETE LINE includes 11 sizes

G-E cast-permafil* transformers designed to meet MIL-T-27 specs

The small, light design of General Electric's new line of cast-permafil transformers makes possible greater flexibility in many electronic designs. Sealing these solventless-resin-type transformers for life has eliminated the need for metal enclosures and fungus-proof coatings. Construction is simple—terminals are anchored directly in the tough, solid, shatter-resistant permafil mixture to cut size and weight by 20 per cent. Machined and punched parts have been kept at a minimum for lower cost.

Cast-permafil transformers have an expected life of 1000 hours or more at 130°C ultimate. The complete line of 11 sizes is available in various terminal arrangements, and is designed to meet MIL-T-27 (Grade 1) performance requirements. For more information, write General Electric Co., Sect. C667-25, Schenectady 5, N. Y.

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- ☐ GEC-795 Single-phase Inductrols
- ☐ GEC-796 Switchettes
- ☐ GEA-5754 Voltage Stabilizers
- ☐ GED-1583 Soldering Iron

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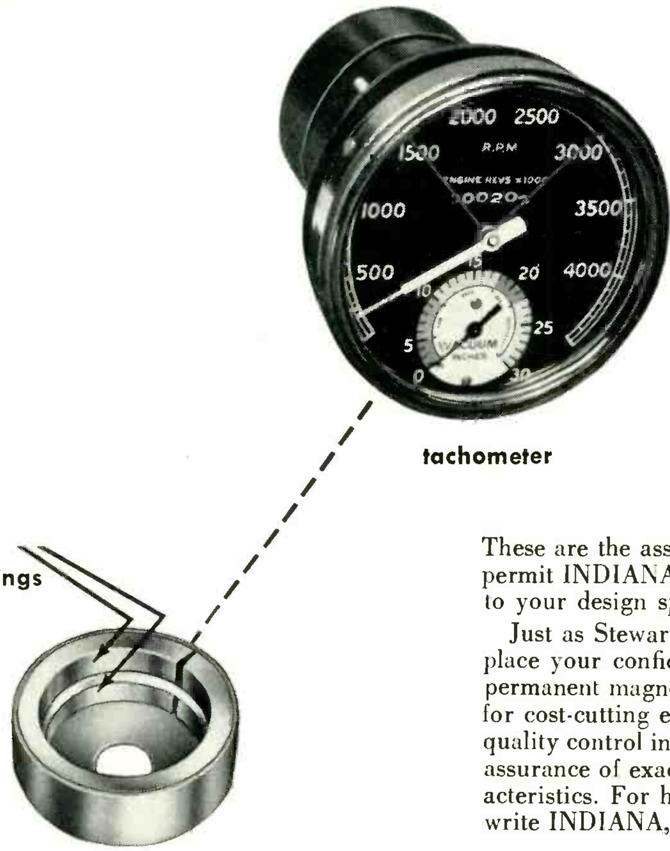
STEWART-WARNER



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Just as Stewart-Warner did, so you, too, can place your confidence in INDIANA for quality permanent magnets . . . for skill in manufacture . . . for cost-cutting engineering aid. Rigorous quality control in every step of production is your assurance of exact magnetic and physical characteristics. For help with your problem, write INDIANA, today.

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DESIGN SUMMARY

Equipment—Electric Tachometer, manufactured by Stewart-Warner Corp., Chicago.

Application—Permanent magnet assembly.

Problem—To design a permanent magnet which would produce sufficient torque and give added stability to this instrument.

Solution—By varying the analysis and heat treatment, INDIANA engineers developed a special Cunife permanent magnet which provided the necessary torque and improved stability. Furthermore, this special Cunife magnet lent itself better to the limited space resulting from the new design.

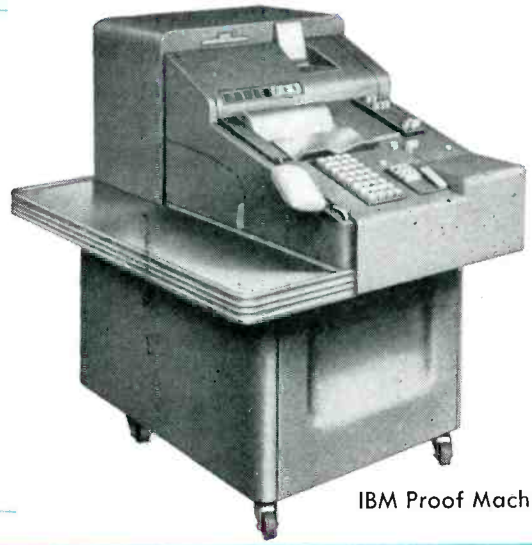
WRITE FOR DESIGN MANUAL NO. 4-A6

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY • VALPARAISO, INDIANA

WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

How IBM gets perfection outside to match its precision inside



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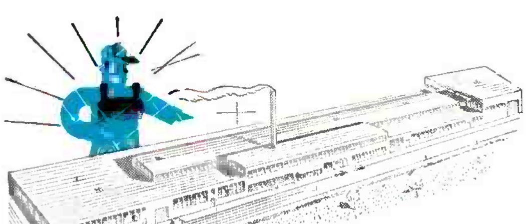

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From a modest beginning five years ago, Communication Accessories Company has grown to one of the largest exclusive toroid coil winding producers in the U. S. today. Why?

We like to think that this growth is due to the thorough, careful handling we apply to each coil . . . and because of the particular skill of our people. Whatever the reason, we'll continue—doing the best we know how—thankful for the trust that important companies have placed in us.

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HIGH CURRENT

Nobatron Model E-6-5

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

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

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

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

COMMON NOBATRON SPECIFICATIONS

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

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

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

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

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

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

OTHER SORENSEN ISOTRONIC PRODUCTS INCLUDE:

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

SPECIFY SORENSEN

For Complete Information Write

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

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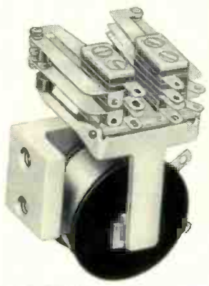
POTTER & BRUMFIELD LEADS IN RELAY DEVELOPMENT & PRODUCTION

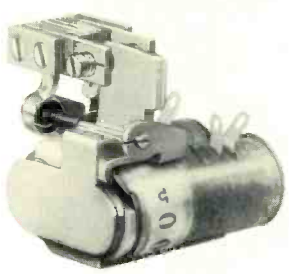
Extra Rugged, Compact 400-Cycle AC Relay Offered in New AF Series

New AF Series, recently developed by Potter & Brumfield, will operate on any frequency in the general vicinity of 400 cycles with 15 grams or higher contact pressure at approximately 2 VA input per movable pole. Advanced construction withstands better than 10-G vibration with any contact arrangement up to 2 Form C (DPDT) contacts.

New unit is available open as illustrated or hermetically sealed with 3-stud mounting and plug-in or solder-terminal glass-insulated header. Coils wound on molded bakelite bobbins with breakdown of 500 V. RMS minimum between all current carrying elements and to ground. Contacts rated 5 amps, 115 volts, 60-cycle, non-inductive load.



Ultra-Sensitive SS Series Feature Dual Coils; 10-G Vibration Resistance

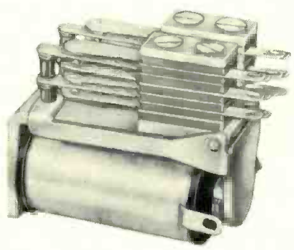


Brand new SS Series, DC Super-Sensitive Relays, provide operation with 10-G vibration resistance on less than 10 MW. New unit utilizes dual coils normally connected in series. Balanced armature with point bearings pivoted in adjustable mounts reduce friction to a minimum. Pure silver contacts rated 2 A at 115-V. AC or 28-V. DC, non-inductive load. Contact arrangement is 1 Form C (SPDT). Available with total coil resistance up to 60,000 ohms and sensitivity range from 1 MW to 2 W. Supplied open as illustrated or hermetically sealed with glass-insulated plug-in or solder-terminal header.

Design Engineer Gets More Help to Meet Tough Relay Requirements

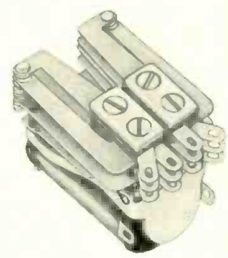
Shown on this page are some of Potter & Brumfield's recent relay developments. Constant creation of new relay structures offers today's design engineer more help in his search for miniaturization, ruggedization, acclimatization, higher contact capacities, more contact combinations, greater sensitivity and longer life.

MH Series Offers Maximum Conversion Efficiency; Many Contact Combinations, DC or AC



Smallest and most versatile of the telephone type relays, MH Series offers maximum coil power, a wide selection of contact combinations and high contact capacity. Available open or hermetically sealed with maximum of 12 contact springs for either DC or 60 cycle AC operation.

MJ Series Feature Longer, More Flexible Contact Arms; Lower Spring Load Rate, DC or AC

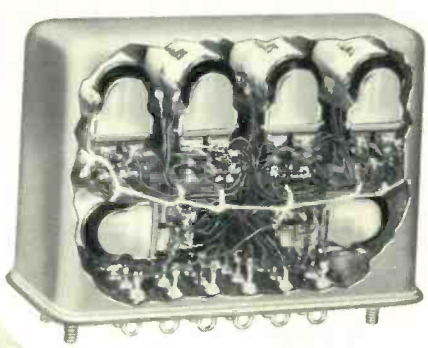


Newly developed MJ miniature telephone type relay features longer and more flexible contact arms which result in a lower spring load rate. This structure permits wider contact gap, more overtravel, improvement in sensitivity, faster action and longer life. MJ supplied open or hermetically sealed, with maximum of 12 contact springs, for either DC or 60 cycle AC operation.

Coils for both relays furnished up to a maximum resistance of 22,000 ohms for either current or voltage actuation. Insulation resistance better than 1000 megohms and breakdown above 500 V. RMS.

Hermetic Sealing or Dust Covering Available for All Individual Relays or Multiple Groups; Keep Out Dust, Fumes, Moisture, Etc.

- New "L" Type deep-drawn steel enclosure accommodates six MH relays or one standard LT telephone type relay, not shown on this page. Mounting is by 4 studs. Available with maximum of 24 solder terminals. Dim. $2\frac{3}{16}$" x $4\frac{11}{16}$" x $3\frac{5}{32}$" high.



- New "D" Type deep-drawn steel enclosure is designed for sealing the AF Series 400-Cycle AC relays, but will accommodate the MH or MJ relays shown above. Supplied with standard octal 7, 9 or 14 pin miniature plug or up to 14 hot-tinned solder terminals. Dim. $1\frac{5}{16}$" x $1\frac{29}{32}$" x $2\frac{9}{16}$" high.

Write Us or Phone Your Local P&B Sales Office for New Master Catalog Illustrating and Describing Our Wide Line of Basic Relay Structures, Housings and Enclosures. Relays for Every Electrical and Electronic Application.

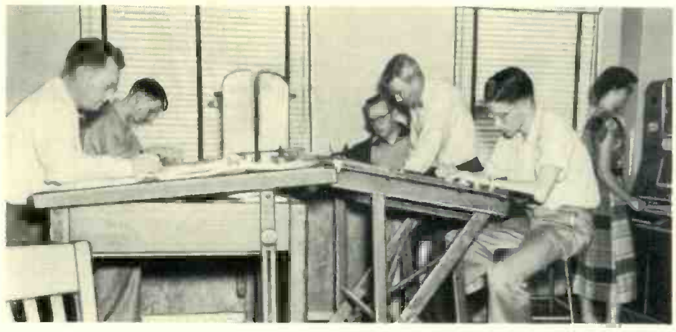
See other side for mailing address

design

Years of experience and close contact with the military and the electrical and electronic industries enables P&B to design and develop relays and similar assemblies to exact requirements. Current MIL specifications are maintained in complete files. All necessary laboratory and testing instruments at your service any time. Certified test reports on request.

production

Three large plants, including over 50,000 square feet of floor space, fully equipped with complete tooling, coil winding, plastic molding, heat treating, glass metalizing, welding, hermetic sealing and machine tools for every operation. Orderly, efficient plant layouts assure steady, precise assembly line production . . . single-shift capacity 10,000 relays per day!



engineering

Extensive research, laboratory and model shop facilities always available. Laboratory equipment includes all types necessary for design, development and type-testing of industrial control and electronic components. Altitude, heat and cold, salt-spray, shock, vibration and other tests completed quickly at reasonable cost.

Potter & Brumfield will solve your relay *design • engineering • production* problems

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about your problems or requirements on relays or similar electro-mechanical assemblies. P&B competent, well-trained personnel and modern plant facilities offer you the finest service in the relay industry. Samples, recommendations and quotations promptly forwarded on request.

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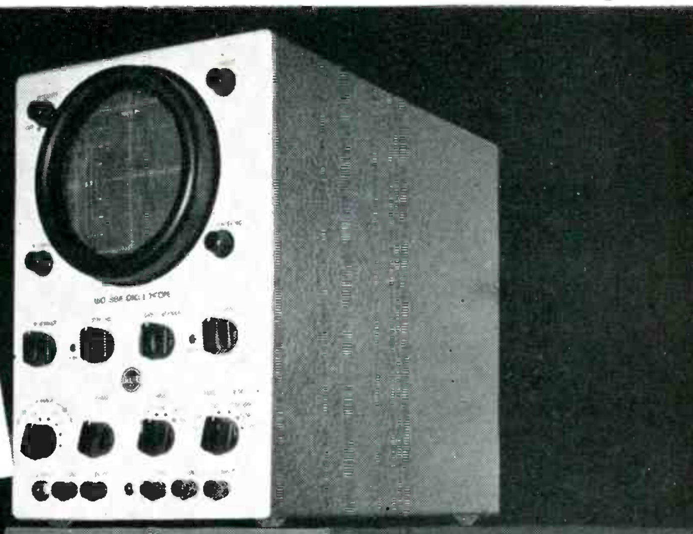
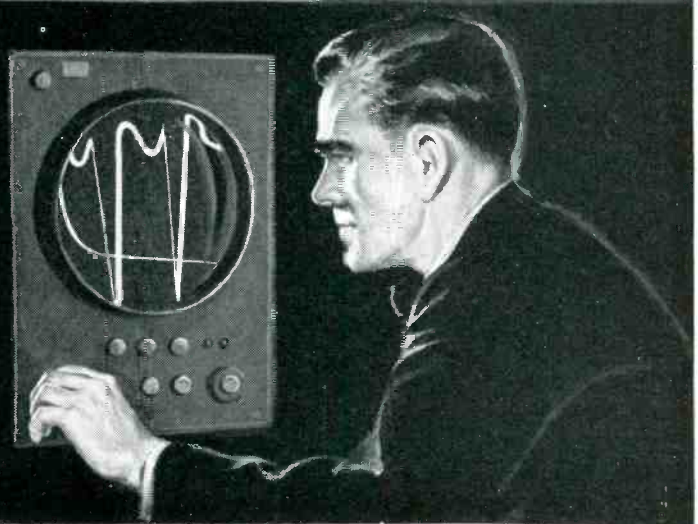


5"
RCA WO-88A
$169.50
Suggested User Price

You can *believe* what you see with an RCA oscilloscope



7"
RCA WO-56A
$237.50
Suggested User Price

The RCA WO-88A 5-inch and WO-56A 7-inch oscilloscopes have the facilities you need for precise *qualitative analysis* and accurate *quantitative measurements* . . . thanks to advanced engineering design

For instance, one of the outstanding features of these instruments is their *remarkably true square wave* response . . . obtained by adequate band width, negligible phase shift, fast rise time, frequency-compensated attenuators, and a complete absence of peaking circuits.

Equally important are the peak-to-peak *voltage-measurement features*—obtained through the use of voltage-calibrated attenuators, front-panel calibrating-voltage terminals, calibrated graph screens, and good amplifier linearity.

Other quality features common to both designs include . . . push-pull direct-coupled amplifiers . . . extra fast retrace . . . shielded CRT gun . . . plus and minus sync . . . line-frequency sweep with phasing . . . and a set of matched probes and cables including a high impedance probe having an input resistance of 10 megohms and an input capacitance of less than 10 μμf!

Before selecting a 'scope for your special needs, be sure to get the full details on the WO-88A and WO-56A from your *RCA Test Equipment Distributor* . . . or write RCA, Commercial Engineering, Section 42FX, Harrison, New Jersey.

RCA® RADIO CORPORATION of AMERICA
TEST EQUIPMENT — HARRISON, N.J.

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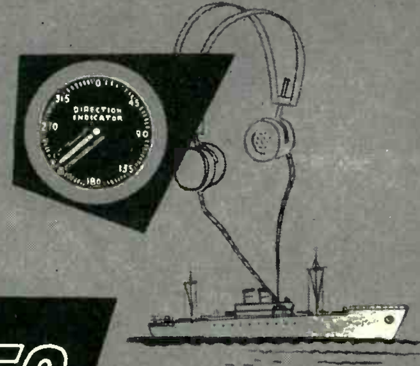
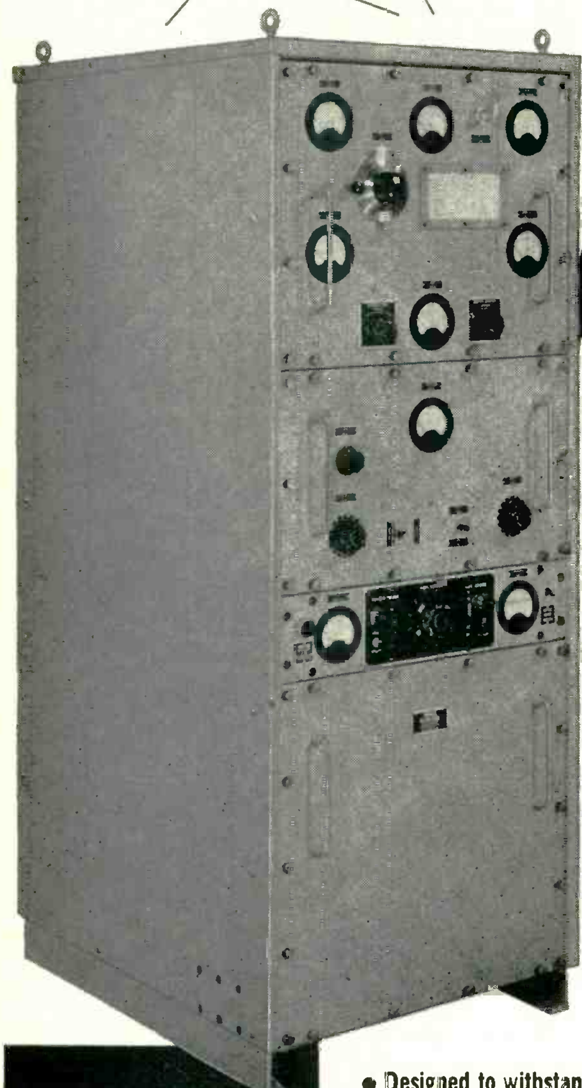
a low frequency HOMING BEACON TRANSMITTER with VARIABLE OUTPUT (25 TO 400 WATTS)





THE GATES MO-3975

- FRONT PANEL CONTROL ADJUSTS CARRIER POWER.
- AVAILABLE IN A WIDE VARIETY OF COMBINATIONS.
- FULLY JAN APPROVED.

This outstanding homing beacon transmitter sets new standards for this type of service. Carrier power is adjustable from 25 to 400 watts by a front panel controlled auto–transformer. Pressurized forced air cooling is provided.

The GATES MO-3975 is available with or without remote control. Transmitter can be supplied for 51½ ohm output or a special antenna coupler is available to couple directly to an L or T type antenna. High level voice modulation is employed, incorporating a peak-limiter to prevent over-modulation. A type 36 automatic code keyer operates from a phase-shift type oscillator at 1020 cycles. Versatile, dependable, the GATES MO-3975 represents the most advanced LF homing-beacon transmitter yet developed.

other features

- Designed to withstand Class "B" shock tests and operate in ambient temperatures between —54°C. and +65°C.
- Heavy steel frame to which each drawer section is secured by captive thumb screws. Heavy roller bearing compound extension type slides provide easy access for maintenance.
- Frequency range: 200-800 KC. Frequency stability: 0.005%. Audio response: ±2 Db. 400-3000 CPS. Noise: 40 Db. below 100% modulation at 400 watts. Power consumption: 2200 watts at 115 V. 60 cycle single phase at 400 watt carrier 100% modulated.
- Fully JAN approved. Built for dependable service under any climatic variations including those encountered in ship-board service.

GATES

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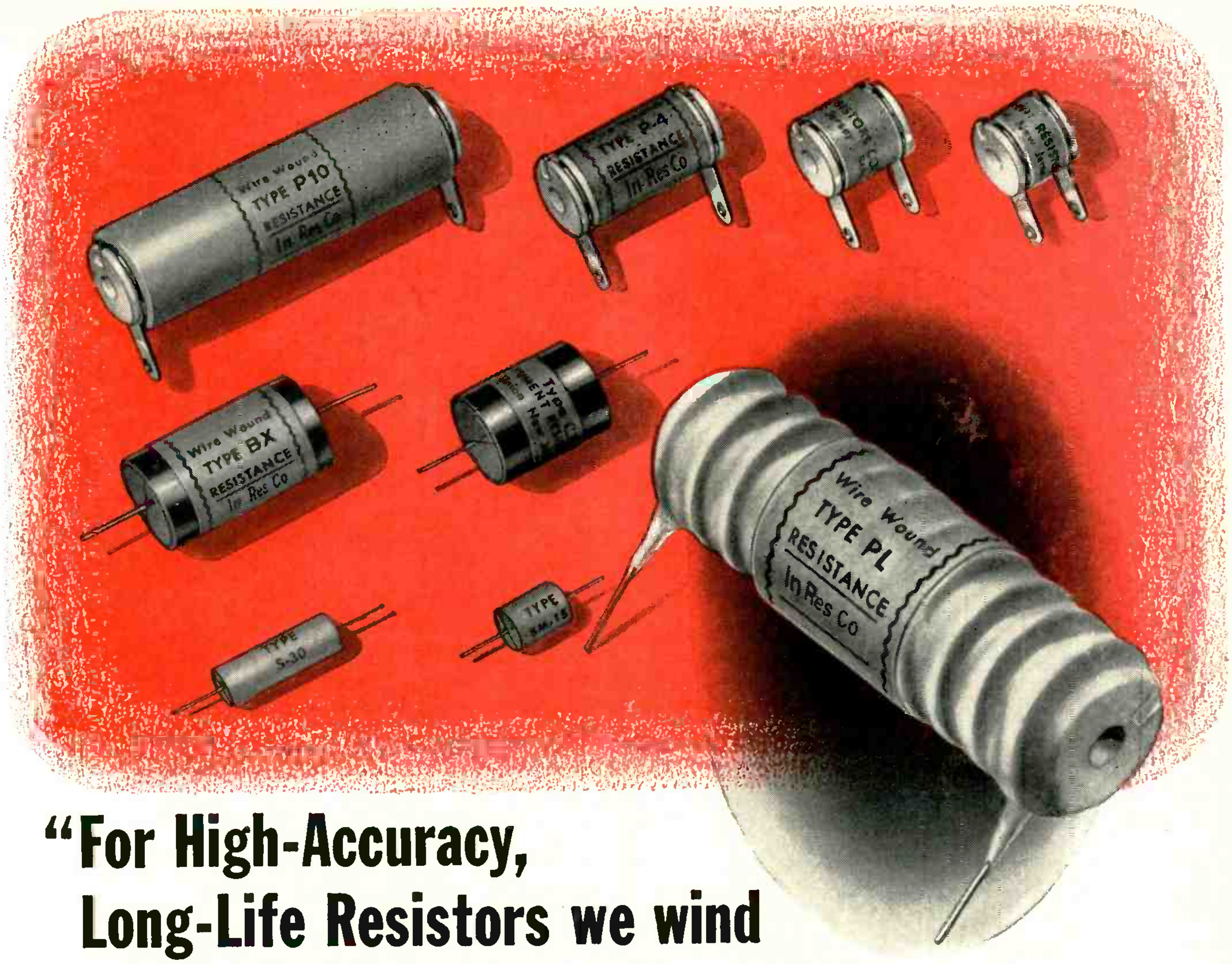

"For High-Accuracy, Long-Life Resistors we wind with D-H Electrical Alloy Wire"

...so states INSTRUMENT RESISTORS COMPANY, of Union, New Jersey, manufacturers of IN-RES-CO quality-built resistors for every electrical and electronic application

IN-RES-CO resistors are wound to meet the most critical requirements without excessive cost; standard inductive and non-inductive units are available in resistance ranges from 0.01 ohm to several megohms—with power ratings from a fraction of a watt to 10 watts. Included, are types especially suited to counter excessive humidity, fungus, space limitations, and temperature rise.

Says Instrument Resistors Company: "For 23 years, we have devoted our facilities exclusively to the development and manufacture of quality resistance components. The fact that today, with such a wealth of experience to our credit, we specify Nichrome, Karma, and D-H Manganin wire for windings, constitutes the strongest endorsement we can offer of these Driver-Harris products."

Nichrome*, Karma*, and D-H Manganin deliver top-level performance—their characteristic electrical and physical properties remaining unchanged even under exceptionally exacting operating conditions. They are ready to go to work for *you*, too—as are more than 80 other Driver-Harris alloys. Profit by consulting with us. We shall be glad to make recommendations based on your particular needs . . . and are confident we can meet your resistance requirements with D-H alloys that will assure the best possible results.

Nichrome and KARMA are produced only by

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

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SUPERIOR ELECTRIC designs, engineers and manufactures Voltage Control Equipment specifically to meet today's demands. A wide range of standard types in numerous capacities and ratings are offered. In addition, The Superior Electric Company — thoroughly experienced in the field of voltage control — offers to work with you in developing special equipment to meet your special needs exactly.

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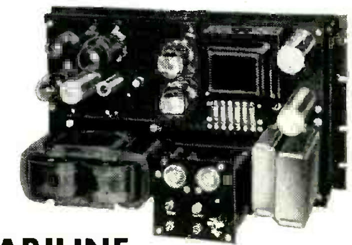

STABILINE
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VOLTBOX
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VARICELL
D-C POWER SUPPLIES

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5-WAY BINDING POSTS

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I am interested in ☐ POWERSTAT Variable Transformers ☐ STABILINE Automatic Voltage Regulators ☐ VARICELL D-C Power Supplies ☐ VOLTBOX A-C Power Supplies ☐ 5-WAY Binding Posts.

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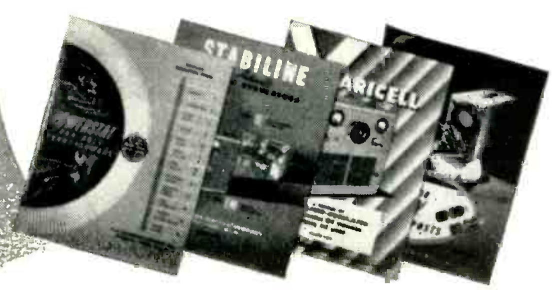

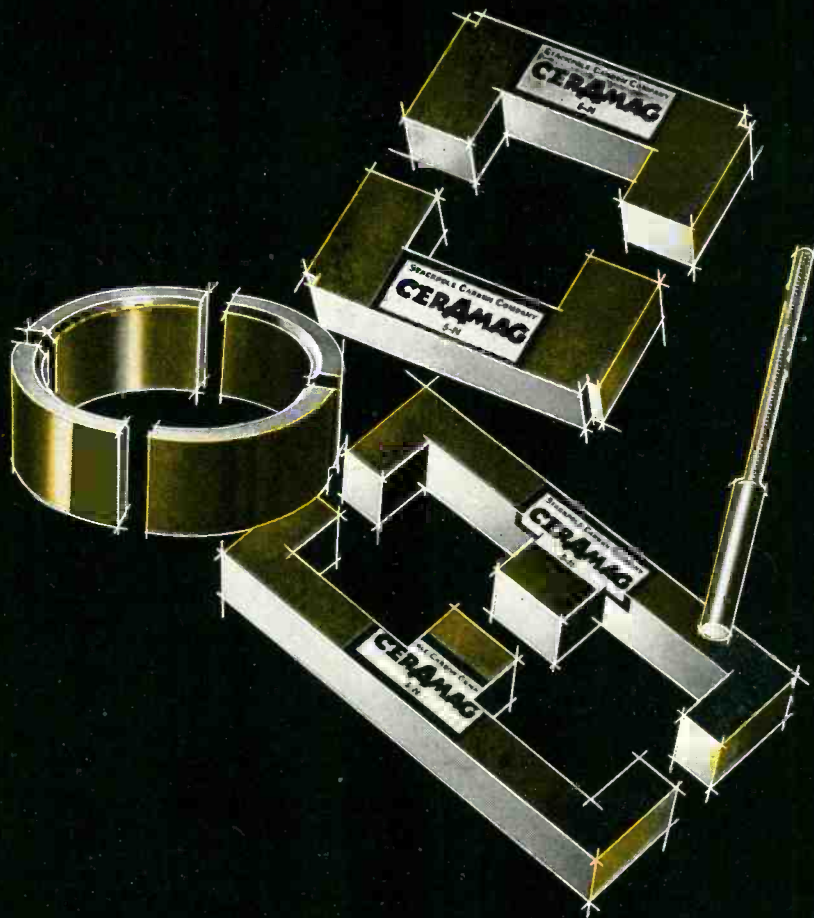

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STACKPOLE *Ceramag*®

FERRITE CORES

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

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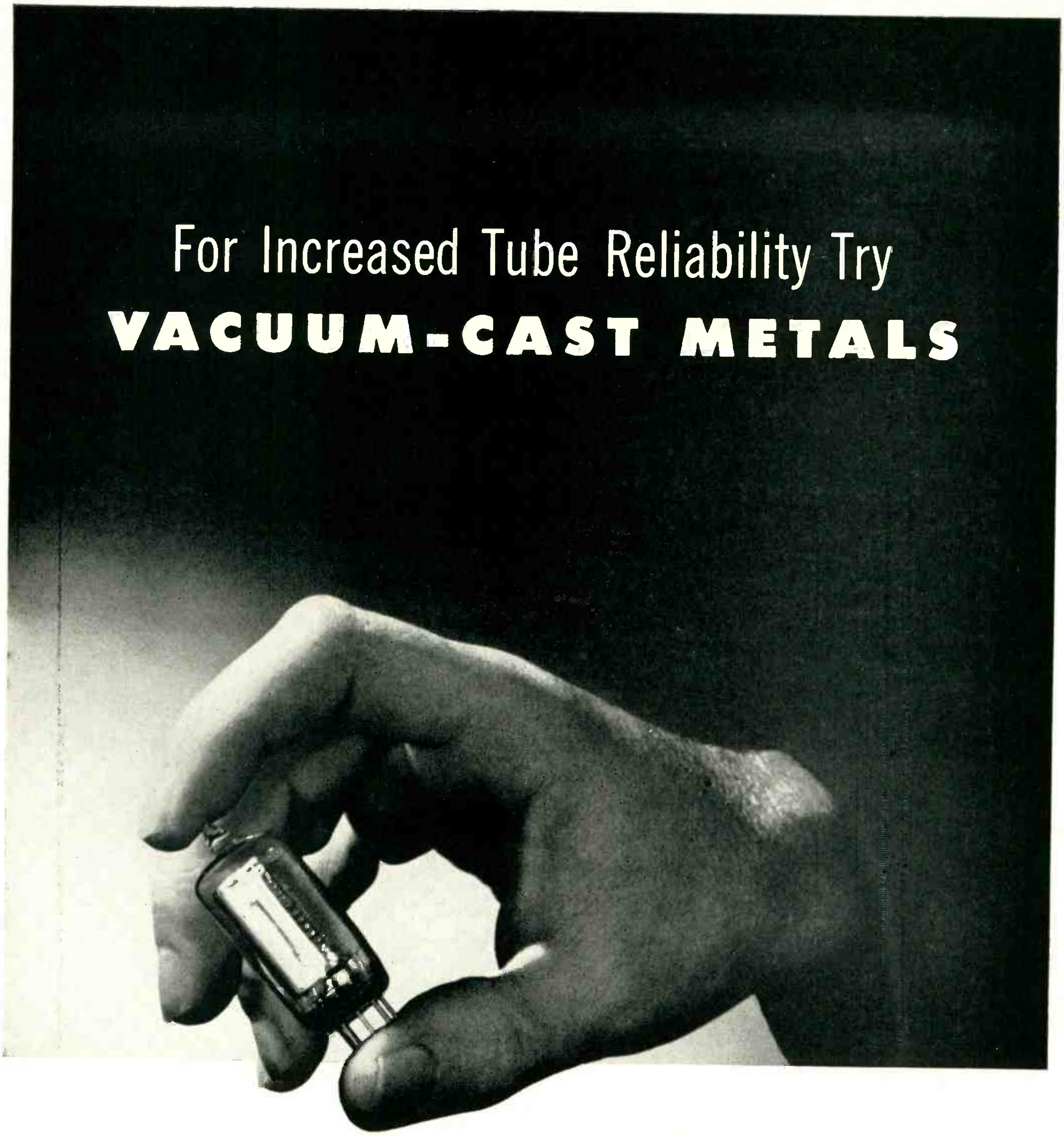

Vacuum-melting removes gases and oxide inclusions from metals and makes them less porous. As a result they contain only traces of gases in the "body" of the metal even after they have been worked.

This indicates that when vacuum-cast metals are used there will be a minimum of outgassing during the storage and operation of the tube.

Nivac P is now being evaluated in vacuum tubes like the thyratron above to reduce pump-down time . . . increase tube reliability . . . and lengthen shelf life.

You may want to conduct your own tests. Commercial quantities of ferrous and non-ferrous metals and alloys are now being vacuum-cast at pressures as low as one millionth part of atmospheric by Vacuum Metals Corporation. Available in either billet or fabricated forms. Write for more information.

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SPECIAL ALLOYS
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Subsidiary of National Research Corporation
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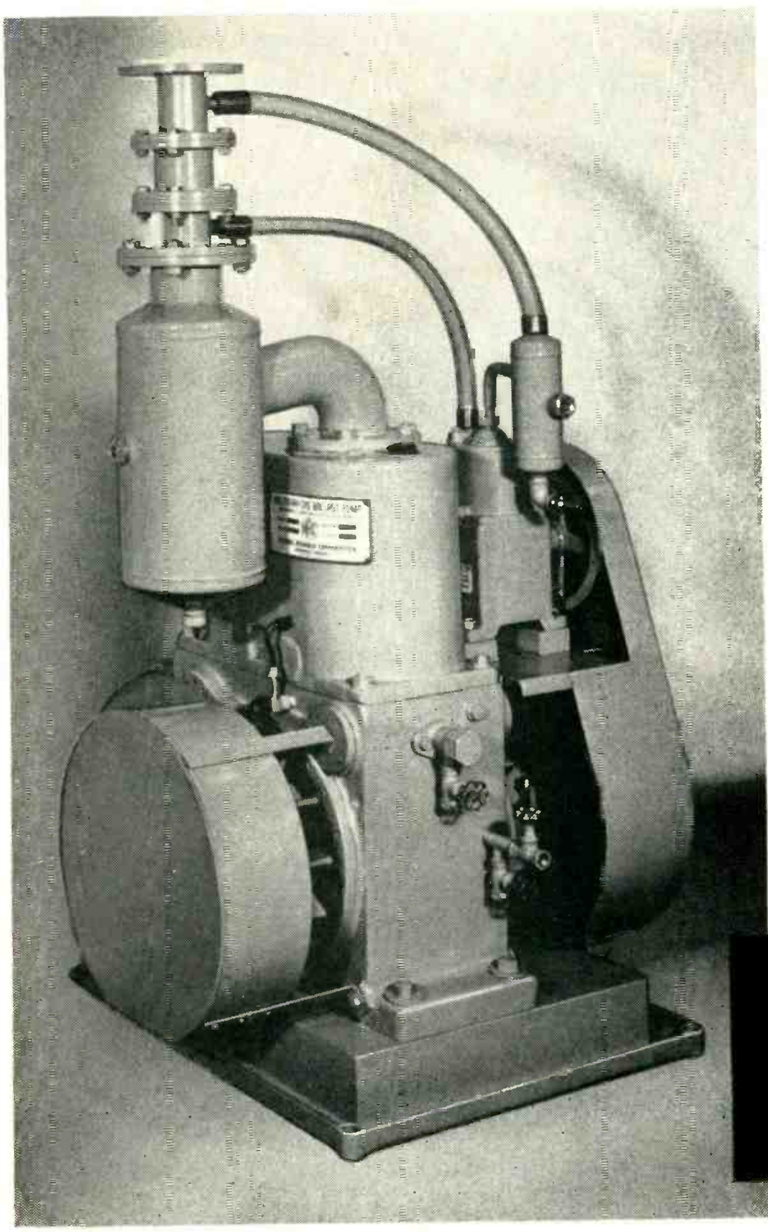
NEW HIGH VACUUM ROTARY PUMP

...<u>Ends</u> Water Vapor Trouble
...Maintains Fast Pump Down Time



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

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

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

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

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

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

NRC

National Research Corporation
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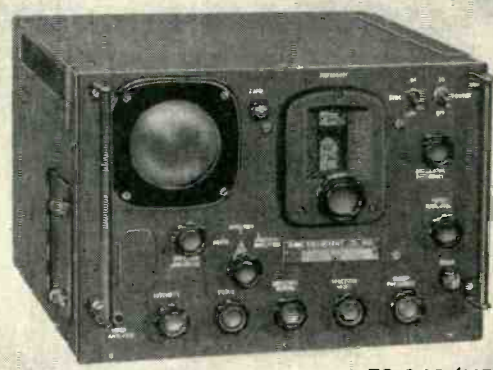
Spectrum ANALYZER TS-148/UP

NEW AND IMPROVED DESIGN

OUTSTANDING PERFORMANCE

MORE RUGGED CONSTRUCTION



TS-148/UP

ACCESSORIES & CASE

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

Specifications . . .

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

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

We also manufacture . . .

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

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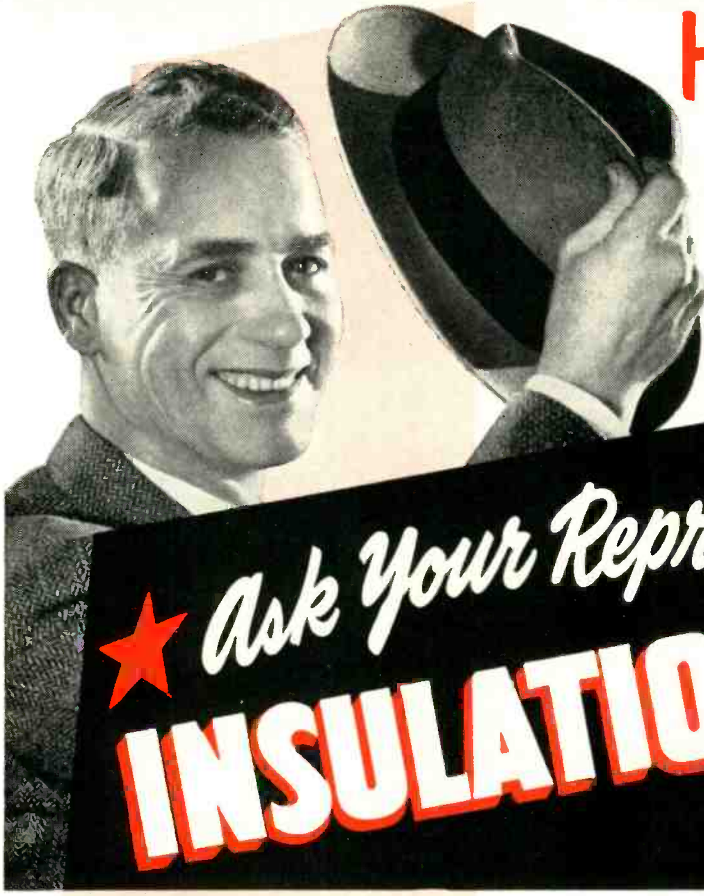

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READY FOR SHIPMENT ...COMPLETE STOCKS OF ALL THESE PRODUCTS:

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No matter what your question, if it concerns the selection and application of electrical insulating materials, an IWI Representative is ready to help you. Backed by the experience of many years acquired in helping electrical manufacturers choose and use the right product in the right way, your IWI Representative offers you a single *source* from whom you can get the dependable technical help you want.

There's no need to ask, or wait for, help from the many different suppliers of every type of insulating materials you use—*just ask your IWI Representative—he has the answers for you—NOW!*

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IMMEDIATE DELIVERY from a fully stocked warehouse near you

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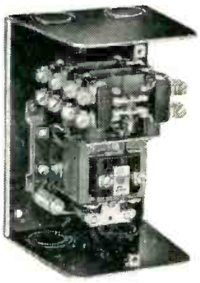
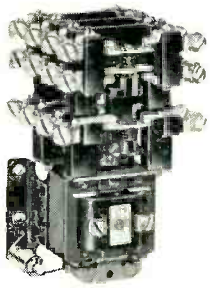
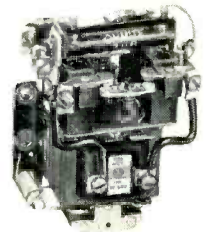
Write For The Address Of The Warehouse Nearest Your Plant



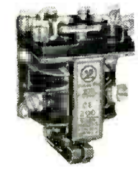
Type BX-44 A-C Relays
4 Normally open & 4 normally closed contacts.



Type BX-840 A-C Relays
8 Normally open & 4 normally closed contacts.



Type BA Thermostat Relays
For 3-wire gauge type thermostats with slow-moving contact elements.

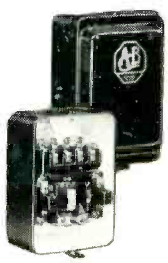


Type CL Low Coil Current Relays
For pilot controls, like oil burners or stokers, which can handle only small relay coil currents.

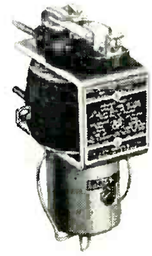
Large A-C Contactors
For applications up to 900 amperes—600 volts.

RELAYS · CONTACTORS · TIMERS · LIMIT SWITCHES
for Laboratory and Production Line Service

Bulletin 609 Manual A-C Starters
Button operated. Overload protection for motors up to 5 hp, 220 v & 7½ hp, 440-550 volts.



Bulletin 709 Magnetic Starters
8 Sizes up to 300 hp, 220 v & 600 hp, 440-550 v.



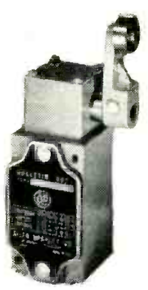
Bulletin 848 Dashpot Timers
Adjustable from 2 to 30 seconds.

Hum-free Latch Relays
For quiet applications.

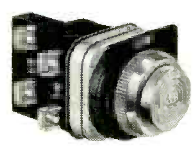
Bul. 849 Pneumatic Timers
Adj. 1/6 sec to 3 minutes.

Bul. 802 Limit Switches
Side push—precision type spring return.

Bul. 801 Limit Switches
Top push—precision type spring return.



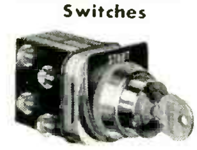
Bul. 802 Oiltight Limit Switches
Large variety of types.



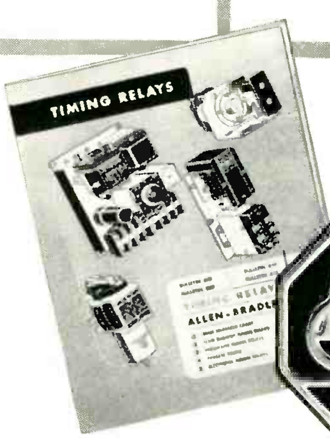
Oiltight Push Buttons

Oiltight Pilot Lights

Oiltight Selector Switches



Oiltight Key-type Buttons



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IRVINGTON extra-flexible Silicone Rubber-Coated Fiberglas* Tubing

The extreme flexibility of Irvington's Silicone *Rubber*-Coated Fiberglas—at both high and low temperatures—was an important factor in its acceptance by the electrical industry when this new Class "H" insulation was introduced almost two years ago.

Originally, Irvington Silicone *Rubber*-Coated Fiberglas Tubing was supplied only in white. Because of its rapidly growing use, Irvington has now taken steps to supply this tubing in a range of *colors* also—subject to minimum order requirements.

Immediate delivery can be made on white tubing for wire sizes from #24 to #0—prices and deliveries will be quoted on request on colored tubing.

For preliminary technical data, just mail the coupon below.

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for Insulation Leadership

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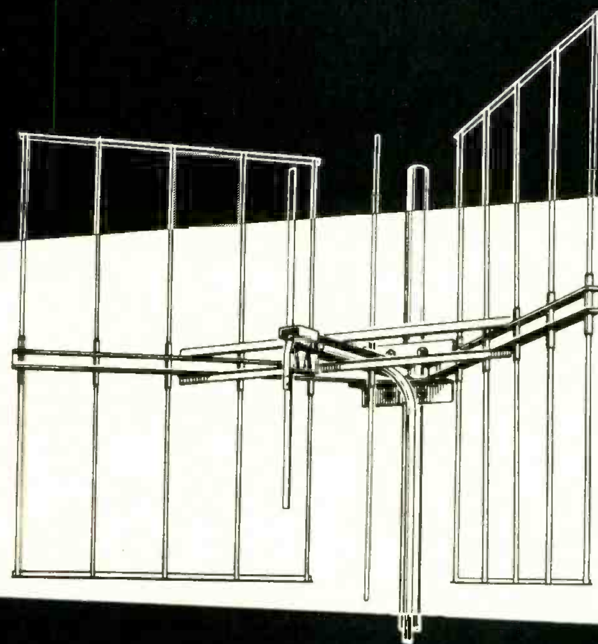

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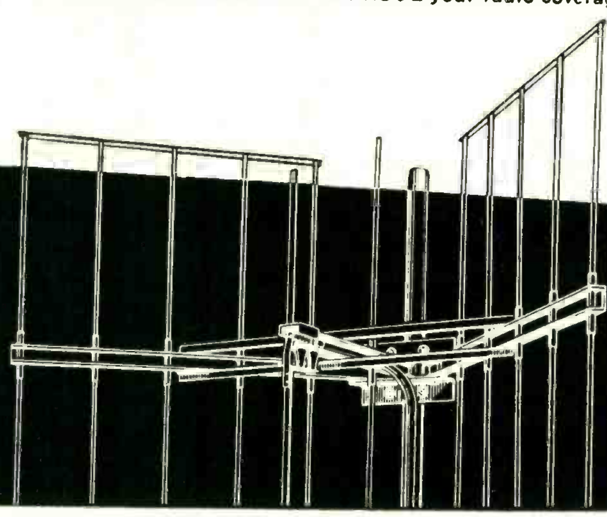
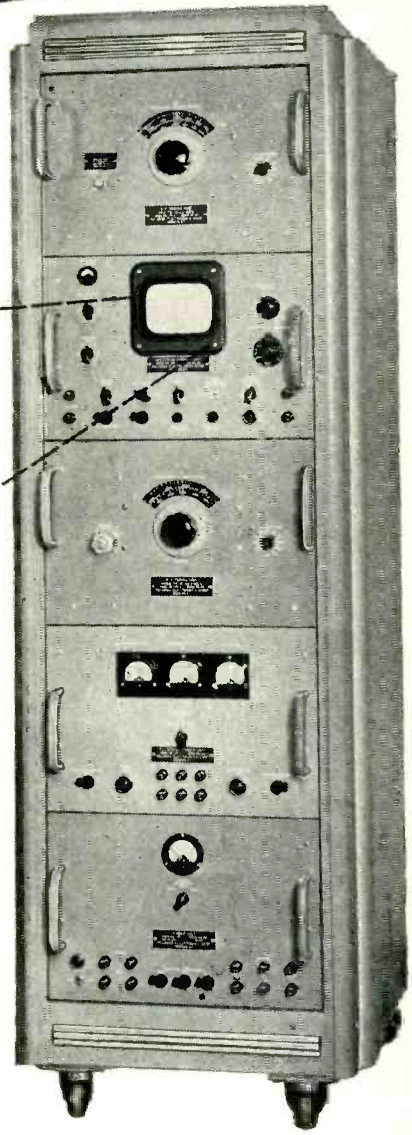
Stronger signals at greater distances are BUILT-IN this new narrow-angle antenna. Ideal for serving long stretches of highway, rail or pipe lines, it is equally effective for point-to-point communications, or back-to-back with other services. Gains up to 12 DB can be achieved by stacking. Vertically polarized, uni-directional, Andrew Corner reflector antennas are available in all mobile communications bands. Put them to work for you to INCREASE and IMPROVE your radio coverage. For more information, write us today.



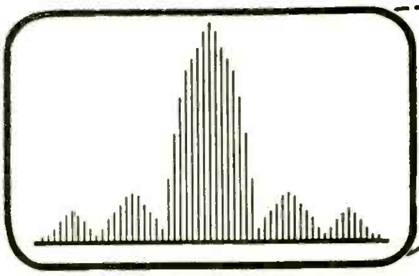
The FIRST
and still the only
ALL-BAND DIRECT READING

SPECTRUM ANALYZER

10 MCS TO 21,000 MCS



Polarad's Model LSA Spectrum Analyzer is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an r.f. signal.



- Continuous tuning.
- One tuning control.
- Resolution is 5KC when dispersion is 5MC per inch per sec.
- 250 KC to 25 MCS display at all frequencies.
- Tuning dial frequency accuracy 1%.
- No Klystron modes to set.
- Broadband attenuators supplied with equipment from 1 to 12 KMC.
- Frequency marker for measuring frequency differences 0-25 MCS.
- Only four tuning units required to cover entire range.
- Microwave components use latest design non-contacting shorts for long mechanical life.
- Maximum frequency coverage per dollar invested.
- 5 inch CRT display.

Where Used:

Model LSA Spectrum Analyzer is a laboratory instrument used to provide a visual indication of the frequency of distribution of energy in an r.f. signal in the range 10 to 21,000 MCS.

Other uses are:

1. Observe and measure sidebands associated with amplitude and frequency modulated signals.
2. Determine the presence and accurately measure the frequency of radio and/or radar signals.
3. Check the spectrum of magnetron oscillators.
4. Measures noise spectra.
5. Check and observe tracking of r.f. components of a radar system.
6. Check two r.f. signals differing by a small frequency separation.

THE INSTRUMENT CONSISTS OF THE FOLLOWING UNITS:

Model LTU—1 RF Tuning Unit—10 to 1000 MCS.
Model LTU—2 RF Tuning Unit—940 to 4500 MCS.
Model LTU—3 RF Tuning Unit—4460 to 16,520 MCS.
Model LTU—4 RF Tuning Unit—15,000 to 21,000 MCS.
Model LDU—1 Spectrum Display Unit.
Model LPU—1 Power Unit.
Model LKU—1 Klystron Power Unit.

Write for Complete Details

Polarad
Electronics Corporation

100 METROPOLITAN AVE.
BROOKLYN 11, N. Y.

Export Dept.: 13 East 40 Street, New York 16, N. Y.
Cable Address: "ARLAB"

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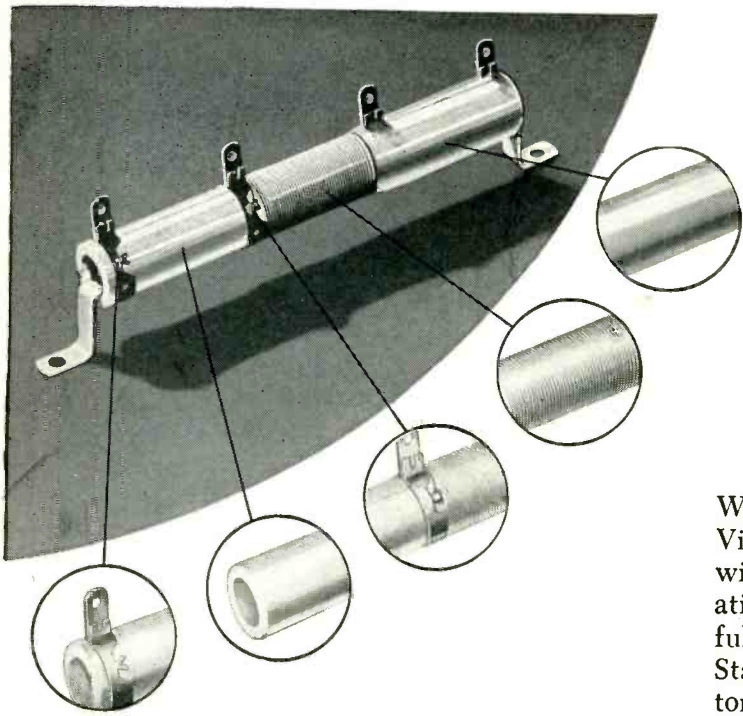

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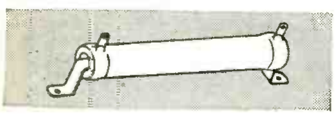
are your

Ward Leonard manufactures its own ceramic cores, Vitrohm enamel and terminals. Even the resistance wire is drawn to our own specifications. Every operation required to build a Vitrohm resistor is carefully and constantly checked and controlled by our Standards Department. That's why Vitrohm resistors assure you complete uniformity, accuracy and reliability, even under the most adverse service conditions.

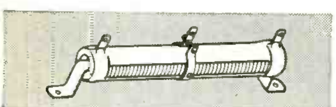
Ward Leonard has the largest selection of stock

7 stock resistors

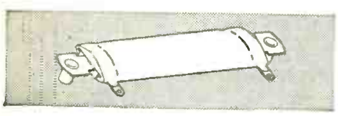
Vitrohm stock resistors range from 5 to 200 watts with resistance values from 1 to 250,000 ohms. Made-to-order Vitrohm's are available from 5 to 550 watts with values from 0.04 to 1,750,000 ohms.



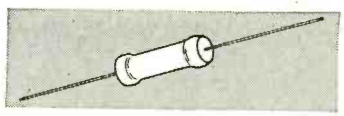
FIXED VITROHM
Used for voltage dropping and current limiting.



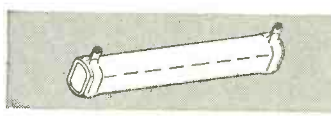
ADJUSTOHM
Gives circuit adjustability for voltage dividing or regulating purposes.



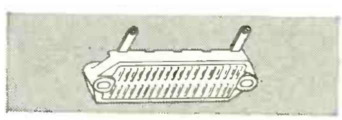
STRIPOHM
For compact aviation, communication and navigation equipment.



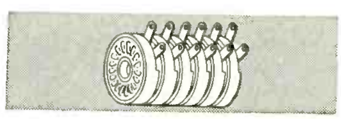
AXIOHM
Used in electronic equipment requiring miniature power resistors.



NON-INDUCTIVE
For low inductance and distributed capacitance in high frequency circuits.



PLAQOHM
Used in compact, high frequency electronic equipment.



DISCOHM
A miniature resistor for low inductance values and distributed capacitance.

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MOUNT VERNON, NEW YORK
Result-Engineered Controls Since 1892

RESISTORS

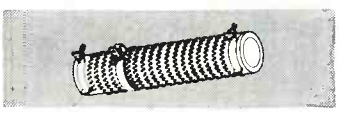
best buy

resistor types and sizes ever offered by any manufacturer. Also available to meet customer's exact specification is a complete stock of components ready for immediate assembly into made-to-order resistors. Our controlled component manufacture and inspection, plus a wider selection of types, make Ward Leonard your best buy in resistors.

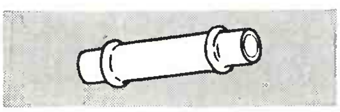
For full information on Vitrohm resistors, write for Catalog No. 15 to Ward Leonard Electric Co., 31 South Street, Mount Vernon, N. Y.

11 made-to-order resistors

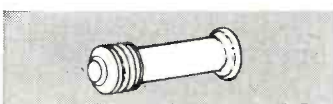
(these plus all the stock resistor types)



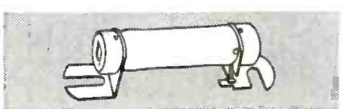
RIBFLEX
Used in circuits where high wattage must be dissipated in small space.



FERRULE TERMINAL
For rapid interchangeability of resistance values or resistor replacement.

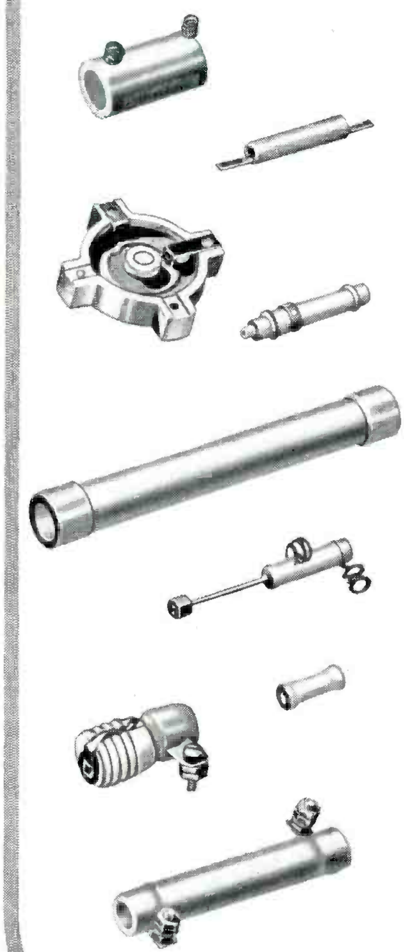


SCREW BASE
With an Edison screw base for mounting to provide rapid means of changing resistance.



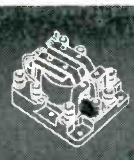
BRACKET TERMINAL
Has leads silver brazed to brackets for easy interchange or renewal of unit.

Special form resistors to meet unusual requirements

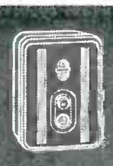


18.3.4

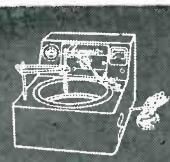
RHEOSTATS



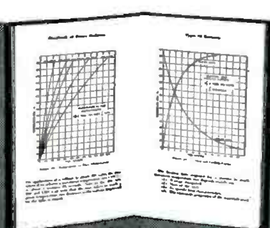
RELAYS



MOTOR CONTROLS



CHROMASTER



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

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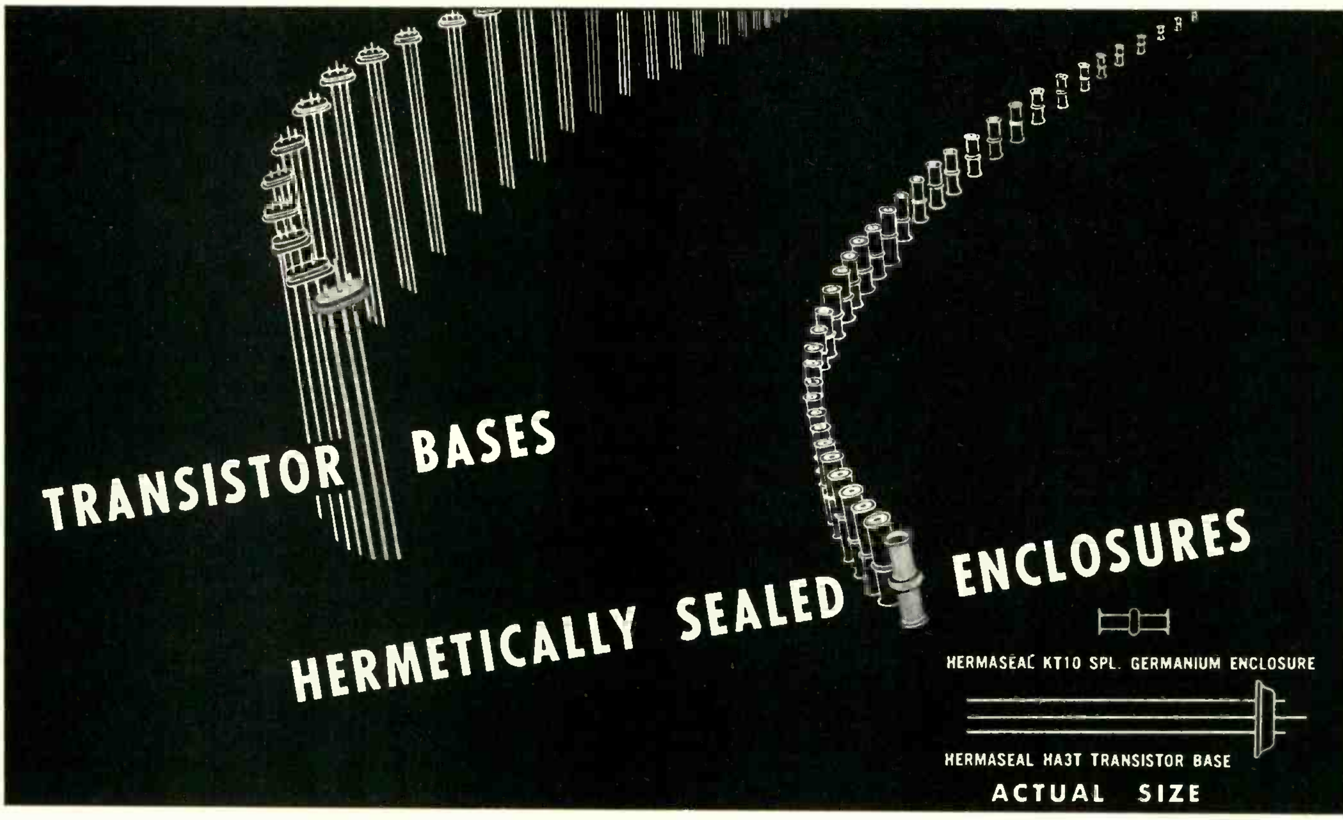

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Let Hermaseal help you with your transistor mounting and protection problems. Our pioneering in the development *and mass production* of bases and sealed containers for solid state devices has reached the point where we are now able to supply them in quantity to additional customers. We have solved many of the problems connected with mounting and heat and humidity protection of germanium diodes, point-contact transistors, and junction transistors for a wide variety of applications.

Hermaseal production and development include smaller, closer tolerance hermetic seals with vastly improved performance characteristics. In addition we are working with new glasses and metal alloys.

Our development and production experience are at your service. Send specifications and sketches of your transistor applications to Hermaseal.

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THE HERMASEAL COMPANY, INC.
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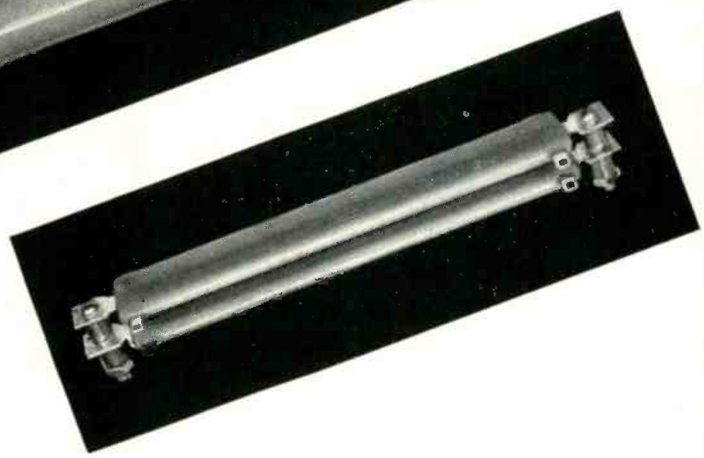

The greatly increased protection made possible by the development of our *high-temperature* gray enamel is the most important improvement of these resistors, but it is not all. True, this enamel is thermo-shock-proof and crazeless; but in addition

THESE RESISTORS OFFER . . .

- **Stronger core with higher resistance to vibration and shock.**
- **Finer resistance wire—made to H-H specifications, especially adapted to these resistors. More uniformly wound, so that failures under stress are eliminated.**
- **Special alloy terminals more securely fastened to the ceramic body by spot-welding—highly resistant to corrosion.**
- **All wire connections are protected by a positive non-corrosive bonding.**

The fixed, the ferrule and the flat types are especially designed for and manufacturd in accordance with JAN-R-26A specifications.

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Rheostats and Resistors

Subsidiary of

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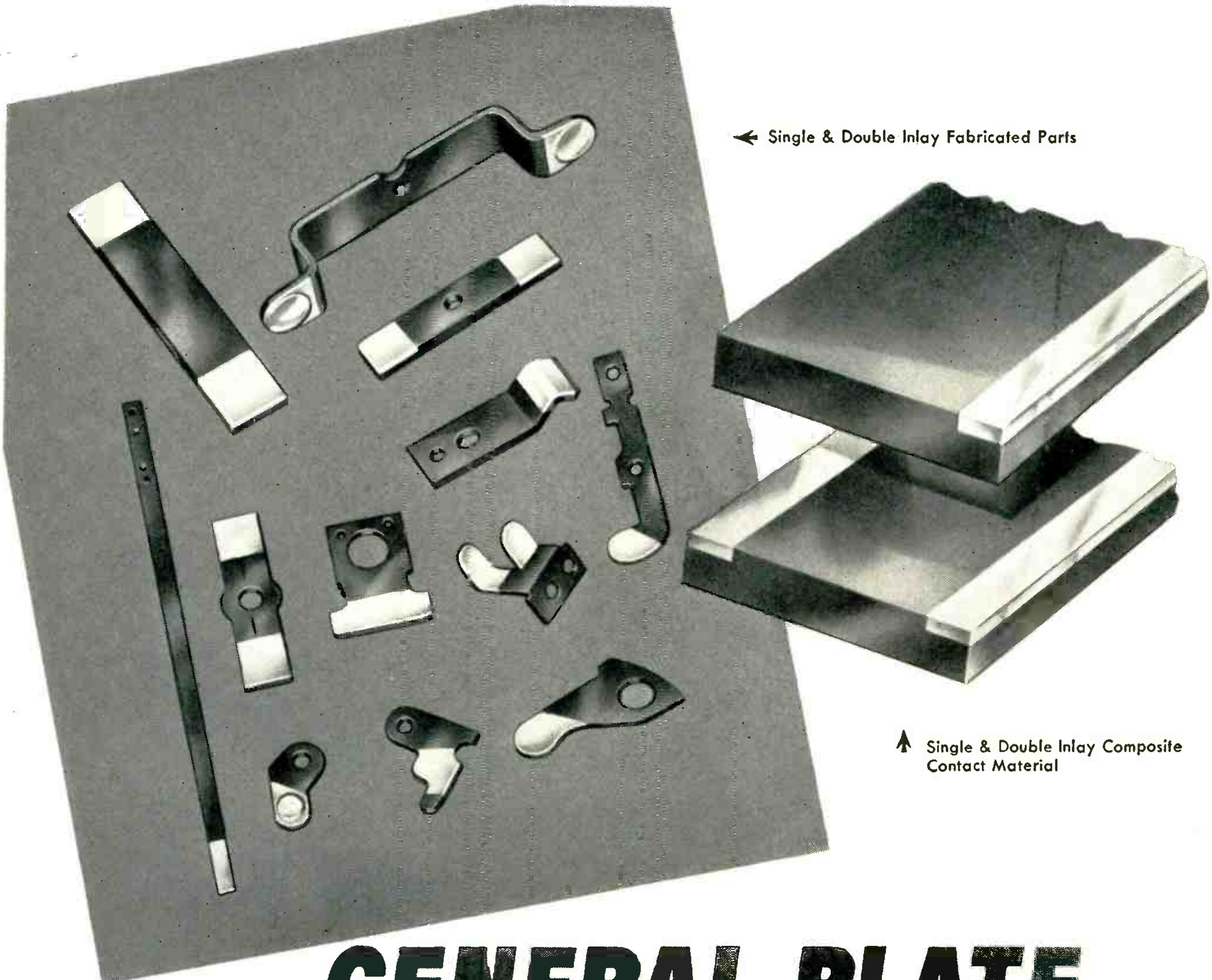

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Composite Contacts Reduce Fabrication Costs . . . Provide Better Performance

General Plate Composite Contacts are an economical solution to your contact problems.

General Plate Composite Contact Materials make it possible to manufacture complete contact assemblies to close tolerances by single blanking and forming operations as compared to other methods whereby the contacts and supporting members are fabricated separately and then assembled by brazing, welding or staking methods.

The junction between the precious metal and the base metal is homogeneous and free of voids resulting in a high rate of heat transfer. The rapid dissipation of heat away from the contact surface materially reduces electrical erosion. In many applications, General Plate Composite Contact Materials provide increased contact life even with a reduction in the thickness of the precious metal as compared to the thickness of the precious metal used in separate contacts.

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The long experience, diverse facilities and manufacturing skill of General Plate will benefit you in the form of service, quality and savings.

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- **A NEW MODEL** *by the leader in tape recording*

Ever since the first AMPEX (the Model 200) set a milestone in progress by making recorded sound "come to life," the broadcasting and recording industries have rightly expected new AMPEX models to set the pace.

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With introduction of the AMPEX 350, a new 30° slant on the top plate puts the reels, editing knobs and all controls within easier reach of any operator — tall or short, standing or sitting. Tape editing is faster and less tedious. Servicing is simplified by pivoting of the top plate and sliding out of the internal assemblies.

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In precision of timing, response to controls and freedom from breakdowns and repairs, AMPEX Tape Recorders have consistently led the industry. For utmost reliability, this new Model 350 has a three motor tape transport mechanism (previously used in the AMPEX 300, but now available in this lower priced machine).

- **A NEW REASON** *to change to the best*

Ultra high fidelity recording is now priced within reach of discriminating users in every field — radio stations, home high fidelity systems, schools, industry and professional music. And because the AMPEX 350 is built to last, it will cost the least per hour, per week and per year.

AMPEX MODEL 350

Tape speeds — 7½ & 15 in/sec. or 3¾ & 7½ in/sec.

Frequency response

15 in/sec. — ± 2 db from 30 to 15,000 cycles
7½ in/sec. — ± 2 db from 30 to 10,000 cycles
± 4 db from 30 to 15,000 cycles
3¾ in/sec. — ± 2 db from 50 to 7,500 cycles

If you plan for tomorrow, buy AMPEX today

For further details write today to Dept. 1228A

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PRECISION RESISTORS

JAN-R-29

METER MULTIPLIERS

Surpass all requirements of JAN-R-29

HERMETICALLY SEALED:

Insures dependable operation under most severe moisture conditions.

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Glazed surface prevents high voltage leakage.

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WINDINGS:

"Certified" low temperature coefficient resistance alloys properly "aged" to provide long term stability.

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Eliminate complete loss of unit if damaged.

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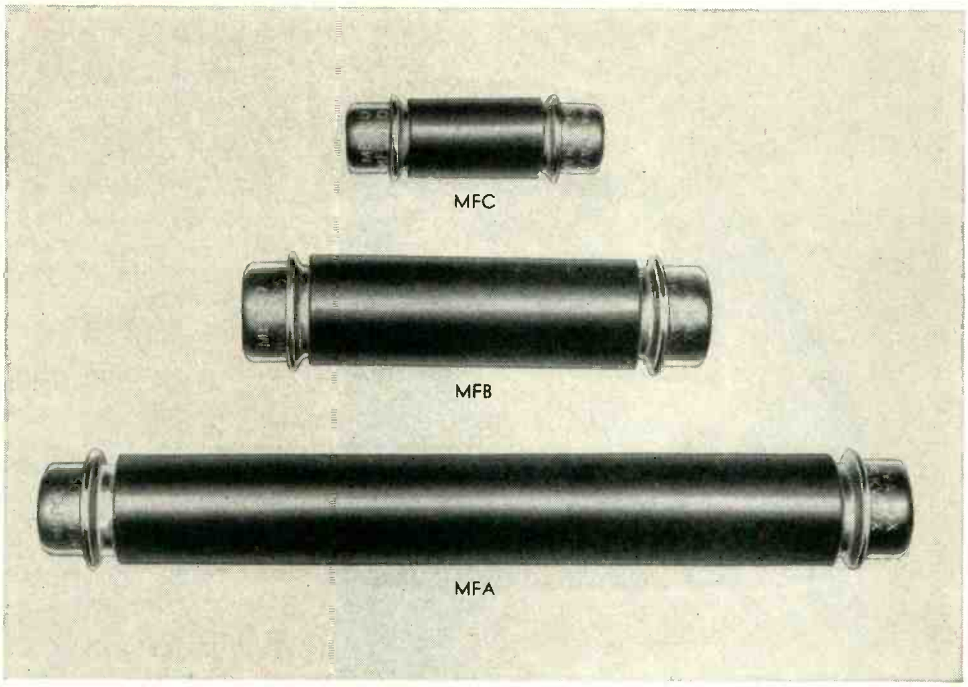
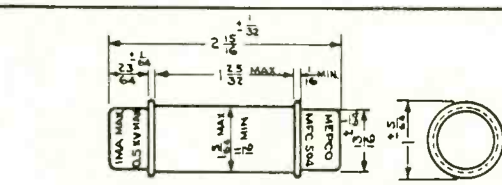
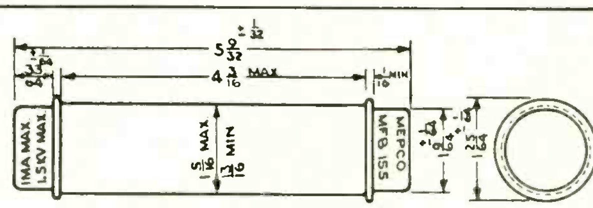
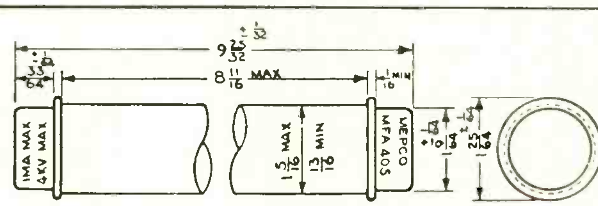
Heavy nickel plated brass. Corrosive resistant. Fit standard fuse clips.



Type	Megohms†	Kilovolts
MFC 504	0.5	0.5
MFC 804	0.8	0.8
MFC 105	1.0	1.0
MFB 105*	1.0	1.0
MFB 155	1.5	1.5
MFB 205	2.0	2.0
MFB 255	2.5	2.5
MFB 305	3.0	3.0
MFB 355	3.5	3.5
MFA 355*	3.5	3.5
MFA 405	4.0	4.0
MFA 455	4.5	4.5
MFA 505	5.0	5.0
MFA 605	6.0	6.0







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MEPCO, INC. 37 Abbett Avenue Morristown, N. J.

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

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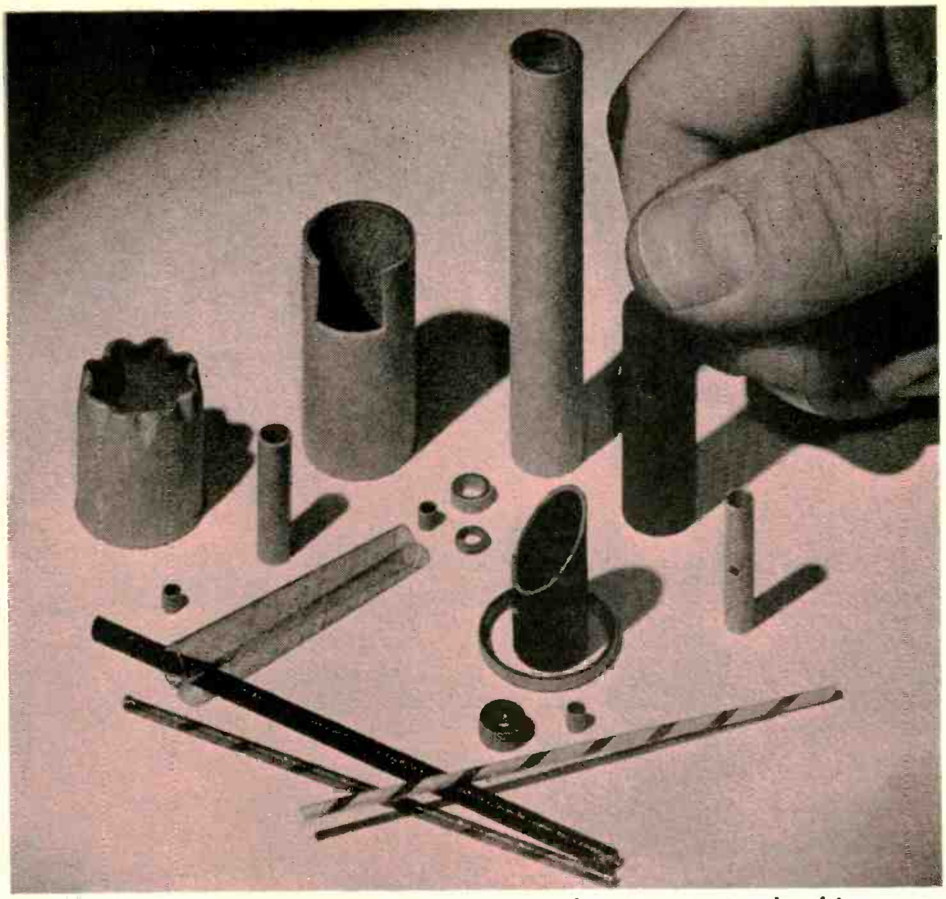

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They have found that Stone's 126-year-old heritage has paid off for them. This rich industrial background has enabled Stone to perfect more accurate methods of manufacture and to improve its mass-production techniques with the result that genuinely superior products are produced at low cost.

Stone specializes in small-diameter, spiral-wound insulating tubing from 3/64″ to 1″ ID. Larger sizes are available, of course. All Stone tubes are custom made, yet mass produced, and can be furnished in hi-dielectric kraft, fish paper, and plastic films in various wall thicknesses and lengths. They can also be formed, notched, punched, printed, dipped or impregnated with a variety of waxes and resins.

We suggest that you get in touch with our nearest representative or write directly to us. In either case, you will find an organization ready and able to serve you with unsurpassed service . . . the kind that has made us one of the world's largest small-diameter paper tube manufacturers.

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

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ELECTRONIC TACHOMETER

for P·R·E·C·I·S·E·L·Y
measuring speed and frequency

- Takes Less Space (12″ x 12″ x 8″)
- Uses Less Power (100 Watts)
- Has Fewer Tubes (Twenty-two)

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SINCE 1884

STANDARD

Write for Bulletin #200

The STANDARD ELECTRIC TIME COMPANY

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

Cramer
TIMING
DEVICES

time delay relays...

PROVIDE YOU WITH POSITIVE CONTROL FOR VITAL PROCESSES AND EQUIPMENT

Accurate, dependable timing is essential to insure the performance of your product . . . to speed up operations to maximum efficiency . . . to prevent work spoilage and to protect vital processes and equipment. Whatever the application, play it safe by specifying Cramer.

TYPE TEC

High accuracy timer, designed to provide an adjustable time delay between the closing of a control circuit and the subsequent closing or opening of a load circuit.

OUTSTANDING FEATURES

- **ACCURATE** . . . Repeat accuracy ½ of 1% of full scale reading. Overall accuracy (inclusive of setting), 2%.
- **EASY TO SET** . . . Micrometer adjusting knob insures extremely precise setting, yet can be set rapidly. Separate progress pointer indicates unexpired time.
- **EASY MOUNTING** . . . Convenient one-hole, meter-type mounting. Designed to blend well with your machine.
- **POSITIVE CLUTCH** . . . Serrated face-plate clutch insures positive engagement. No friction element to slip or wear.
- **TOTALLY ENCLOSED SWITCH** . . . Quick-make, quick-break, snap-type. Handles 10 amps. non-inductive at 110 volts A.C.
- **EXTRA STRENGTH MOTOR** . . . High torque Cramer motor provides extra reserve strength for adverse operating conditions.

the R.W. CRAMER CO., INC.

Box 3, Centerbrook, Conn.

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Interval Timers — Time Delay Relays — Time Totalizers — Cycle Timers — Running Time Meters — Pulse Timers — Hermetically Sealed Military Timers — Synchronous Timing Motors — Reset Timers — Duplex Cycle Timers — Percentage Timers — Clutch Type Motors — Multi-Contact Timers — Chart Drive Motors — Intervalometers

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SEND FOR COMPLETE INFORMATION ABOUT CRAMER TIME DELAY RELAYS

R. W. CRAMER CO., BOX 3, CENTERBROOK, CONN.

☐ Please send complete information about your Time Delay Relays.

☐ I am also interested in your bulletin on Synchronous Timing Motors.

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Title: ____________________

Company: ____________________

Address: ____________________

City & State: ____________________

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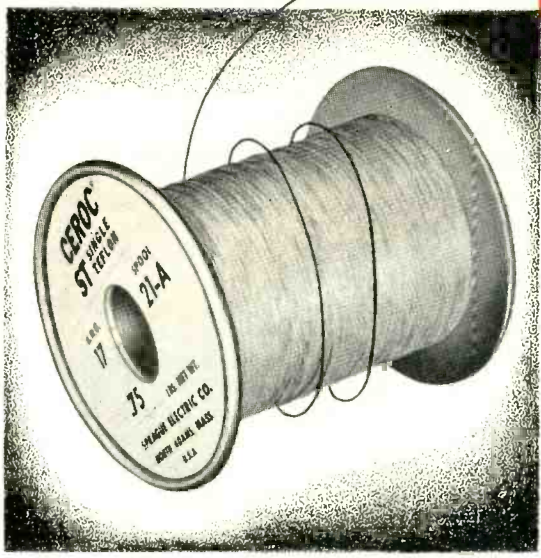
HIGH TEMPERATURE magnet wires

FOR CLASS H+ OPERATION



If your problem is the design of reliable miniaturized electrical equipment, investigate the size and weight savings possible with Ceroc Magnet Wires.

Ceroc Magnet Wires operate at temperatures well above the 180°C limit for Class H insulation, because they have a base insulation of a thin, flexible ceramic material. No other wire uses this patented construction!

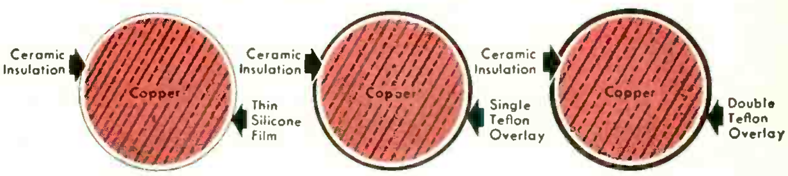
For operation at 250°C, Ceroc ST (Single Teflon) and Ceroc T (Double Teflon) have a tetrafluoroethylene overlay. Both have been used successfully up to 350°C in short-time military applications. Ceroc 200 for 200°C application has a silicone coating on the ceramic to facilitate winding.

Not only does the construction of Ceroc Magnet Wires permit very high current densities, but it also results in better cross-over characteristics in windings than those obtainable with all-plastic insulated wires.

For engineering data on Ceroc Magnet Wires, write on your business letterhead to the Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

Sprague, on request, now will provide you with complete application engineering service and assistance for optimum results in the design and manufacture of components using Ceroc High-Temperature Magnet Wires.

ENLARGED CROSS-SECTIONS OF CEROC MAGNET WIRES



CEROC 200 CEROC ST CEROC T

SPRAGUE

PIONEERS IN HIGH TEMPERATURE MAGNET WIRE

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

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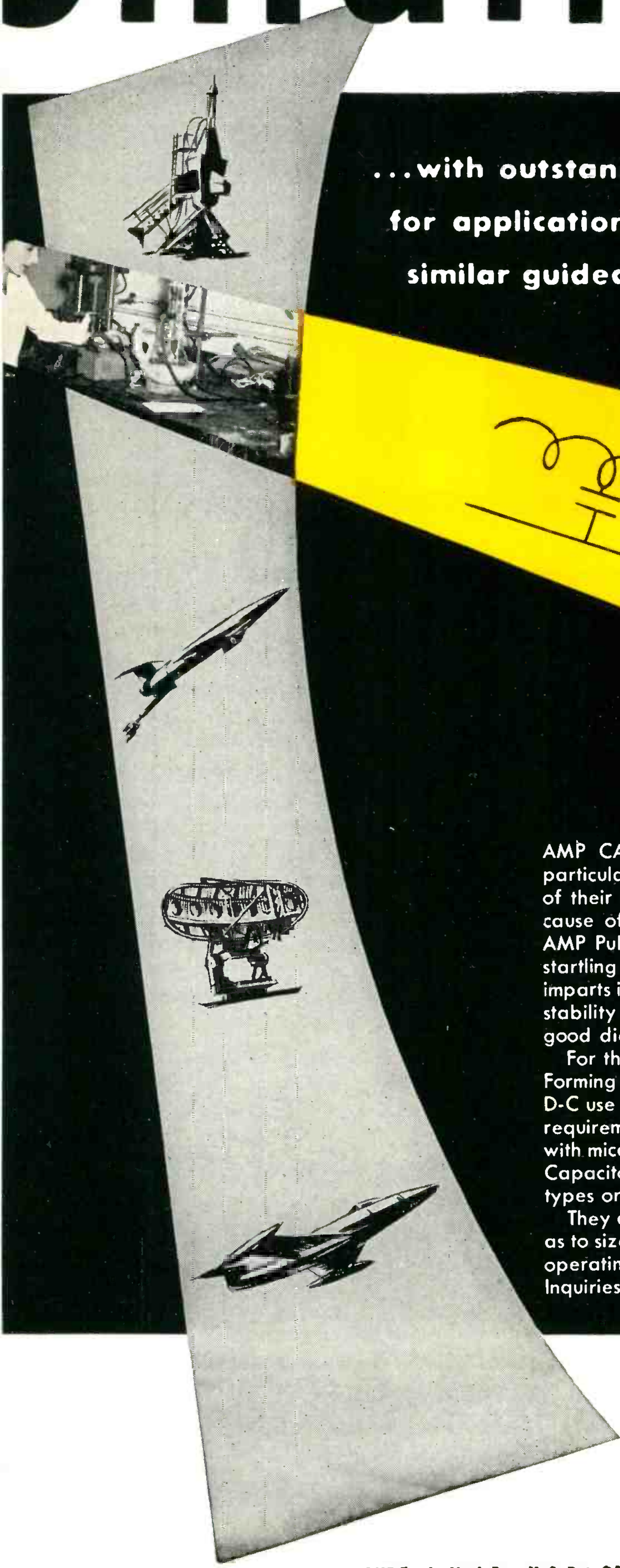
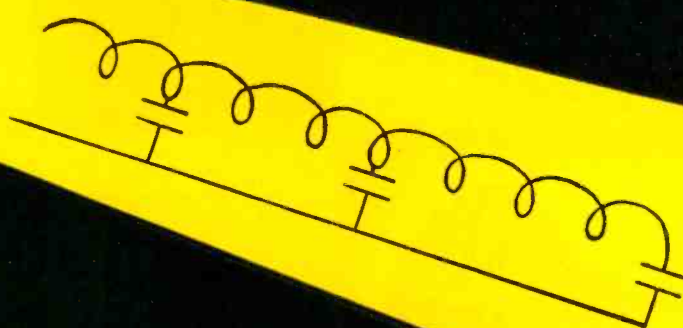


...with outstanding STABILITY and RELIABILITY for application in radar, missile control, and similar guided systems!



AMP CAPITRON* Capacitors and Pulse Forming Networks are particularly suited for radar and guided systems not only because of their remarkable size and weight characteristics, but also because of their outstanding stability and reliability in operation. AMP Pulse Forming Networks are fabricated with AMPLIFILM,* a startling new synthetic dielectric, chemically similar to mica, which imparts its unique combination of extremely high dielectric strength, stability over wide temperature ranges, low power factor, and good dielectric constant to these products.

For this reason CAPITRON* High Voltage Capacitors and Pulse Forming Networks are designed and fabricated for either A-C or D-C use in applications where the mechanical, electrical or thermal requirements are such that standard or catalog capacitors made with mica, paper or plastic dielectrics would be inadequate. These Capacitors and Networks are not made in a standard line of types or models.

They are designed in each instance for the specific requirements as to size, shape, working or test voltage, capacitance, life or other operating conditions of the equipment in which they are to be used. Inquiries are invited.

AMP is also nationally recognized leader in the field of solderless terminals, simplified wiring devices and, automatic wire termination. Write for our "Quality Control" brochure.

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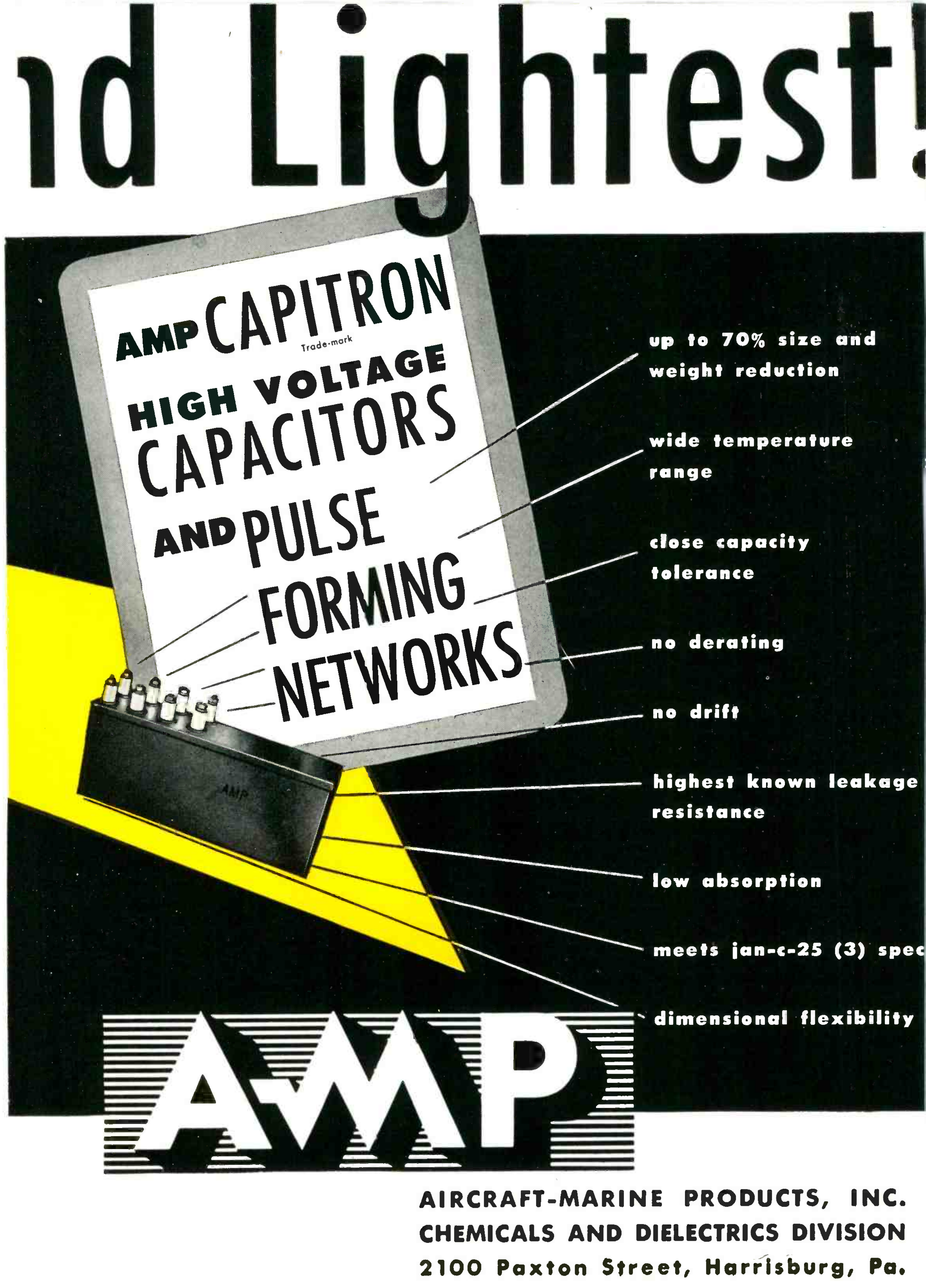
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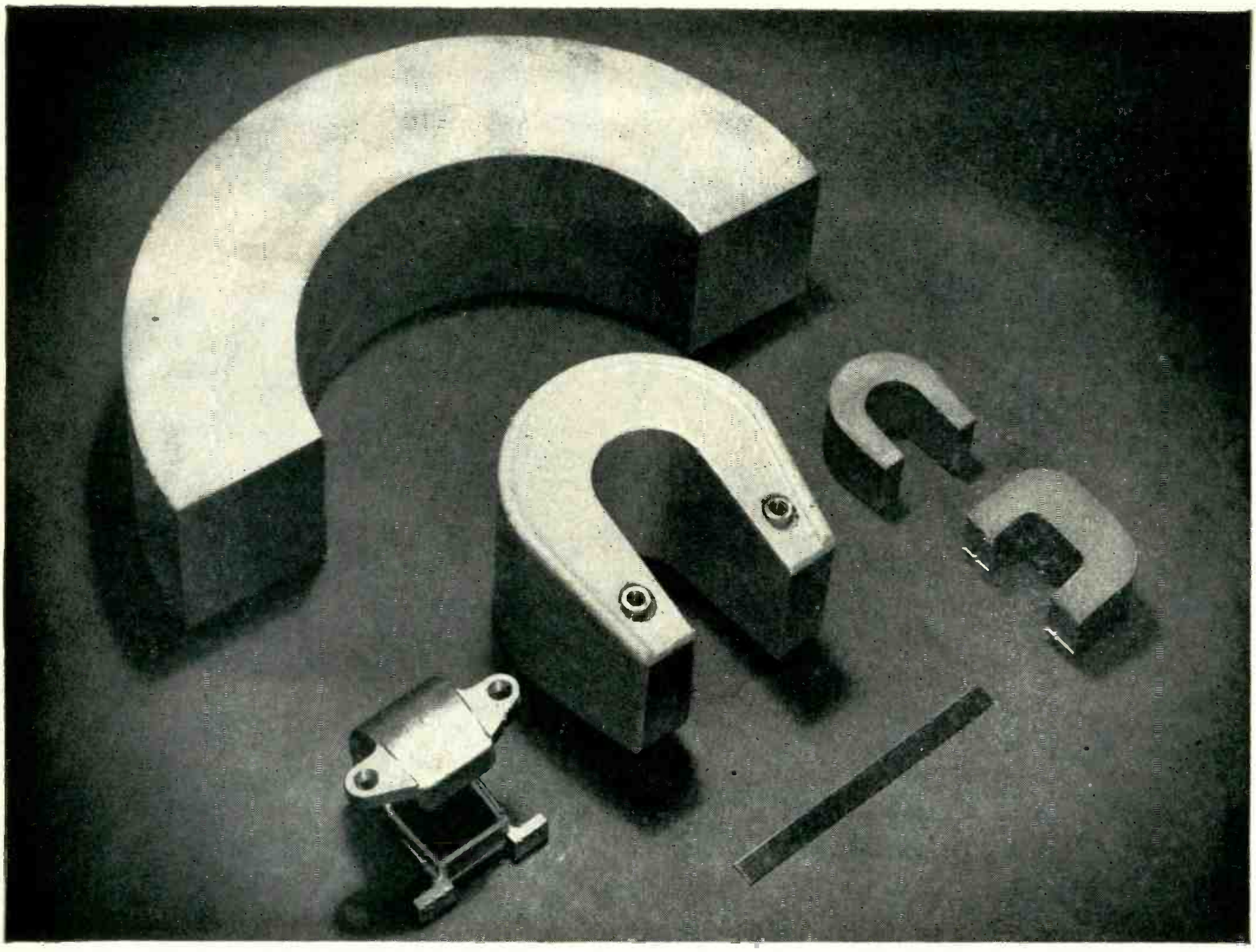

PERMANENT MAGNETS and ASSEMBLIES for Magnetrons and Traveling Wave Tubes

The group of magnets illustrated above, weighing from a fraction of a pound up to 75 pounds, are indicative of the wide range of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need, with die-cast or sand-cast aluminum jackets, Celastic covers, etc. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified . . . magnetized and stabilized as desired. ● *Let Arnold handle your magnetron and traveling wave tube permanent magnet requirements.*

Made to your Specifications

. . . ANY SIZE, SHAPE OR COATING REQUIRED

★ *We'll welcome your inquiries*

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

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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.

Every ADLAKE Relay is tested—*and guaranteed*—to meet specifications!

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Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

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DEPRECIATION

And Its Crucial Economic Role

The sixth annual McGraw-Hill survey of Business' Plans for New Plants and Equipment, just completed, reveals some remarkable facts about the role of depreciation in our economy. To most people, depreciation is a technical term, used by accountants to discuss a dull subject. But it really is a simple matter: It is the amount of money set aside each year by a company to replace plant and equipment that is wearing out. And here are some facts from this survey* which show how depreciation can make the difference between prosperity and recession in the United States:

1. *In 1953, about half of all the money spent on new manufacturing plants and equipment will come from depreciation reserves.* For the future, manufacturing companies are relying even more heavily on this source of money. In the years 1954-56, they count on using their depreciation funds to pay for almost two-thirds of the new plants and equipment now planned.

2. *The amounts of money made available by depreciation allowances vary greatly from industry to industry.* Some industries, such as those producing steel, chemicals and petroleum products, will have relatively large amounts of cash available from their depreciation reserves. In considerable measure, this is because the government is allowing them to accumulate such reserves at an accelerated rate as an encouragement to build facilities required for national defense. But most of the companies engaged in the production of textiles, processed foods and many kinds of machinery have had little chance to benefit by this provision for accelerated depreciation. Hence, they have much less money available from depreciation reserves.

3. *There is a definite shortage of investment funds in the industries that have relatively low depreciation allowances.* Taken together, the coal mining, textile, food processing, machinery and other metal-fabricating industries plan to spend about $4.7 billion for new plant and equipment this year. But they report that they would spend $1.5 billion *more* per year during the period 1954-56 if sufficient funds were available.

4. *Eighty-five per cent of the manufacturing companies covered by the survey reported that they plan to invest all their depreciation funds* to keep equipment up-to-date and to provide capacity for new products and new markets. These companies could let their depreciation funds pile up as idle cash. But the intention is to spend most of them for capital equipment.

*The sixth annual McGraw-Hill survey of Business' Plans for New Plants and Equipment included companies that provide 25 per cent of all industrial employment and 60 per cent of employment in those industries where capital investment is highest. These companies are mostly the larger companies in their respective industries. A copy of the full report of this survey can be obtained by addressing: Department of Economics, McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 36, N. Y.

Hence, there is a direct relationship between the amount of depreciation funds available and the level of capital investment. And it is upon the latter that the level of general prosperity decisively depends. One-third of all industrial workers are engaged in producing or installing such equipment.

This fact that the level of depreciation allowances has a major bearing on the level of capital investment should not surprise anyone. In several foreign countries where these allowances have been increased, investment has boomed. The two nations with the highest ratios of investment to national income are Canada and Norway. Both countries adopted flexible depreciation policies after World War II. In Sweden and The Netherlands also, flexible depreciation allowances have contributed to rapid industrial expansion. Finally, the tremendous investment brought about by our own rapid amortization program shows dramatically the importance of depreciation in stimulating capital expenditures.

Obsolete Tax Laws

In spite of this record, the fact remains that our laws and the business procedures that govern depreciation allowances — in particular the laws and rulings that govern the deduction of depreciation from taxable corporate income — are still based on antique and obsolete accounting concepts which take no account of depreciation's dynamic role in our economy. The internal revenue code still requires most companies to depreciate their equipment over a long period, even though these small annual allowances cannot possibly pay for the investment that is necessary to keep a plant up-to-date under today's rapidly changing technology, with its production of new and improved machinery.

The only allowance made by the government for rapid depreciation is that which is authorized for certain types of plants during the defense emergency. Under this policy most companies are unable to use accelerated depreciation for tax purposes. And as defense projects are completed, the number of new authorizations is dropping. We may lose the chance to utilize fully this powerful tool for sustaining investment because, under our ramshackle emergency tax structure, accelerated depreciation is available only to a minority of firms on a temporary basis.

New Policy Needed

A sensible, up-to-date depreciation policy for tax purposes is long overdue. Either the Treasury must modernize the internal revenue code on its own initiative, or Congress must take the lead by writing into permanent law a flexible depreciation policy applicable to all companies.

Treasury experts now have before them a number of proposals to allow faster depreciation for the average firm. The U.S. Chamber of Commerce has suggested that companies be allowed to deduct from taxable income 25 per cent of the cost of new equipment in the first year, with the remaining cost to be deductible over the life of the facilities. The Machinery and Allied Products Institute has long sponsored a formula that would allow full deduction in two-thirds of the estimated life of the property. In Congress, Chairman Reed of the Joint Committee on Internal Revenue Taxation has stated that we need a more flexible depreciation policy. Senator Frear of Delaware has introduced a bill that would let a business make its own choice on how fast to depreciate its equipment.

It will take time and study to determine which of these various proposals best fits the needs of the economy without sacrificing unduly the revenue needs of the government. If we are to have a new depreciation policy, designed for a long period ahead, it must be carefully worked out. But this much is clear right now: *The development of a flexible depreciation policy on the part of the federal tax authorities is one of the most important steps that can be taken to sustain prosperity. When we talk about depreciation, we are talking about the money that pays for almost two-thirds of the new manufacturing facilities now scheduled for construction. We are talking about the new investment and the new jobs on which our continued prosperity depends.*

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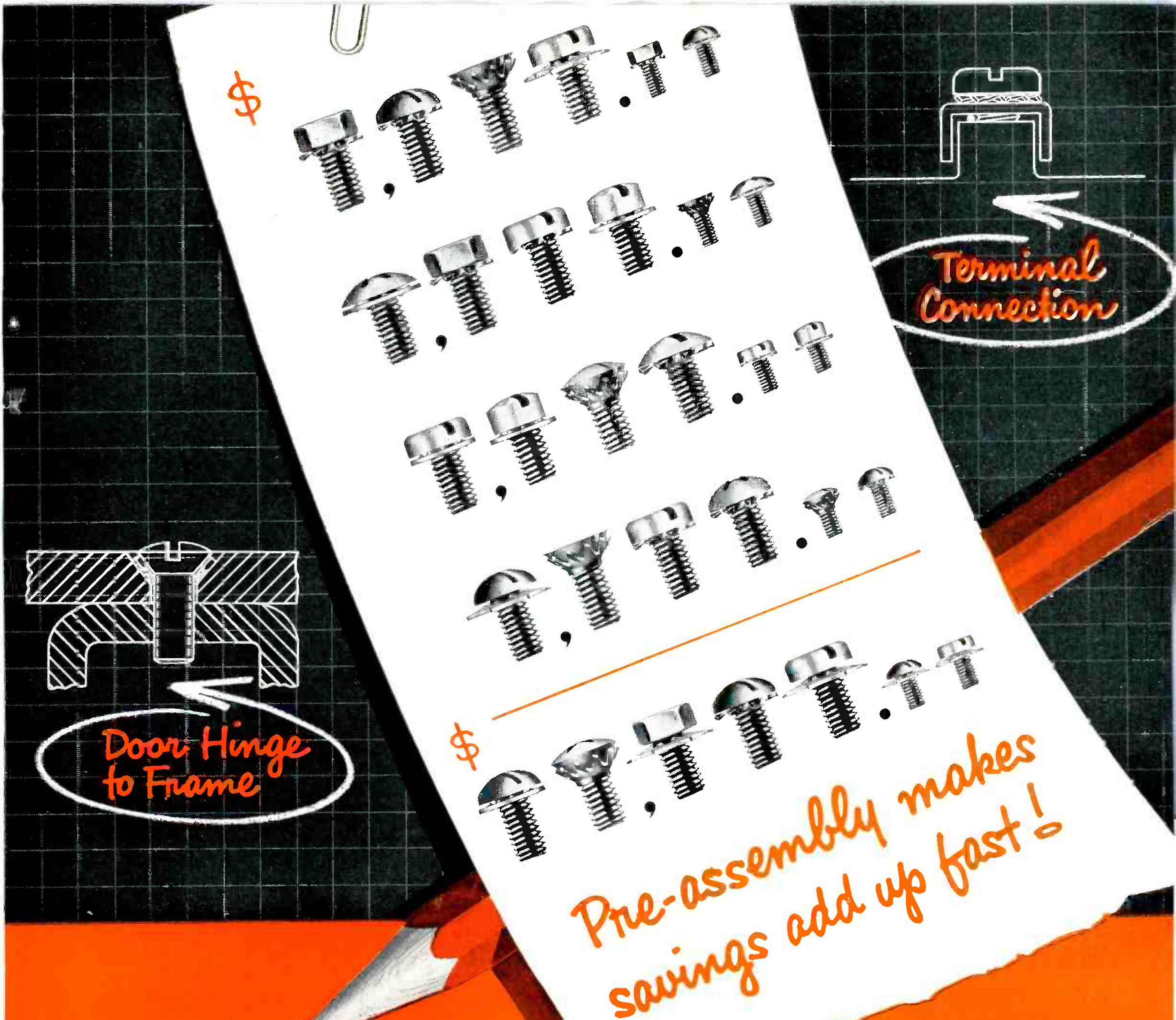

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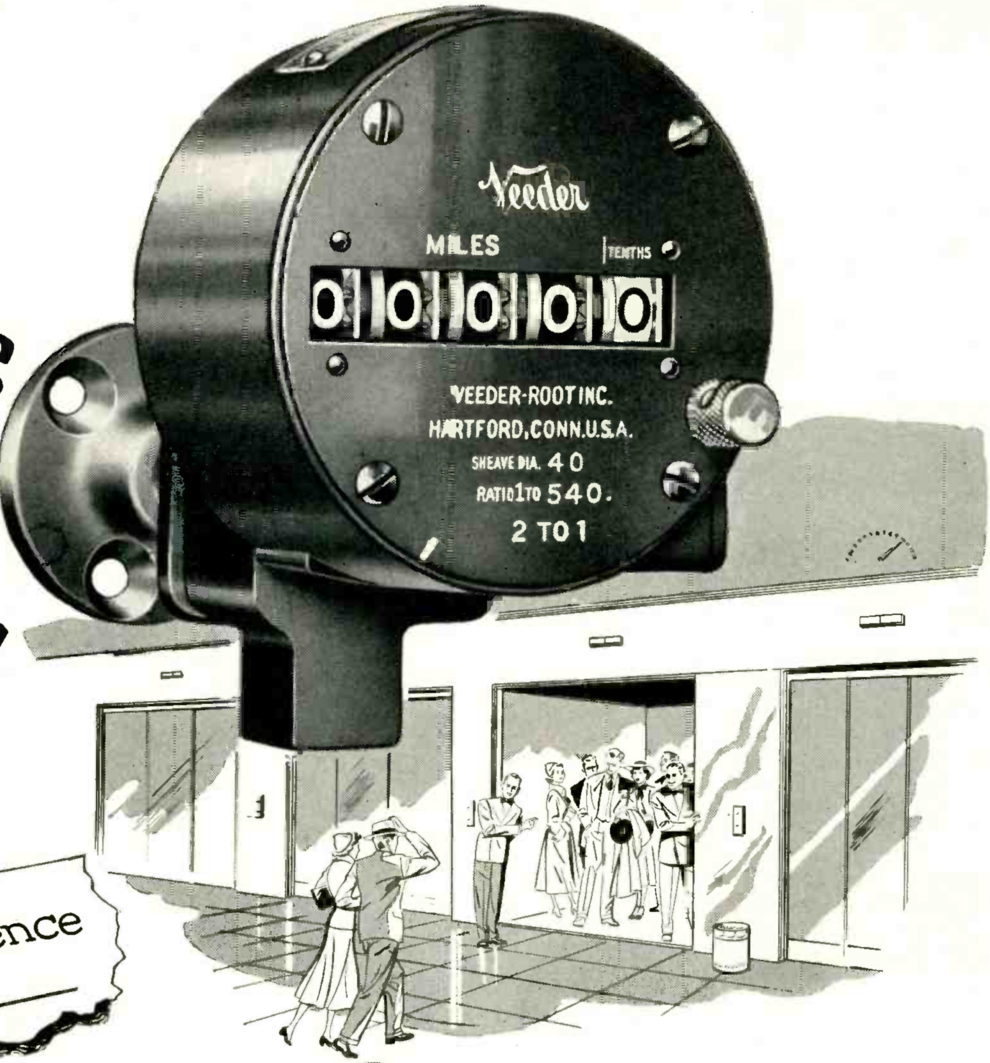

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Elevator Mileage Recorders give accurate figures on vertical miles . . . so that it can be plainly seen ... *in advance* ... when it's time to replace cables, overhaul cars, motors, and what have *you . . . including your life.*

Yes, the V-R wheelmark monogram protects millions of people daily, from the depths of the sea to the stratosphere. Of course, not all V-R Products and services are available nowadays

. . . but if your work counts importantly in defense, then you can count on Veeder-Root to help you, as soon as rush commitments permit.

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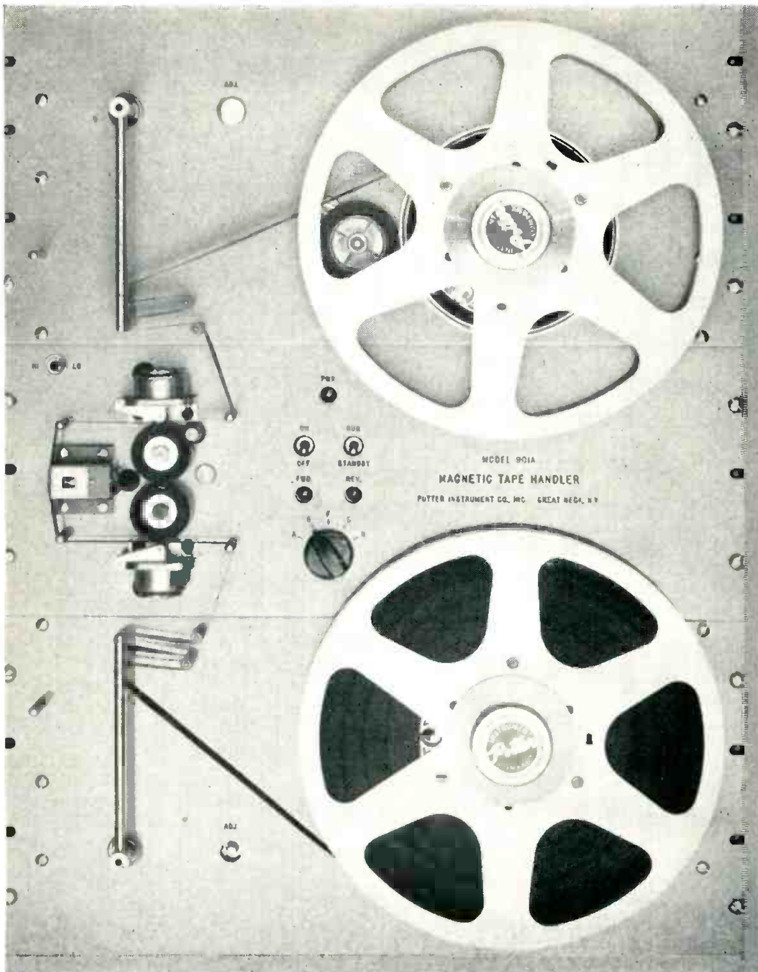

Announcing THE Potter

DIGITAL

MAGNETIC-TAPE HANDLER

A PRECISION RECORDER AT A REASONABLE PRICE!

SPECIFY IT FOR:

START-STOP RECORDING
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DATA REDUCTION
•
TELEMETERING
•
SORTING
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COLLATING
•
LIST PROCESSING

SPECIFICATIONS

	Model 901A	Model 901B
Tape Width	½"	¼"
*No. of tracks	6	2
Reel Size	NAB Standard, 10½"	
Reel Capacity	2400 ft.	
Tape Speed	Dual-speed, 15 and 30 inches/sec.	
Start & Stop Time	5 millisecond, either direction.	
Control	Manual, or remote pulses, 15 volts positive.	

*Greater number of tracks available on special order.

ASSOCIATED DATA HANDLING COMPONENTS

Complete Data Handling Systems or individual plug-in components are available. Recording and playback amplifiers, electronic counters with transfer gates, shift registers, and other associated data reduction components can be supplied for special data handling problems.

Here is a new high-speed Magnetic Tape Handler for every data recording application. Exclusive features provide maximum versatility, complete dependability, ease of operation, and simplicity of maintenance, *and do it at a price thousands of dollars below anything now available*.

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Unique in every respect, this outstanding Potter precision instrument provides 5 millisecond start and stop, forward or reverse, from external signals. Record, playback, or compare—every desirable function can be accomplished easily.

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New photo-electric proportional servo tension controls assure uniform tape tension over the recording head at all speeds. Independent reel drives, controlled by the servos, assure freedom from tape breakage or spilling.

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Do you have a problem in efficient *and economical* data handling? Check the performance specifications in the column at the left and, for complete information on how to fit the Potter Magnetic-Tape Handler into your program, **write, now, to Dept 6C.**

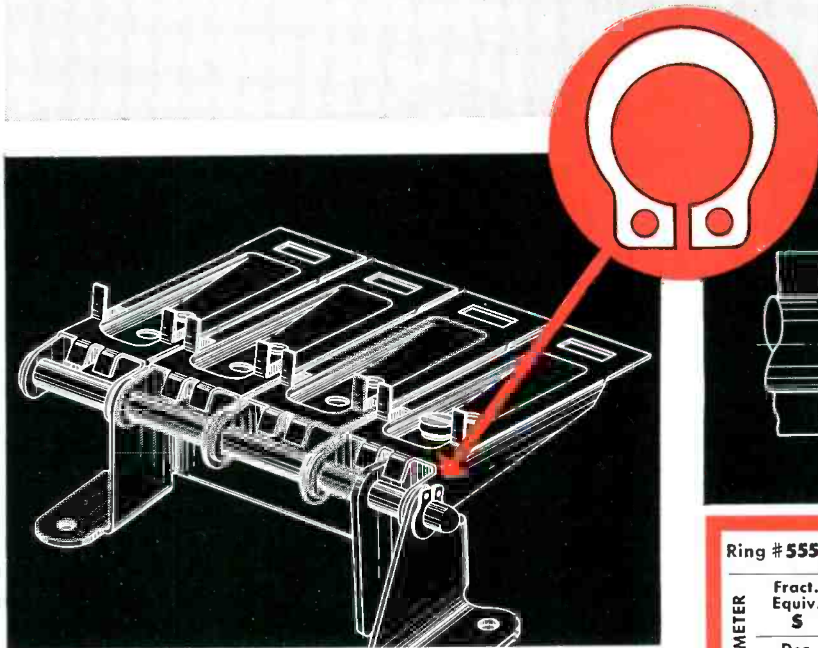
INSTRUMENT Potter COMPANY 107

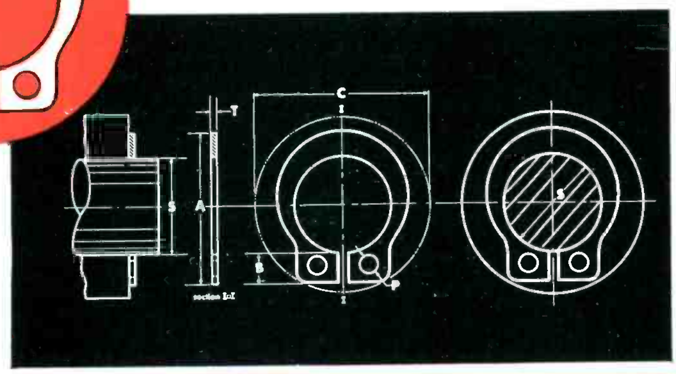
POTTER INSTRUMENT COMPANY

INCORPORATED

115 CUTTER MILL ROAD, GREAT NECK, NEW YORK

New Waldes Truarc GRIP Ring requires no groove, holds fast by friction, can be used over and over again





Ring #5555		5555-12	5555-13½	5555-18	5555-25	5555-31	5555-37
SHAFT DIAMETER	Fract. Equiv. S	1/8"	—	3/16"	1/4"	5/16"	3/8"
SHAFT DIAMETER	Dec. Equiv. S	.125	.136	.187	.250	.312	.375
SHAFT DIAMETER	TOL.	±.002	±.002	±.002	±.002	±.003	±.003
RING DIMENSIONS	Thickness T	.025	.025	.035	.035	.042	.042
RING DIMENSIONS	Thickness TOL.	±.0015	±.0015	±.002	±.002	±.002	±.002
RING DIMENSIONS	Length A	.268	.285	.364	.437	.553	.626
RING DIMENSIONS	Lug B	.078	.078	.097	.097	.141	.141
RING DIMENSIONS	Hole P	.042	.042	.042	.042	.078	.078
RING DIMENSIONS	Min. Ring C Clear	.33	.34	.44	.50	.67	.73
Approx. Ultim. Thrust Load (Lbs)		20	20	25	35	50	60

The Waldes Truarc Grip Ring is a new, low cost fastener that provides a positioning shoulder secure against moderate thrusts or vibration. Installed on a straight ungrooved shaft, the Truarc Grip Ring can be assembled and disassembled in either direction with Truarc pliers.

The Grip Ring can be installed tightly against a machine part in order to take up end-play. The basic Truarc design principle assuring complete circularity around periphery of the shaft and the ring's unusually large radial width combine to exert considerable frictional hold against axial displacement. The ring can be used again and again.

Find out what Waldes Truarc Retaining Rings can do for you. Send us your drawings. Waldes Truarc engineers will give your problems individual attention without obligation.

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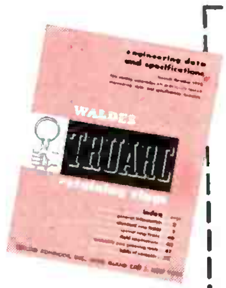

WALDES

TRUARC

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RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

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

Waldes Kohinoor, Inc., E 065
47-16 Austel Place, L.I.C. 1, N. Y.

☐ Please send me sample Grip-Rings (please specify shaft size ____________)

☐ Please send me the complete Waldes Truarc catalog.

(PLEASE PRINT)

Name ____________

Title ____________

Company ____________

Business Address ____________

City ________ Zone ____ State ________

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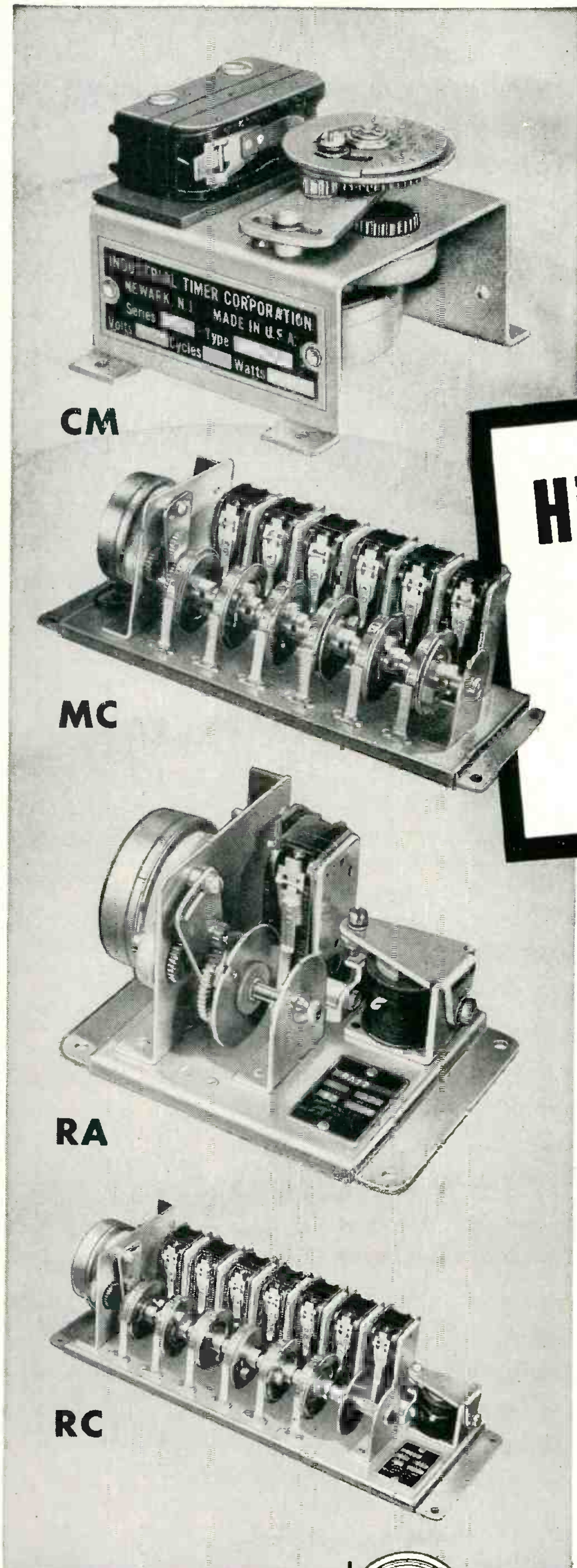

These Industrial Timer Corporation timers provide accurate and highly dependable instruments for control of a single operation or multiple operations (simultaneously or in sequence).

OUTSTANDING FEATURES ARE:

(1) the wide range of over-all time cycles obtainable from any one model;

(2) the ease with which over-all time cycles can be changed;

(3) the simplicity with which individual cams can be adjusted for ON and OFF periods, and positioned in specific timing sequence.

Highly Dependable
Synchronous Motor Driven
Cam Timers

Series CM CAM RECYCLING TIMERS

The Series CM Cam Recycling Timer repeats a definite electrical ON and OFF time cycle continuously. The cam is coupled to the motor by means of a simple gear and rack assembly—and the over-all time cycle can be easily changed by substituting gear racks. (Bulletin 33)

Series MC MULTI-CAM TIMERS

The Series MC Timer is identical to the CM Timer, but operates 2 to 6 circuits. All cams are mounted on a single shaft, which assures a common time cycle for all circuits. Each cam, however, is independently adjustable for a specific timing sequence. (Bulletin 34)

Series RA SINGLE CYCLE CAM TIMERS

The Series RA Timer provides a single time cycle upon being actuated electrically from remote control. A pawl on the cam eliminates necessity for prolonged closing of relay switch when starting. (Bulletin 35)

Series RC SINGLE CYCLE MULTI-CAM TIMERS

The RC is identical to the RA, but operates from 1 to 6 additional circuits. Thus it provides all the features of the Series MC Timer, plus the single cycle control afforded by the RA. (Bulletin 35)

Send us specifications, and we shall make recommendations based on your particular needs. Bulletins sent free on request.

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

Timers that Control the Pulse Beat of Industry

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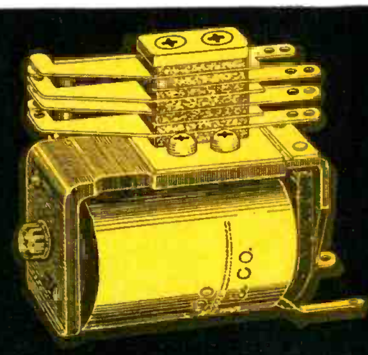
CLARE RELAYS

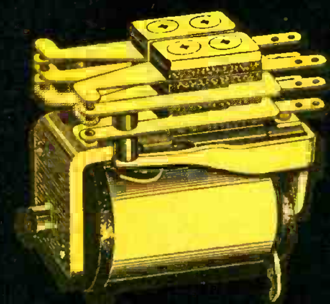
will meet most exacting small-space requirements

CLARE TYPE K RELAY

First small size, lightweight telephone type relay. Famous for operating speed and resistance to vibration.

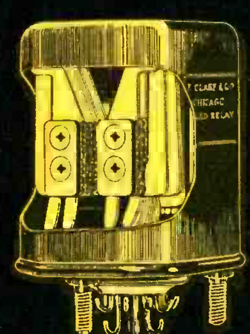


TYPE KX—Adds greater operating range and sensitivity with slightly longer coil.



TYPE R—Adds 120% greater sensitivity and 200% greater operating range than Type K.

TYPE N—Operates on less than 50 milliwatts with 10,000 Ohm coil, 1 form C contact and standard adjustment.



HERMETICALLY SEALED RELAYS

Type N Relay hermetically sealed in steeled container... a feature available with all Clare relays.

CLARE pioneered the small-relay field with the Type K relay. Since that time it has been the mainstay of design engineers who must have a superior relay to operate in extremely small space.

The Clare Type K not only has the advantages of small size and light weight but it is capable of exceedingly fast operation, gives adequate contact pressure and is highly resistant to shock and vibration. Its long life and all-around dependability have enabled this relay to meet many complex engineering requirements.

In order to meet customers' specifications which the Type K would not quite fill, Clare engineers have developed three other small, light weight relays. All retain the basic operating and physical characteristics of the Type K. Two of them, the Type KX and the Type R, have the famous Clare reed armature suspension of special alloy. This has long been recognized as one of the subtler reasons for the superior performance of the Clare Type K relay.

The Type KX adds greater operating range and sensitivity by use of a slightly longer coil which can be safely wound to 8000 ohms resistance. The Type R adds still greater operating range and sensitivity by use of a coil not only longer but of greater diameter. The Type N relay is designed for operation on very low power. It employs a close-coupled magnetic circuit, generous use of magnetic iron and highly efficient coil design. This permits high sensitivity while retaining high contact pressure (minimum 30 grams) and adequate contact gap (minimum 0.0015″).

All these relays are available enclosed in hermetically sealed gas-filled containers which increase their life, reliability and usefulness under extreme conditions of altitude, temperature, moisture, fungi, dust and dirt.

Clare sales engineers are located near you. For complete information call the nearest Clare office or contact: 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

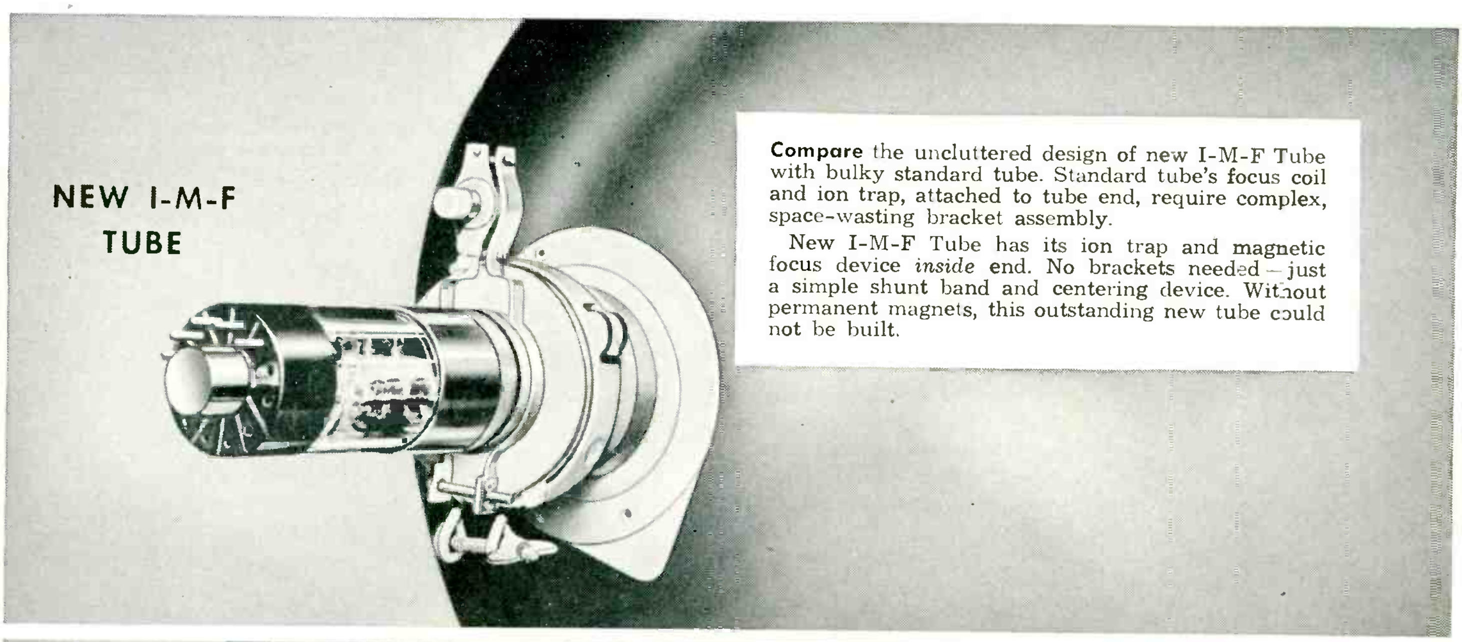
Carboloy permanent magnets help eliminate parts, simplify

Latest television advance is G.E.'s new I-M-F *pre-focused* picture tube. It employs tiny, powerful Carboloy permanent magnets to help eliminate focusing dials and external assembly units . . . to cut costs, keep image in sharper focus always.

Here's how the tube is designed: A drastically smaller and simplified magnetic ion trap and magnetic focusing unit are now built *inside* the tube . . . replacing old-style external ion trap, focus coil and mechanical supports.

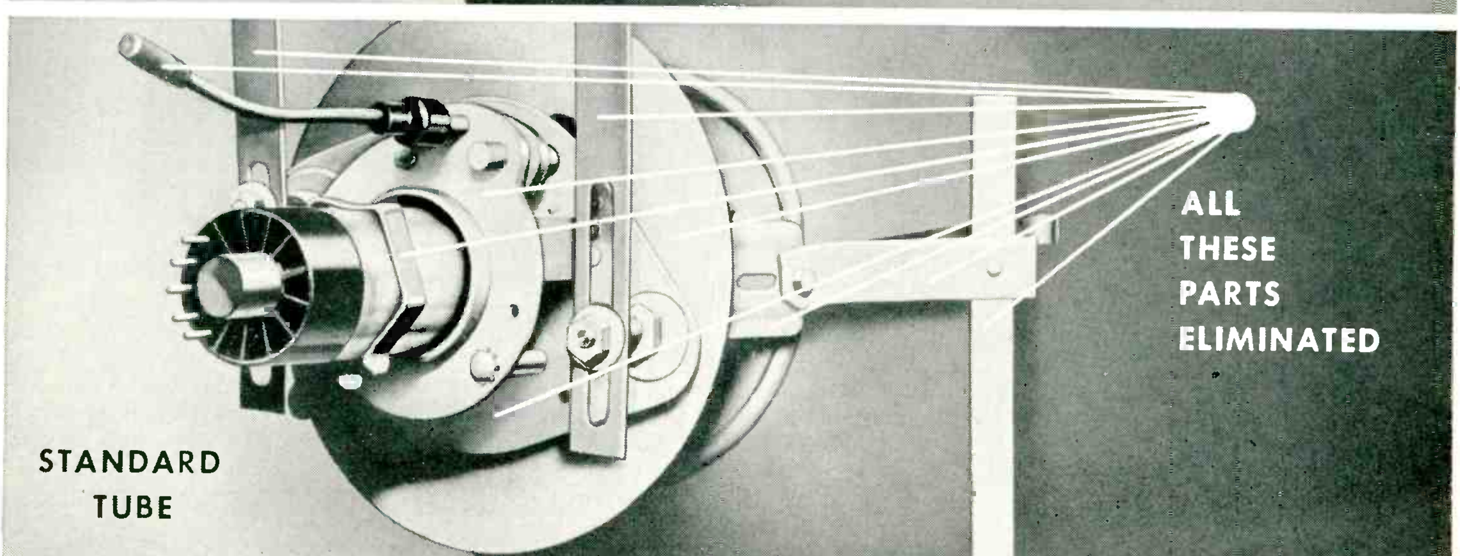
One Carboloy magnet – half the size of a pea, one-tenth the size of the magnet formerly used – now supplies ample, lasting field energy for the new ion trap. Three slightly larger Carboloy magnets furnish the strong magnetic energy needed in the new focusing unit – a job that once required a bulky focus coil plus a complicated mounting device.

Thus, thanks to the magnets, the new tube is more simple in design, more compact. Three costly exterior units are done away with. The tube takes up less space, saves material, assembly expense and adjustment time . . . the set weighs less. Viewers get sharper pictures . . . won't have to bother with a focusing dial. A typical case of product improvement with Carboloy permanent magnets.



Compare the uncluttered design of new I-M-F Tube with bulky standard tube. Standard tube's focus coil and ion trap, attached to tube end, require complex, space-wasting bracket assembly.

New I-M-F Tube has its ion trap and magnetic focus device *inside* end. No brackets needed – just a simple shunt band and centering device. Without permanent magnets, this outstanding new tube could not be built.



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WESTON Ruggedized Instruments

have *EXCLUSIVE* zero correctors

No desirable instrument features were sacrificed in order to produce these truly ruggedized and effectively sealed instruments. With typical WESTON thoroughness, every feature has been retained including even the zero corrector. And *true* ruggedness has been achieved by new but thoroughly proved design concepts, such as shock-resistant spring backed jewels . . . flat windows of tough, anti-static, and glare reducing plastic . . . new high-strength tubular pointers, and a method of shock mounting and sealing that assures accurate indications under extremes of shock, vibration, temperatures, humidity, and downright abuse. Available in 2½" and 3½" D-C, R-F, A-C movable iron and rectifier types. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

Connection terminals molded into internal rubber increase current carrying capacity.

Tough, flat plastic windows reduce glare and are *really* shock resistant.

WESTON Instruments

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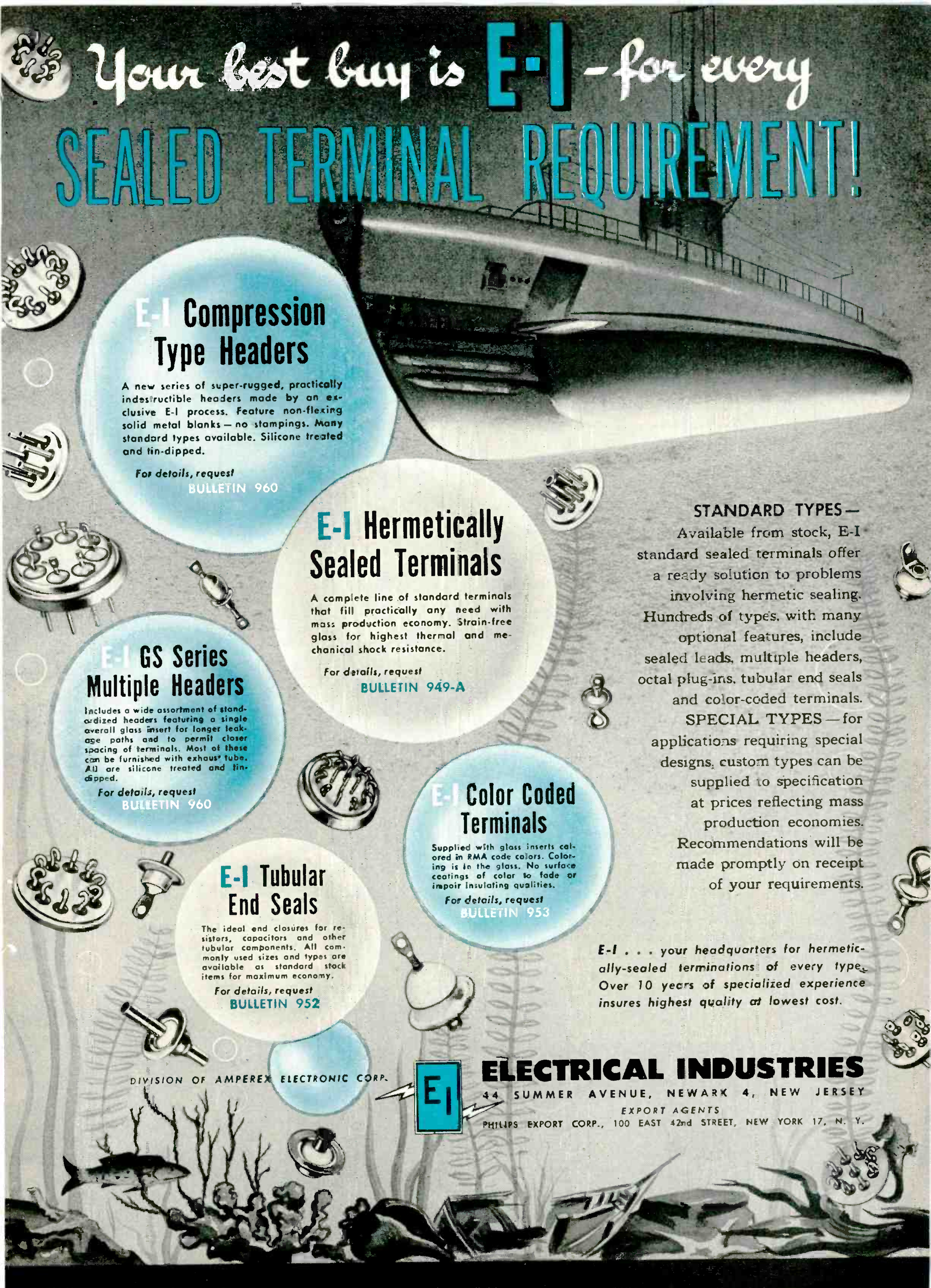

Your best buy is E-I - for every
SEALED TERMINAL REQUIREMENT!
E-I Compression Type Headers
A new series of super-rugged, practically indestructible headers made by an exclusive E-I process. Feature non-flexing solid metal blanks — no stampings. Many standard types available. Silicone treated and tin-dipped.
For details, request BULLETIN 960
E-I Hermetically Sealed Terminals
A complete line of standard terminals that fill practically any need with mass production economy. Strain-free glass for highest thermal and mechanical shock resistance.
For details, request BULLETIN 949-A
E-I GS Series Multiple Headers
Includes a wide assortment of standardized headers featuring a single overall glass insert for longer leakage paths and to permit closer spacing of terminals. Most of these can be furnished with exhaust tube. All are silicone treated and tin-dipped.
For details, request BULLETIN 960
E-I Color Coded Terminals
Supplied with glass inserts colored in RMA code colors. Coloring is in the glass. No surface coatings of color to fade or impair insulating qualities.
For details, request BULLETIN 953
E-I Tubular End Seals
The ideal end closures for resistors, capacitors and other tubular components. All commonly used sizes and types are available as standard stock items for maximum economy.
For details, request BULLETIN 952
STANDARD TYPES — Available from stock, E-I standard sealed terminals offer a ready solution to problems involving hermetic sealing. Hundreds of types, with many optional features, include sealed leads, multiple headers, octal plug-ins, tubular end seals and color-coded terminals.
SPECIAL TYPES — for applications requiring special designs, custom types can be supplied to specification at prices reflecting mass production economies. Recommendations will be made promptly on receipt of your requirements.
E-I . . . your headquarters for hermetically-sealed terminations of every type. Over 10 years of specialized experience insures highest quality at lowest cost.
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44 SUMMER AVENUE, NEWARK 4, NEW JERSEY
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PHILIPS EXPORT CORP., 100 EAST 42nd STREET, NEW YORK 17, N. Y.

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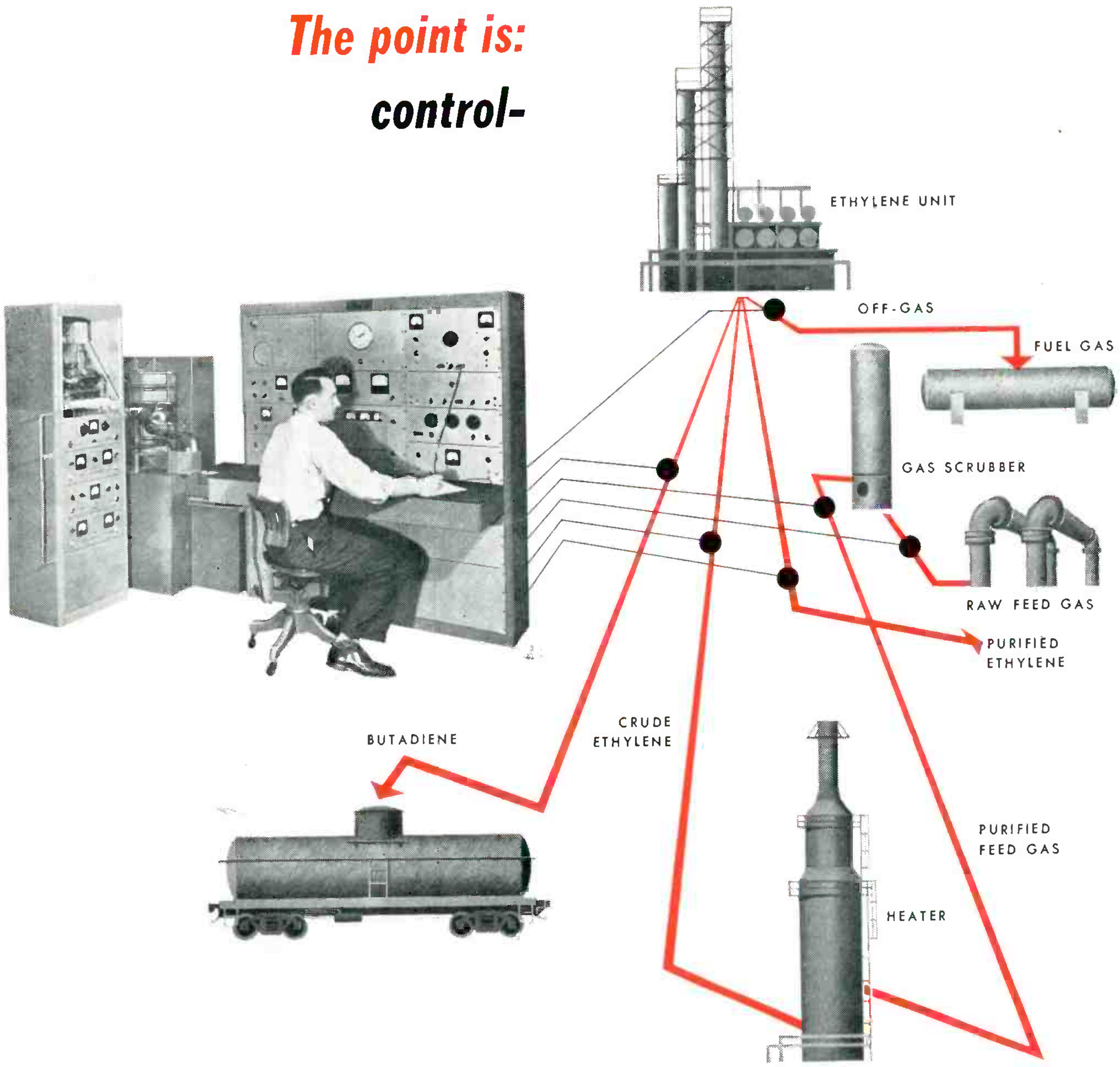
The point is:
control-



IN THE huge Texas plant of Jefferson Chemical Company, Inc., at Port Neches, Texas, approximately 50,000 complex control analyses of hydrocarbon mixtures have been made on a single Consolidated Analytical Mass Spectrometer since 1947. These figures indicate the speed, accuracy, and trouble-free service that can be built into a sensitive analytical instrument. For year-in, year-out operation this versatile control instrument offers decided advantages: the cost-per-analysis is only a fraction of the cost by any other method and the results are available in permanent graphic form in a fraction of time otherwise required. One operator and a Consolidated Mass Spectrometer will accomplish complete control over the most complicated chemical processes—in minutes.

Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, Philadelphia, New York, Chicago, Dallas*

analytical instruments for science and industry

Mass Spectrometer

The Consolidated Analytical Mass Spectrometer shown above is used extensively by leading refineries throughout the world for analytical research as well as process control. For complete information on this instrument, write for Bulletin CEC 1800-X10

Choose the PROPERTIES you want

...with GLOBAR Ceramic Resistors
TRADE MARK

What combination of resistor properties will help you solve your electrical or electronic resistance problem? Low temperature coefficient...or high? Low voltage coefficient...or extremely high? Normal dissipation capability...or exceptional? Or should one or more of these properties be in between the extremes?

GLOBAR Brand Ceramic Resistors are engineered to your specifications—to give you the most favorable combination of properties to satisfy *your* circuit requirements. The combinations possible cover a very wide range, as these typical uses indicate: Resistance where needed as a circuit element in television and radio receiver circuits, in hearing aids, printed circuits, radio transmitters, etc.; suppressing parasitic oscillations in electron tubes; compensating for temperatures in measuring instruments and coils; stabilizing voltages or speeds in machinery; arresting surges in electrical circuits; providing time delays; and many others.

Other advantages you gain in using GLOBAR Brand Ceramic Resistors include: rugged ceramic body, long life, mechanical and chemical stability.

Whatever your requirements in resistors, whether for normal or difficult circuits, it will pay you to investigate GLOBAR Brand Ceramic Resistors. Our engineers are ready to assist you—without obligation. Just send complete circuit information, and tell us what you expect from the resistors you need.

● For useful engineering data on GLOBAR Brand Ceramic Resistors, send for your copy of Bulletin R. Write Dept. E 87-36.

GLOBAR
TRADE MARK

Ceramic Resistors by CARBORUNDUM

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company, Niagara Falls, New York

87-36

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New!

High Linearity

Infinite Resolution

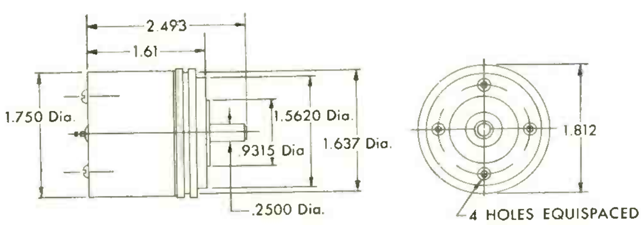
REVOLUTIONARY, UNIQUE

spiralpot

MULTI-TURN SLIDE WIRE POTENTIOMETER

Long Life

Low Noise



With linearities of ±0.1%, ±0.05% and ±0.025% (both independent and zero based ratings) and rotational tolerances of +1°, −0°, new precision grades of Spiralpot Potentiometers are now available to fill high precision requirements. Designed specifically for high resolution and exceptional linearity applications such as servo control and computers, the Spiralpot can be obtained with shaft rotation up to 7200°. The inherent advantages of a true slide wire action, such as smooth operation, minimum noise and infinite resolution, are increased by design extras such as stainless steel shaft, ball bearings, positive mechanical stops, and a starting torque of less than .6 oz.-in. to give a unit which has extremely long life of over one million cycles (20 million revolutions in a ten-turn unit) and operational shaft speeds up to 500 rpm. These advantages add up to make the Spiralpot one of the biggest advances in precision potentiometer design.

Write for Bulletin 101 A

SPECIFICATIONS

RESISTANCE: 2 ohms/360°, and from 50 ohms/360° shaft rotation to 250 ohms/360° shaft rotation. Standard resistance ranges for 3600° (10-shaft turns) units: 500, 1000, 1500, 2000, 2500 ohms.

POWER RATING: 5.0 watts at ambient = +25°C.

LINEARITIES AVAILABLE: (Based on percent of terminal voltage)

±0.1% Normal (Independent)	±0.1% Zero Base
±0.05% Normal (Independent)	±0.5% Zero Base
±0.025% Normal (Independent)	±0.025% Zero Base

RESOLUTION: Infinite.

MECHANICAL SHAFT ROTATION: For Standard Units (±0.1% linearity). 3600°+3°,−0°.

For Precision Grade Units: 3600° + 1° − 0° (Other linearities)

TORQUE: Starting: less than 0.6 oz.-in. Running: less than 0.3 oz.-in.

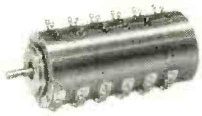
LIFE: Will operate within specifications after one million cycles (20 million revolutions for a 10-turn unit).

TEMPERATURE RATING: Operating range from − 55°C. to + 71°C.

VOLTAGE BREAKDOWN: Will withstand 1000v 60 cycle (rms) for 5 minutes. (At sea level).

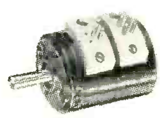
WEIGHT: 4.0 oz.

OTHER GIANNINI POTENTIOMETERS



Gangpot

2½" dia; ¼" shaft; 1 to 6 sections, Aluminum Case; 360° rotation; ±0.3% lin. 4 watts/sec; 2K to 300K ohms; Vernier Screwdriver Phasing. Ball bearings.



Minigang

1⅛" dia; ¼" shaft; 1 to 6 sections, Aluminum Case; 360° rotation; ±0.5% lin. 2 watts/sec; 500 to 70,000 ohms, Ball bearings.

Rectipot

Straight-line motion along axis. Linear or functional output. 200 to 60,000 ohms. 5 sizes, 1" dia. from 2.33" to 6.54" long. Stroke ⅕" to 5".

Universal

1.74" dia; ¼" shaft; 360° rotation; ±0.3% lin; 4 watts; 2K to 200K ohms, Aluminum Case. Ball Bearings. 40 and 50 db log functions 20K ohms.

Giannini INSTRUMENT QUALITY POTENTIOMETERS

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

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REALLY New!

ACTUAL SIZE

COMPLETE
miniature
FREQUENCY STANDARD

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

1. JAN-ized construction throughout.
2. SPACE-SAVING, 1½" dia. x 4½" high.
3. WEIGHT, approximately 10 ounces.
4. AVAILABLE in 400 and 500 cycles.
5. ACCURACY—.002% (15° to 35°C).
6. SHOCK-MOUNTED on Silicone rubber.
7. POWER REQUIRED, 6 V. at 300 ma. 70 to 200 V. at 1 to 5 ma.

WRITE FOR DESCRIPTIVE LITERATURE, SPECIFYING "TYPE 2007"

Also, manufacturers of frequency standards, multi-frequency standards, chart-recording chronographs, firing-cycle timers, the Watch-Master Watch Rate Recorder and other high-precision frequency and timing instruments, controlled by our tuning-fork oscillators.

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

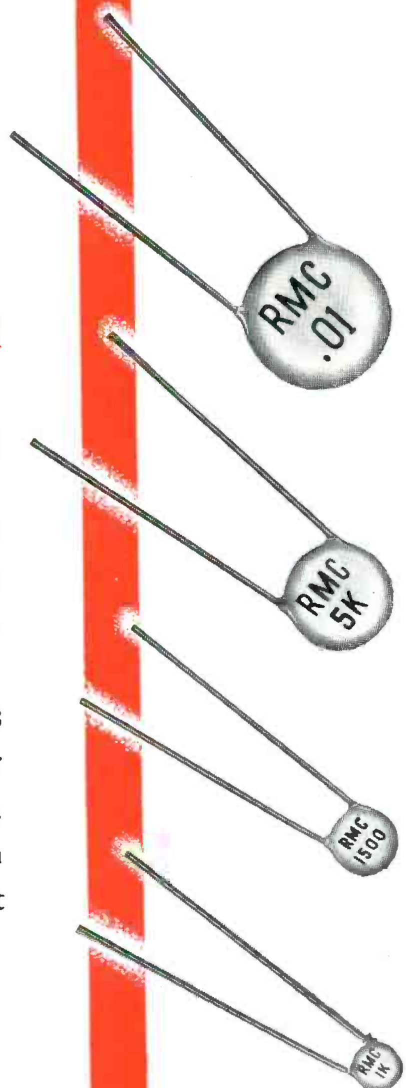
American Time Products, Inc.

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

MANUFACTURING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

RMC By-Pass DISCAPS

are Rated at 1000 Working Volts



Modern Engineering Requires This
"HEAVY DUTY" CERAMIC CAPACITOR

The heavier ceramic dielectric element made by an *entirely new process* provides the necessary safety factor required for line to ground applications or any application where a steady high voltage condition may occur. Designed to withstand constant 1000 V.A.C. service.

It is wise to specify RMC "HEAVY DUTY" by-pass DISCAPS throughout the entire chassis because they *cost no more* than ordinary lighter constructed units.

Specify them too, for your own peace of mind, with the knowledge that they can "take it." And if you want proof—request samples.

"RMC DISCAPS" The Right Way to Say Ceramic Condensers

A New Development from the RMC Technical Ceramic Laboratories

DISCAP CERAMIC CONDENSERS

RMC

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TAYLOR ***Insulation (Fish Paper)***
is extremely tough . . . has high dielectric strength and excellent bending qualities . . . its hard surface resists abrasion from contact with rough spots in slots.

Want to make something of it?

Make it into armature slot insulation, armature end laminations, field coil insulation, metal box liners, washers, arc shields, formed slot wedges, formed specialties . . . or any other applications requiring excellent electrical characteristics. Color: gray.

Make it from sheets and rolls . . . or ribbon rolls for automatic machines.

SPECIFICATIONS

Thickness range . . . . .005″ to ⅛″
Finish. Calendered or uncalendered
Punching . . . . Up to ⅛″
Sheet size . . . . 56″ x 90″

Roll width 56″ in thicknesses of .005″ through .090″. Coils down to ¼″ for thicknesses of .005″ through .090″.

PROPERTIES

Mechanical

Tensile Strength, psi
(Lengthwise) 14000 min.
(Crosswise) 6000 min.

Elmendorf Tearing Strength, grams

	*MD	*CD
.005″	100	120
.007″	190	220
.010″	250	300
.015″	375	450

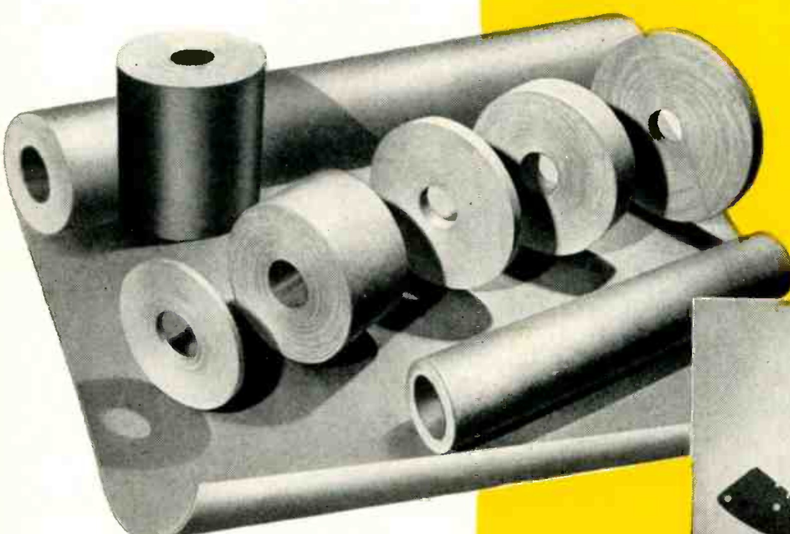
*MD—Machine Direction
*CD—Cross Machine Direction

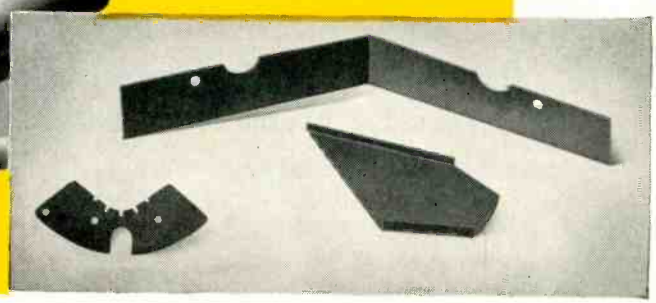
Electrical

Dielectric Strength, vpm
Short Time Test

.004″—.005″	200 min.
Over .005″—.015″ incl.	300 min.
Over .015″—.040″ incl.	250 min.
Over .040″—.060″ incl.	175 min.

Arc Resistance, seconds 100





Make it easy for yourself the next time you are buying insulation. Call your Taylor Engineer . . . he will be glad to help you select the Taylor Insulation that will best fit your needs. Also ask him for samples of our other grades of vulcanized fibre—Commercial, Bone, Super White, Abrasive and Built-Up—as well as Taylor *Phenol, Silicone and Melamine Laminated Plastics* . . . see where they can fit into your design plans.

Taylor Fibre Co., Norristown, Pennsylvania—La Verne, California

TAYLOR
Laminated Plastics
Vulcanized Fibre

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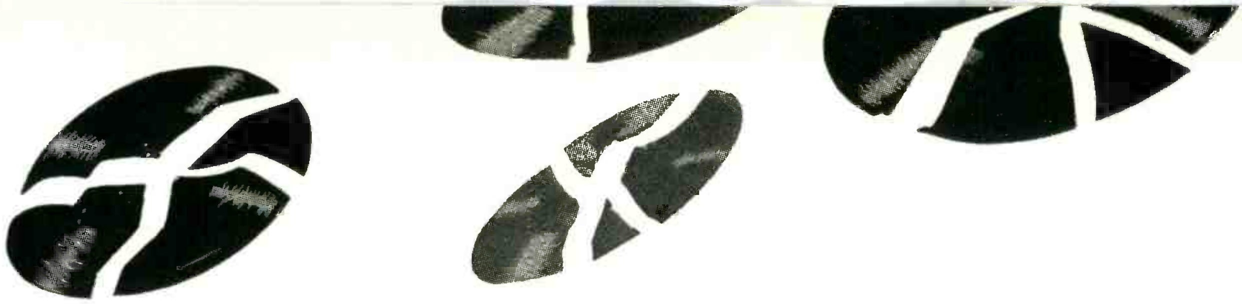
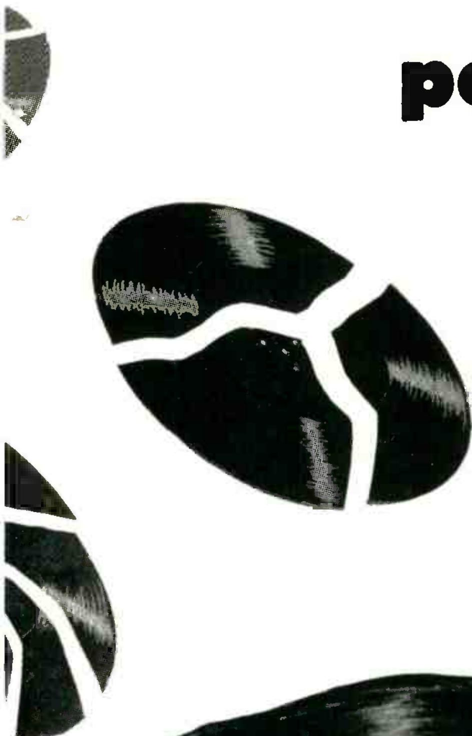




portrait of an engineer...

Engineers are a happy lot, until faced with a moment like this:

A recording is completed. The disc is put on the playback table . . . but it's full of "pops," "ticks" and "hisses".

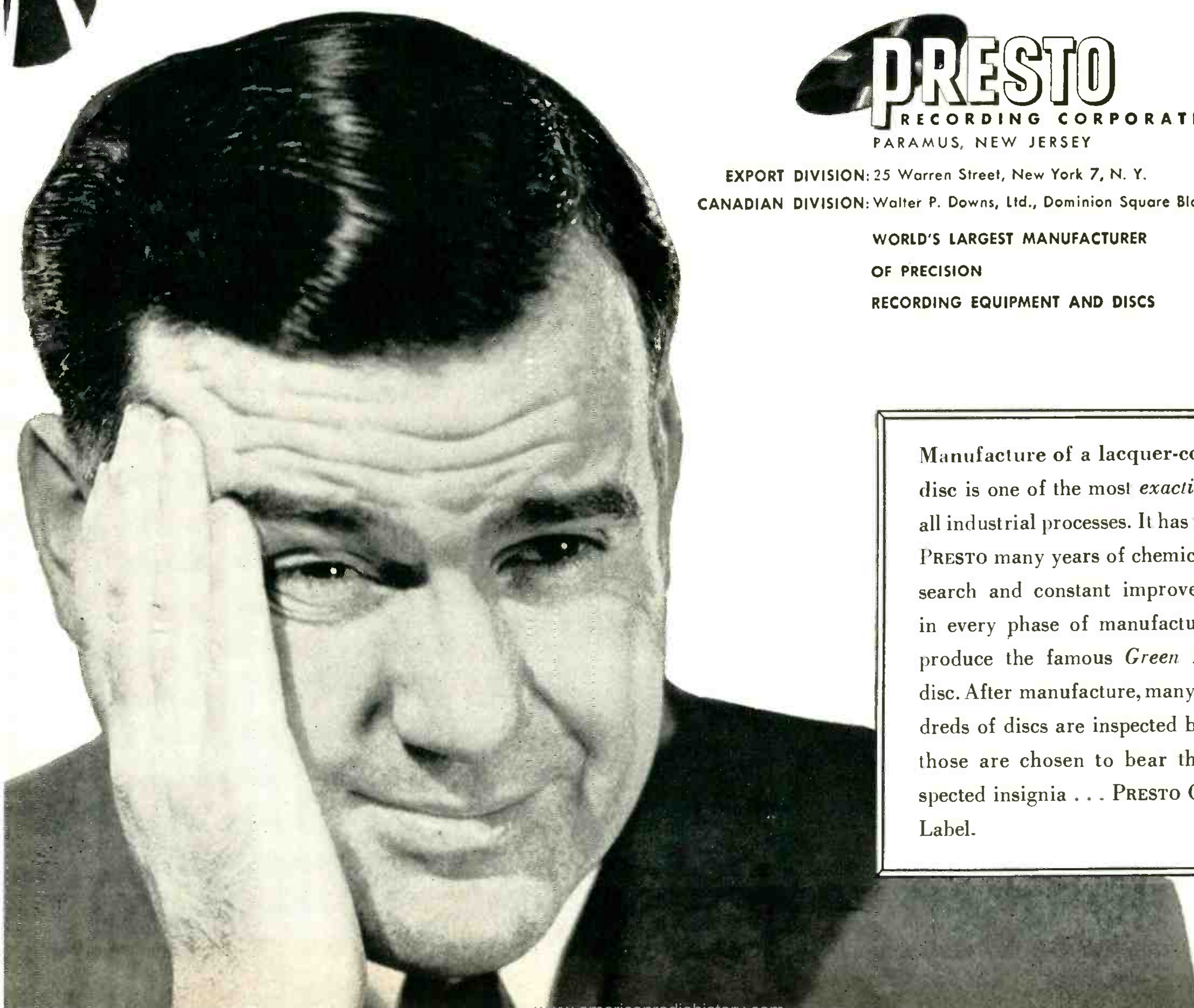
This can easily happen in the life of any engineer, if he has not been discriminating in his selection of recording discs.

If this picture fits you . . . you are ready for a change in brand. And the wisest change is to PRESTO Green Label discs . . . because this label is your assurance of the smoothest lacquer surface available and top performance every time.

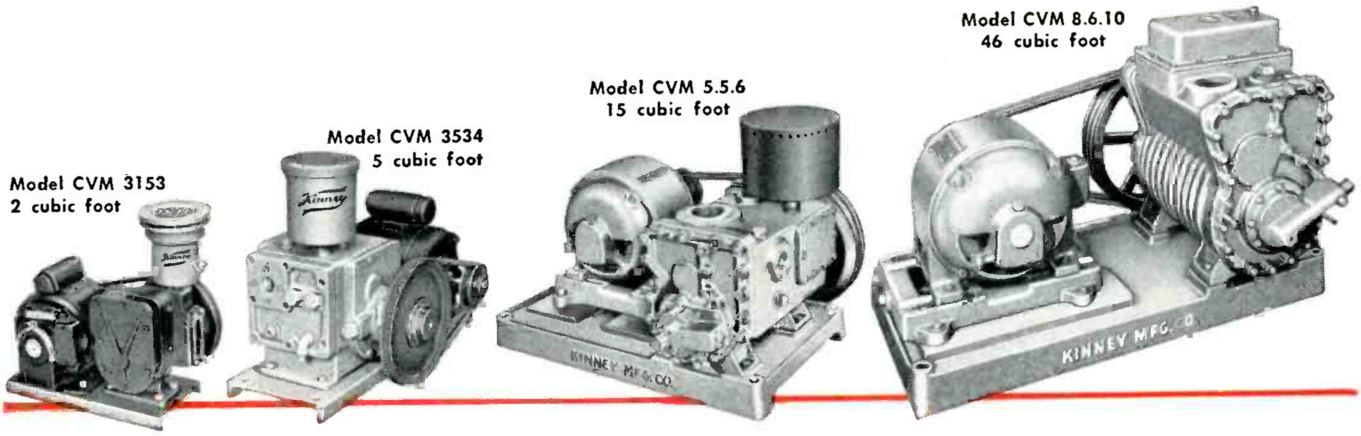
PRESTO
RECORDING CORPORATION
PARAMUS, NEW JERSEY

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



Manufacture of a lacquer-coated disc is one of the most *exacting* of all industrial processes. It has taken PRESTO many years of chemical research and constant improvement in every phase of manufacture to produce the famous *Green Label* disc. After manufacture, many hundreds of discs are inspected before those are chosen to bear the respected insignia . . . PRESTO Green Label.



COMPOUND VACUUM PUMPS

ONE pump casing . . . ONE motor and drive shaft . . . TWO pumping chambers connected in series — this is the basic design of the Kinney Compound Vacuum Pump. Built in four sizes — with 2, 5, 15, and 46 cu. ft. per min. displacements — the Kinney Compound Vacuum Pump fills an important place in high vacuum systems. Because the Compound Pump pulls to 0.2 micron or better, it often handles the complete vacuum job without diffusion pumps or mercury vapor pumps. Each pump retains better than 50% of its theoretical pumping speed right into the less-than-one-micron zone . . . assures fast pump down for most efficient utilization of processing time. Each pump provides the low-maintenance, high-efficiency operating advantages that have made Kinney Vacuum Pumps the first choice of Industry. They are easy to service . . . no special tools are required.

Experienced vacuum engineers, here in Boston and in our branch offices, will be glad to discuss the application of vacuum in your plant. KINNEY MANUFACTURING CO.— manufacturers of vacuum and liquid pumps. Boston, New York, Chicago, Detroit, Cleveland, Atlanta, Philadelphia, Pittsburgh, Los Angeles, Charleston (W. Va.), Houston, New Orleans, San Francisco, Seattle, and foreign countries.

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Send Bulletin V-51B describing complete line of Kinney Vacuum Pumps.

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Company ....

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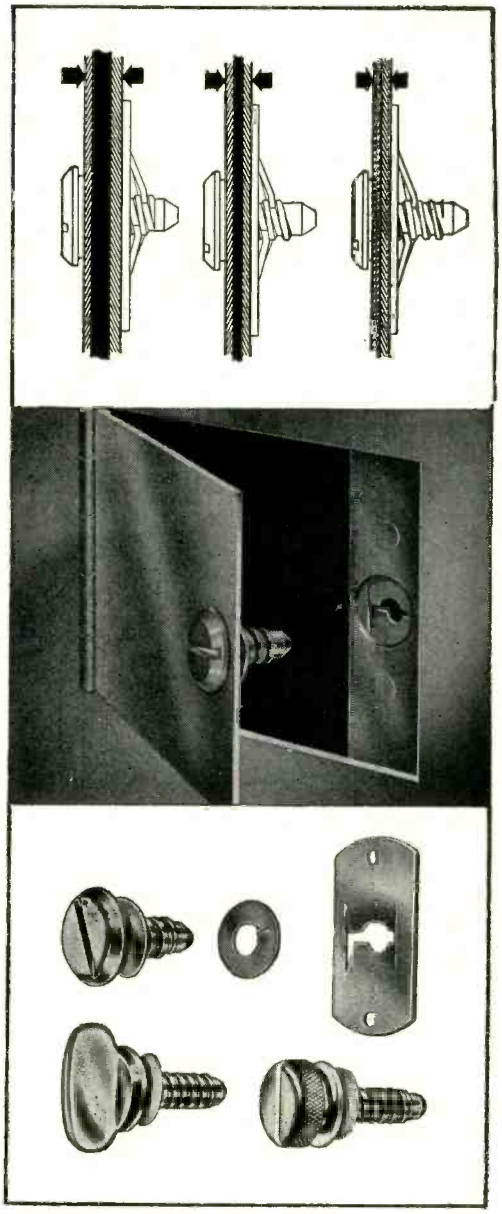
through thick or thin—

one fastener



each grip length serves a wide range of thicknesses—to speed assembly and simplify stock requirements

In many ways, you save time and money with Southco Screw Fasteners. In countless applications, the wide grip range is but one of many advantages. Tension is always uniform, never too tight or too loose. A turn of the screw locks or unlocks, instantly. Installation is easy, without special equipment. Tapped holes are eliminated, along with screws, bolts, lock nuts, lock washers, etc. Alignment is not critical because fasteners "float" in the outer panel. Skilled help is not required. Even if access plates or doors or frames become warped, Southco Fasteners continue to perform, easily and efficiently, for the life of the assembly.

You get all these advantages and more, when you use Southco Fasteners. For complete information write Southco Div., South Chester Corp., 1417 Finance Bldg., Philadelphia 2, Pa.

Important for military contractors! Prompt deliveries now possible because of recently expanded plant facilities.

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PAWL · SCREW AND SPRING · DRIVE RIVETS · ANCHOR NUTS · ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

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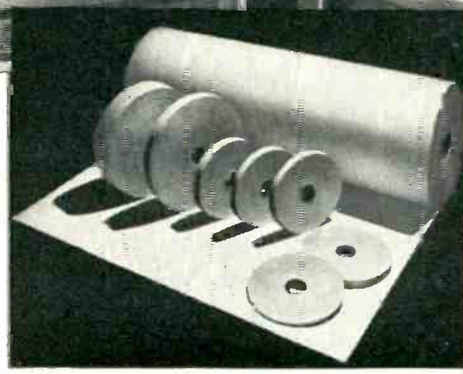


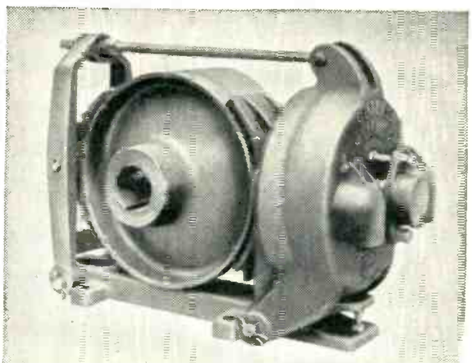
Quinorgo Electrical Insulations are high dielectric, heat-resistant sheet materials made of purified asbestos for use on equipment up to 130 C. Available in tape and roll forms.

How Cutler-Hammer, Inc. protects coils of giant Supermagnets with Quinorgo® electrical insulation

PROTECTING COILS in giant C-H Supermagnets is difficult because of the heat generated by the tightly packed pancake coils. This problem is complicated by the need to utilize every bit of space to gain maximum lifting power. After experimenting with many insulating materials, including coatings, Cutler-Hammer chose Quinorgo No. 3000 for Supermagnet strap insulation.

Quinorgo fully meets the exacting requirements of Cutler-Hammer—as well as those of other well-known electrical manufacturers. Quinorgo is a moderate priced, high-temperature insulation, for use alone or in "composites." Available in two types with slightly different impregnation characteristics. Both types combine high dielectric and mechanical strengths, with uniform texture and caliper. They maintain these properties under operating temperatures up to 130 C.

Quinorgo Electrical Insulations may lower your production costs and improve product performance. For more information write for the 32-page booklet "PYROLYSIS PROTECTION PAYS WELL" (EL-40A) Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.



Cutler-Hammer's success with Quinorgo No. 3000 on giant Supermagnets led the company to use this insulation as a component of the series wound Type "M" magnetic brakes which are so widely known throughout the industry.

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

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when to use Hermetic's New *Vac-tite** Compression Seals

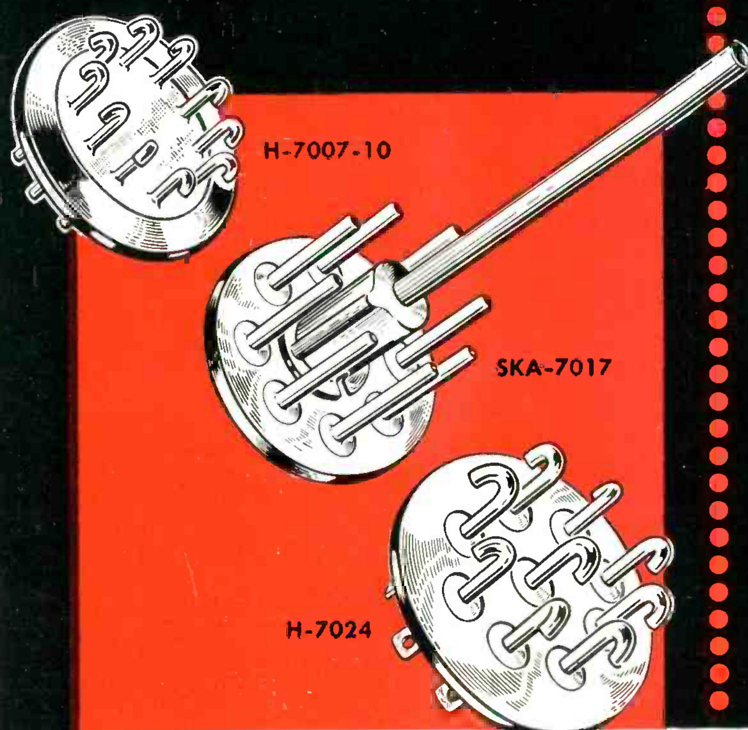
and why...

The following styles of proven VAC-TITE compression seals are available:

1. Individual terminals and feed-throughs with a full range of hooked, flattened and pierced, turret and lug-type terminations for every application.
2. All-glass construction multi-terminal headers featuring larger leakage paths and an absence of moisture pockets.
3. Individually glassed plates available in a multiplicity of standard designs and easily adaptable to special designs in a variety of shapes and sizes for every requirement.
4. Plugs for standard sockets in several mounting types . . . such as octal, 7-pin miniature, noval as well as rectangular shapes.

when vacuum tightness is a requisite, HERMETIC's proven compression seals are guaranteed to be vacuum tight, as evidenced by Mass Spectrometer Test.

when a RUGGED seal is required for application under adverse design conditions, the massive compression construction resists destructive deflection and permits direct mounting of components on the metal body.



Write for complete information on how HERMETIC engineers can apply "All-Glass" Compression Seals to your regular or special applications. Available, too, is HERMETIC's Brochure CS on Compression Seals, as well as a 32-page catalog on its standard line.

*VAC-TITE is HERMETIC's new vacuum proof compression-construction glass to metal seal.

SEALED IN ... HERMETIC HEADERS

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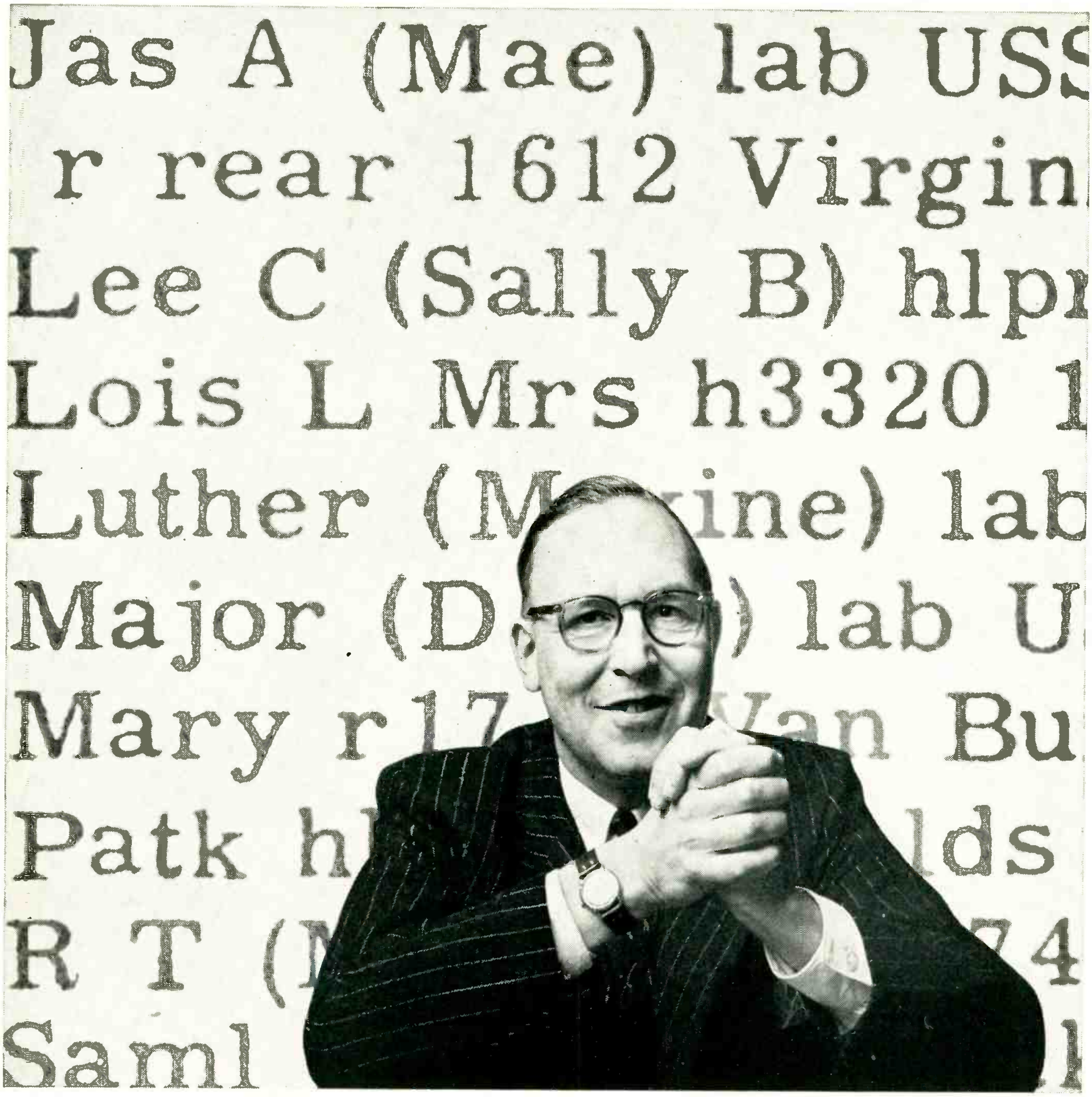

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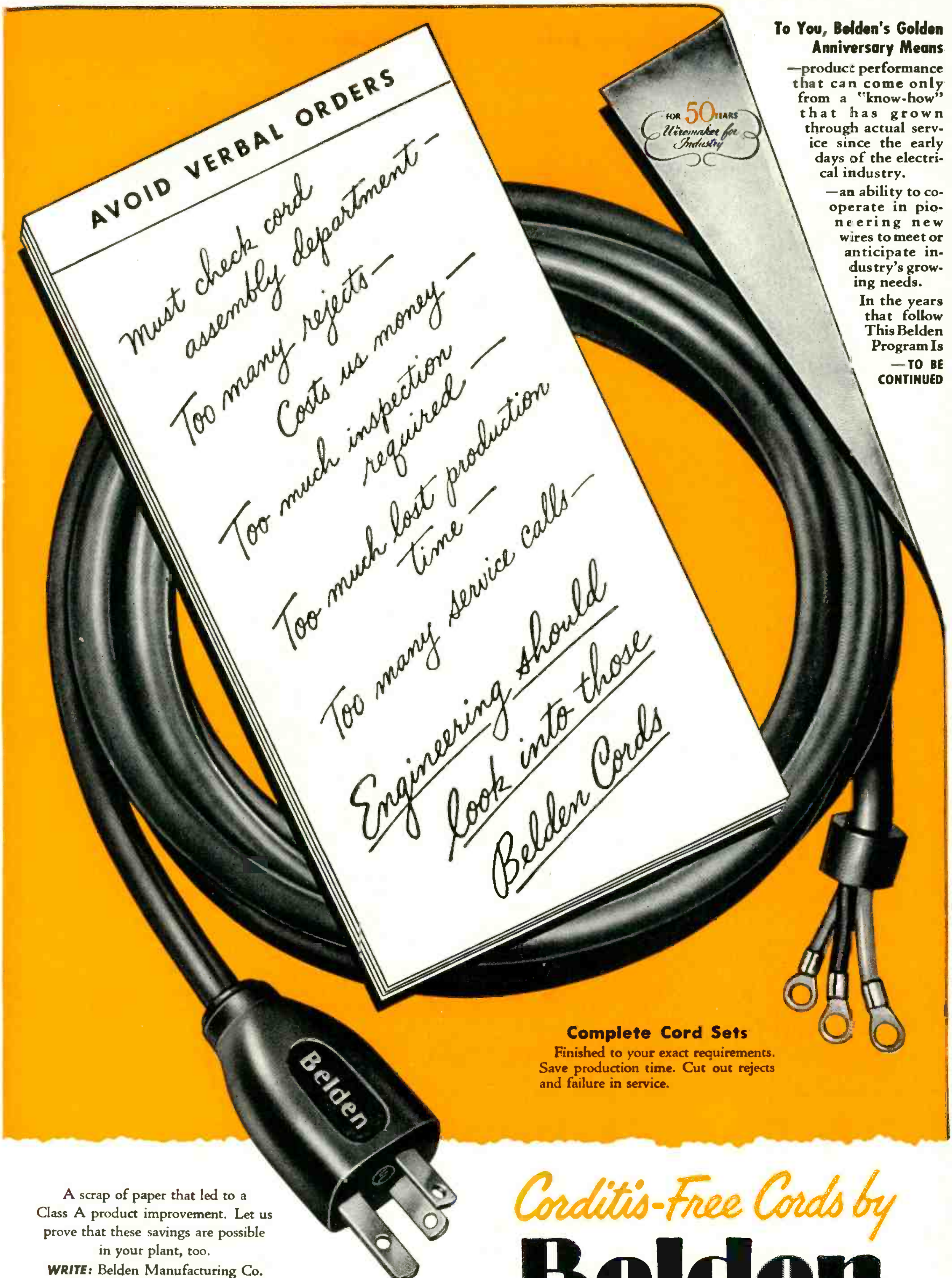

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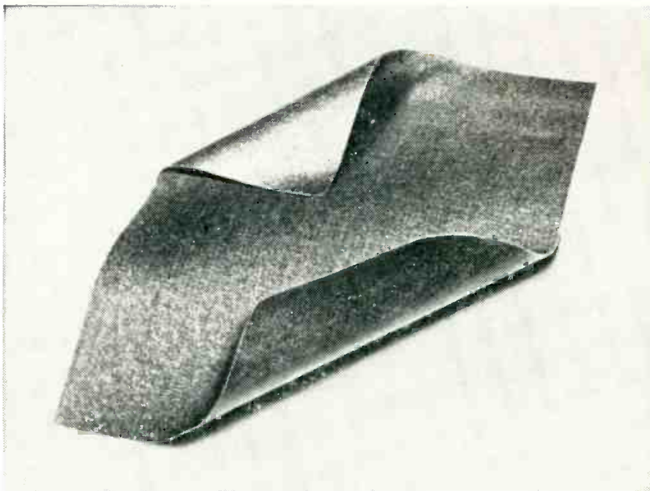

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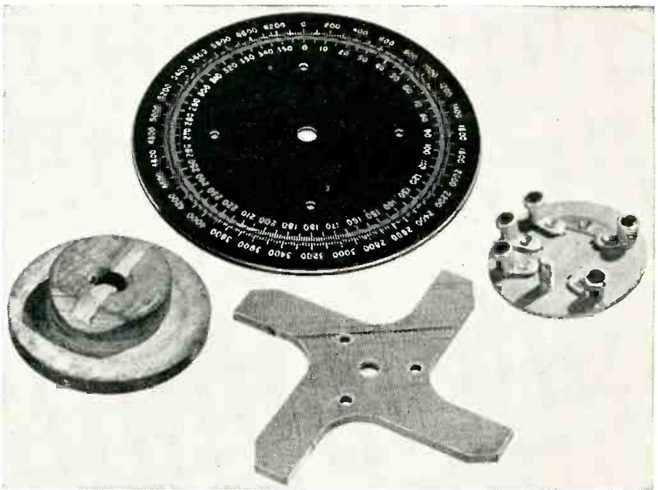

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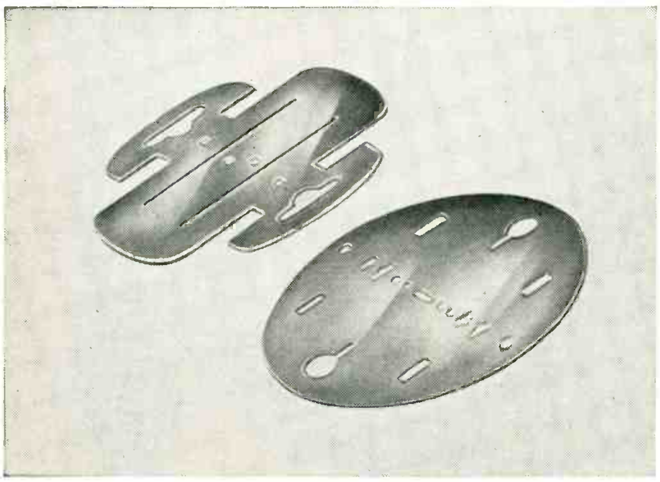

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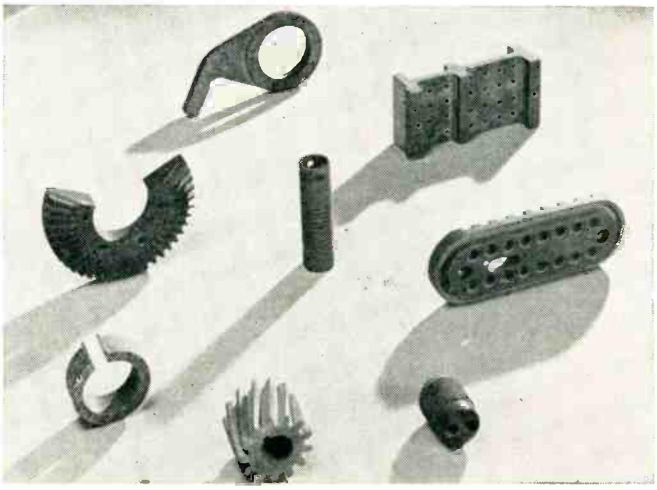

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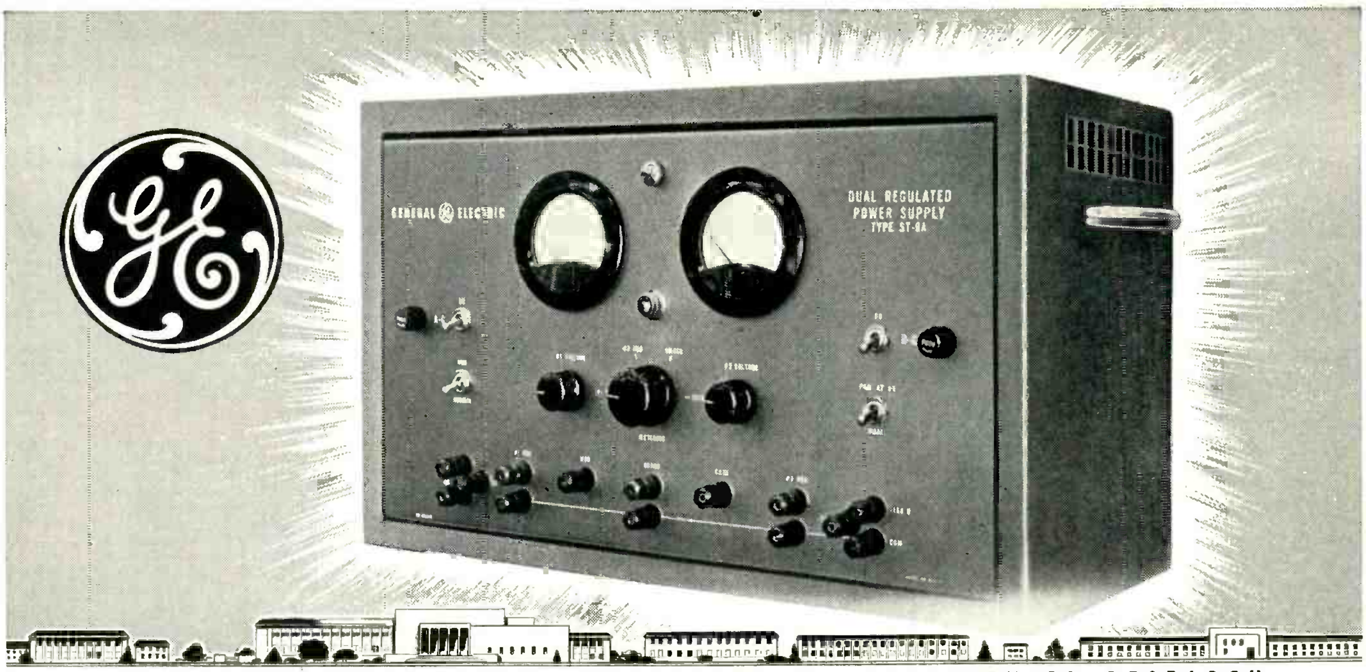

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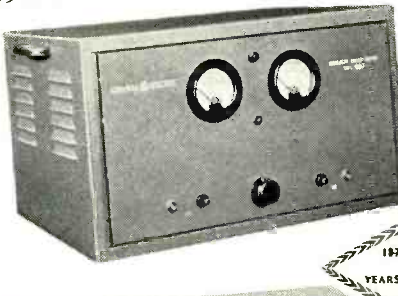

TYPE ST-9A ELECTRICAL SPECIFICATIONS

OUTPUT VOLTAGES

#1 Regulated—Continuously variable, 0-500 volts, maximum current 100 ma
#2 Regulated—Same as #1
Parallel #1 and #2—Continuously variable, 0-500 volts, maximum current 150 ma
Unregulated—Approximately 650 volts no load, maximum current 200 ma
—75 Volts—VR tube regulation, 0-2 ma
—150 Volts—VR tube regulation, 0-4 ma
Filament Supply—6.3 volts a-c at 10 amps

REGULATION

Better than ½% + ½ volt

RIPPLE AND NOISE

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INSTRUMENTS

Milliameter 0-300 ma d-c; voltmeter 0-500 volts d-c; voltage and current can be metered at #1 and #2 Regulated and Unregulated outputs; total current drawn from all outputs can be metered and it should not exceed 200 ma

OVERLOAD PROTECTION

3 amp fuse in the a-c line; ⅜ amp fuse in the d-c line; overload of any degree on the regulated outputs will harm neither the supply itself nor the instruments.

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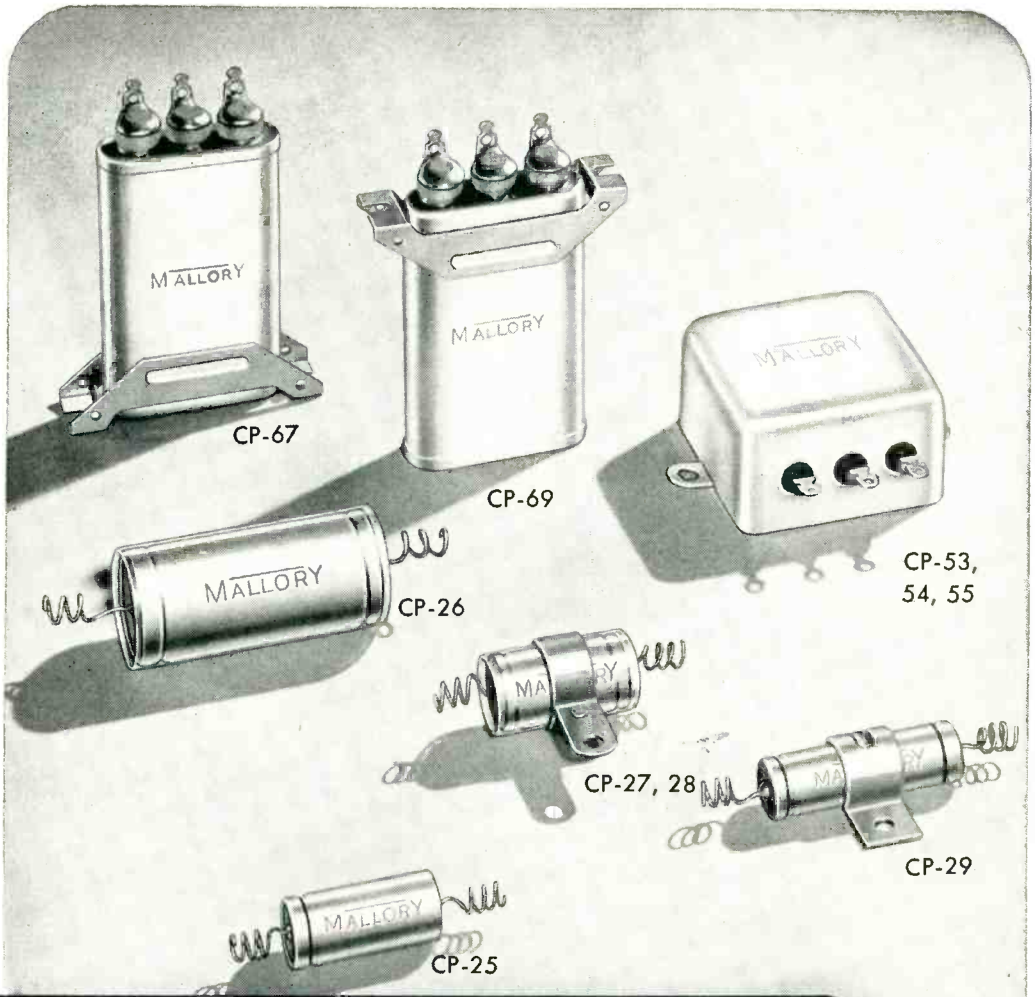

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New Folder Describes JAN-C-62 Capacitor Types

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CROSS TALK

▶ **COLOR** . . . Several manufacturers have publicly demonstrated experimental compatible-color-television receivers and, in the main, the results have been good. There will, no doubt, be more such showings prior to official NTSC recommendations to the FCC, political and competitive pressures being what they are.

Gun-jumping is understandable, and in some instances unavoidable. The important thing is to be sure that demonstrations are carefully planned and executed, and that the public gets a realistic picture of what lies ahead, and how far ahead it lies.

▶ **TRANSISTORS** . . . Industry circles were fascinated by statements recently released by two hearing-aid makers. One said transistors don't stand up. The other said they do.

Since both manufacturers are reputable, one conclusion is that transistors do or don't stand up, depending upon what kind you use and how they are hooked up and packaged. This conclusion is by no means novel, because no one claims that transistors are perfect. It will be a long time before they are, if indeed perfection is possible in any manmade thing.

Meanwhile, transistors will continue to find their way into products for which they are suitable at this stage of the art, with refinements that broaden their application coming along at a rate likely to be considered rapid even in the electronics industry.

▶ **NEW MARKET** . . . Materials-handling-equipment manufacturers find themselves in a fast-growing business these days; industry in general is committed to a more or less fixed labor rate, is increasing the efficiency of production machinery as fast as it can and now looks elsewhere for further savings.

There is business in this movement for makers of radio transmitters and receivers. Just the other day we saw five two-way-radio-equipped fork lift trucks in a Standard Pressed Steel plant just north of Philadelphia. Here was an industrial communications system rendering much the same kind of service that has effected operating economies for taxicab companies.

Industrial Truck Association figures indicate that 29,668 fork trucks were sold in 1952, so the market is well worth anybody's while.

▶ **MECHANIZATION** . . . Beginning on page 130 of this issue is a production-technique story considered particularly interesting. Dip soldering has been known for many years. Never, however, has it been applied to such complex electronic equipment in precisely this way and on such a scale.

Perhaps even more important is the fact that printed circuits, plug-in components and other allied techniques are everywhere at long last becoming major factors in the production of one type of electronic equipment or another. It is the simultaneous adoption of such things, rather than any one of them alone, that determines the shape of things to come in the field of electronics.

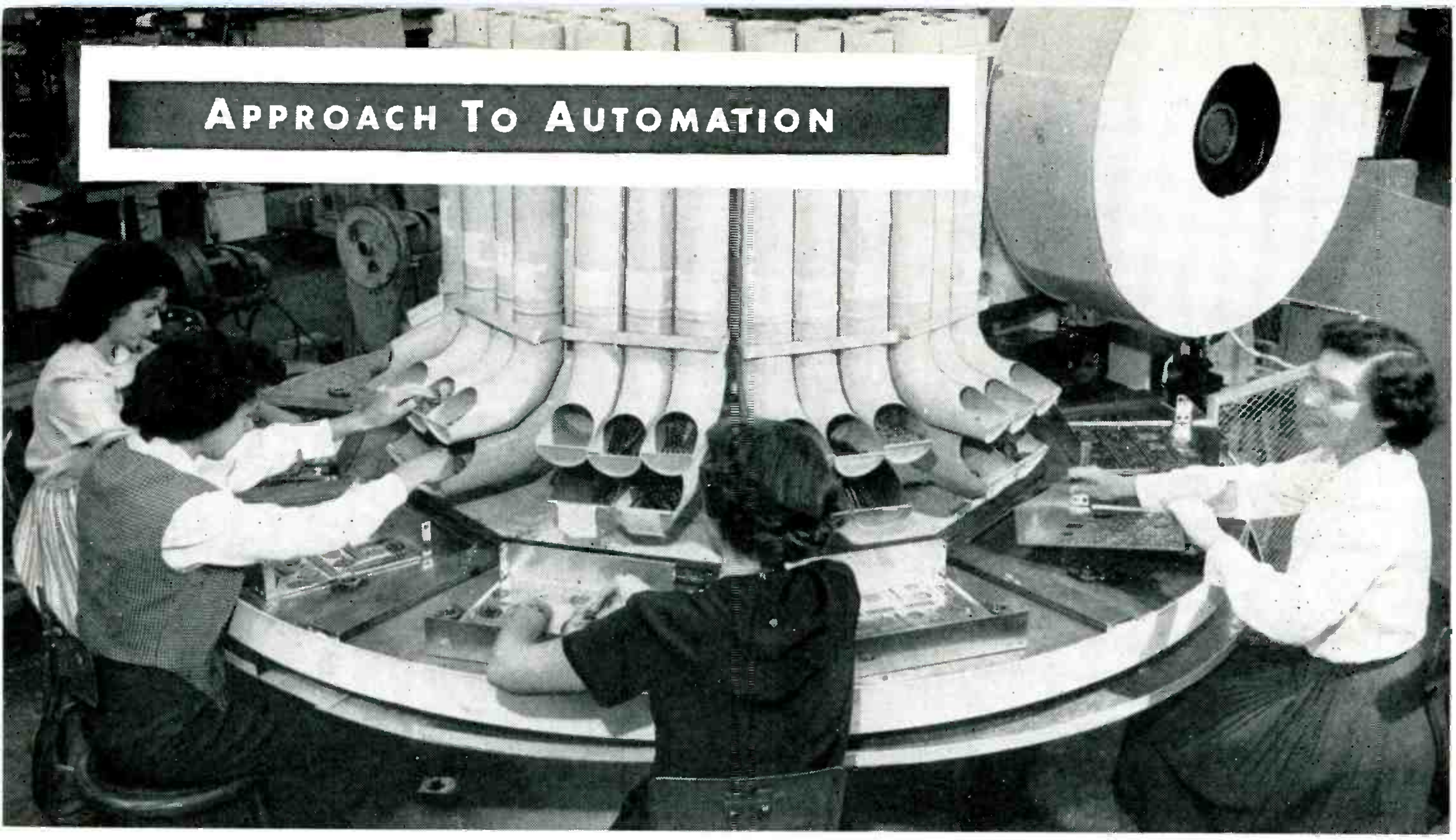
This may be the first commercially significant year for circuit mechanization.

▶ **EXPORTS** . . . International standardization work on electron tubes has just been upgraded. It used to be handled by the International Electrotechnical Commission on a subcommittee basis. Now it is handled by a full-fledged technical committee.

IEC meets in Opatija, Yugoslavia the end of June. Why is this important to us? Because you can't sell tubes in export markets if they won't fit the sockets.

▶ **CHOICE** . . . Two competitive receivers recently underwent a test. One operated beautifully but failed to survive a 30-foot drop. The other had poor sensitivity, but was unaffected by the fall.

It is suggested that the prospective customer buy both sets, one for communications and the other to drop.



Rotary riveter, nicknamed the pipe organ, uses 40-ton press to fasten 93 rivets in one operation after workers drop into each chassis the special sockets and pin plates needed for dip soldering. Rotary table indexes to next operator every 12 seconds, making capacity of machine 300 completed units per hour. Captive rivets are already on each piece loaded in

Mechanized Dip Soldering

First published details of revolutionary new electronic production technique built around a machine that solders 424 joints at once by dipping the inverted television chassis in a pool of molten solder. Similar dip-solder machines are used for radios

By K. M. LORD

Plant Manager, Radio and Television Dept.
General Electric Co., Electronics Park, Syracuse, N. Y.

TWO PLANTS of the General Electric Company have been using a mechanized dip-solder process in the manufacture of radio and television receivers since 1949. Radios are being dip-soldered at the Utica, N. Y. plant and television sets at Electronics Park in Syracuse. The new technique was developed to replace the slower and less efficient process of assembling hundreds of parts in television and radio receivers with needle-nose pliers and a hand soldering iron.

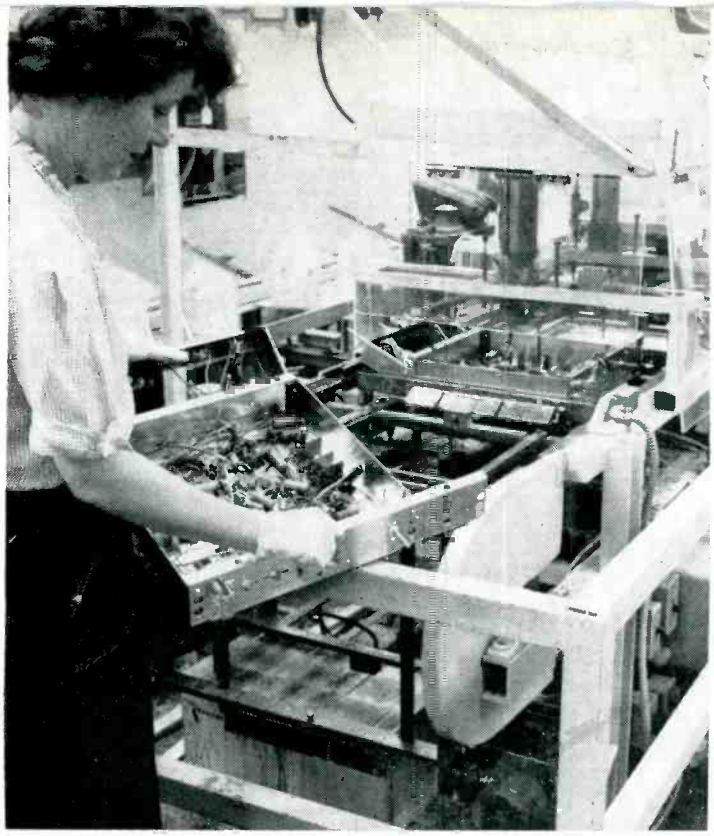
The primary benefits from dip-soldering as a production technique have been increased efficiency in the factory and better performance of radio and tv sets in the home.

In outward appearance, the dip-solder television chassis resembles to a large extent a conventional chassis. Actually, it is so constructed as to make possible the application of further automatic mechanized processes as they are developed and perfected.

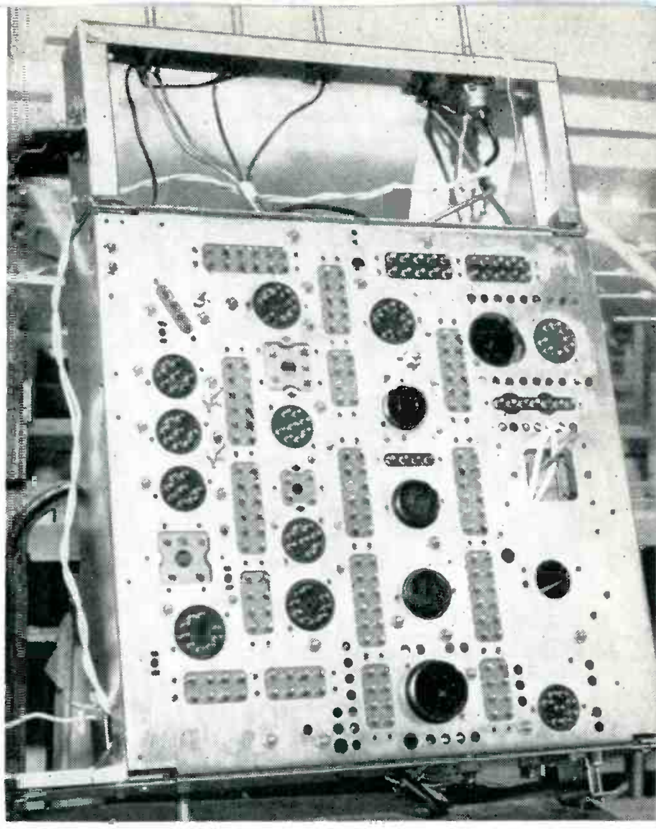
The dip-solder chassis, with its excellent performance characteristics, represents the beginning of a new era in receiver manufacture—the age of mechanization.

Many of the basic principles of the dip-solder process have long been used in radio tube production. Here, leads from the internal tube elements are connected to the pins in the base of the tube by dipping the pins of the assembled tube in molten solder.

Four years ago, the mechanized soldering method was first applied in the final assembly of components on television terminal boards. Since then, the method has been mastered



Loading chassis onto conveyor of dip-soldering machine for television assembly line. Hood with Lucite draws off rosin fumes, keeping them entirely away from workers



Appearance of top of television receiver chassis after dip-soldering of the 424 pin-type terminals having over 1,000 individual leads. Socket adapters are added after soldering

# of Television Receivers

to the point where the entire main chassis of both television and radio receivers, as well as terminal boards, are produced in this way.

Application of dip-soldering to moving-conveyor assembly of receivers involved almost 100-percent revision in subassembly lines, in component fabrication methods and in the main assembly lines. Each operation had to be changed and streamlined to serve more quickly and efficiently the highly mechanized system of final assembly.

Ground Pin Riveter

In the metal parts section of the television plant, the basic tv chassis plate is first punched and formed. This plate, which forms the main deck of the chassis, moves to a section where one of the first steps is taken in preparing for the ultimate dip-soldering. Here the chassis plate is placed on a conveyor to pass through one of a battery of ground riveters.

The ground riveter is a semi-automatic machine which assembles ground pins and spring washers and secures them to the tv chassis. An air-operated oscillating hopper orients and feeds the ground pins. Another mechanism feeds spring-steel concave washers in strip form from a reel to a position directly beneath the machine's ram. A staking punch picks up a pin from the hopper, threads the pin through the washer, cuts the washer from the strip and stakes the assembly of pin and washer to the chassis. Sharp edges of the washer bite into the chassis to insure a good permanent ground connection.

Each television main deck has a punched hole at each location where ground connections to the chassis are needed. An operator removes the chassis from the conveyor and places it in the ground pin machine in such a way that a vertical anvil projects through each of these holes in succession. A foot pedal is pressed to activate the air cylinder of the machine when the chassis is properly positioned.

Each ground pin machine operation leaves a hollow pin, like that of a radio tube, firmly secured to the chassis plate and ready for insertion of leads that are to be grounded. At present 41 ground pins are assembled to each chassis. Production per machine runs as high as 1,200 pins and washers per hour, which is five times as fast as the former method of positioning pins and washers by hand.

Rotary Riveter

After insertion of ground pins, the television chassis travels by belt conveyor to a rotary riveter built around a 40-ton Niagara press. This performs the equivalent of 93 individual rivet machine operations on 29 pin plates and terminal strips in one stroke. The capacity of the rotary riveter is 300 completed units an hour.

Individual pin plates and strips are purchased with captive eyelets at the ends of each. Two types of terminal pins are used on these plates. The bead chain type, used only in television, is a straight tubular pin slightly rounded at the top, with the same circumference at the bottom and the top. The second type, the split pin, is larger at the bottom than the bead chain type. The split pin is tapered to the top, and this tapered section is slit at four points. When the terminal lead wires are inserted in the pin, the split end grips and holds the component in position until the dip-solder machine completes the connection. The split pin is used exclusively in radio receivers and on television terminal boards. It is being used to a lesser extent in the television chassis.

Rising above the bed of the rotary riveter are 25 round vertical pipes in groups of five. These are kept filled with the different types of pin plates, pin-type tube sockets and pin terminal strips required, all having captive mounting rivets. At the five operating stations around the machine, operators pick the plates out of the pipe ends and position them in the empty chassis units as the table is indexed past them automatically at a preset production rate by a motor-driven Geneva drive. The general appearance of these pipes has earned the machine the nickname pipe organ.

For the last stop in its trip around the rotary riveter, the chassis passes under the riveting press. When in position, a cam-operated limit switch and contactors operate the press to clinch all 93 rivets in one stroke.

Use of this machine saves considerable direct labor. In addition, it has completely eliminated the usual tripping of foot pedals and the resulting fatigue which accompanied the older individual-riveter method.

After manual removal from the rotary riveter, the chassis is equipped with front and rear aprons on which operating controls have previously been mounted in subassembly operations. The chassis is then conveyed overhead to the start of one of the many main assembly lines.

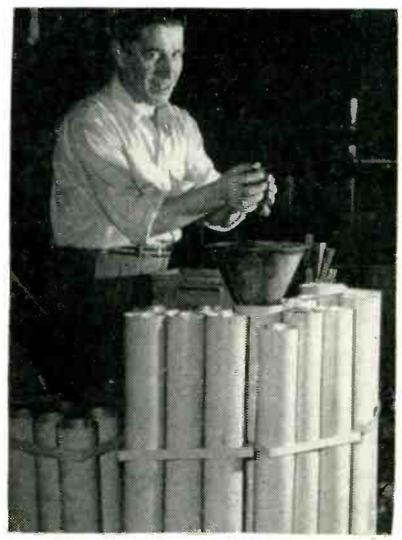
Ferris Wheels

Simultaneously with preliminary work on the main deck of the television chassis, the leads of hundreds of different components are being cut and formed in another section of the plant preparatory to insertion in the chassis. The automatic machines that have been developed for this purpose, known as ferris wheels, cut and form the ends of resistors and capacitors at a maximum rate of 2,200 pieces per hour. The ferris wheels are two circular tool holders which are mounted on the machine base in parallel and rotate continuously. One tool holder plate is adjustable along the horizontal axis by means of a screw thread and knob to fit the different lengths of components.

Mounted on the holders are eight sets of die blocks, evenly spaced around the circumference. The sides of these blocks are recessed so that forming of the component wire leads is completed in the recess and cutoff is performed against the bottom edge of the recess. Mounted rigidly on the machine are two cut-and-form blocks against which the die blocks rotate to cut and form the component leads.

In operation, the part is placed in two notches of the moving die blocks by hand. It is carried automatically through the cutting and forming stage and ejected by means of a rotating knockout to a chute at the rear. Under this chute is a corrugated cardboard box that serves for parts storage and fits directly into the parts dispensers on the main assembly line. This eliminates handling of the formed parts until they are actually inserted in the chassis.

Beginning operators use template with ground riveter, but soon memorize locations of holes for ground pins

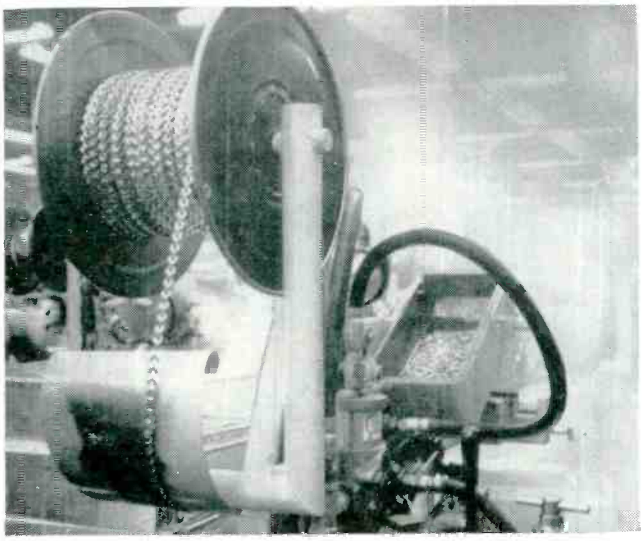


Loading hoppers of rotary riveter

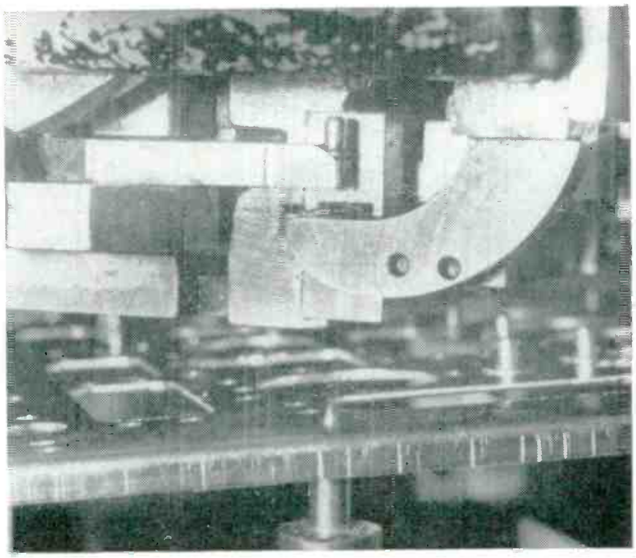
Two brushes under each machine rotate continuously to clean the cutting edges of the die blocks.

Each main television assembly line is laid out in the shape of an elongated U. The chassis units travel around on a moving conveyor in front of operators who work from a sitting position. In front of each operator are up to ten boxes and trays holding the components or wires for which she is responsible. Each component or length of wire is inserted in the chassis by placing its leads into two of the tubular terminals provided.

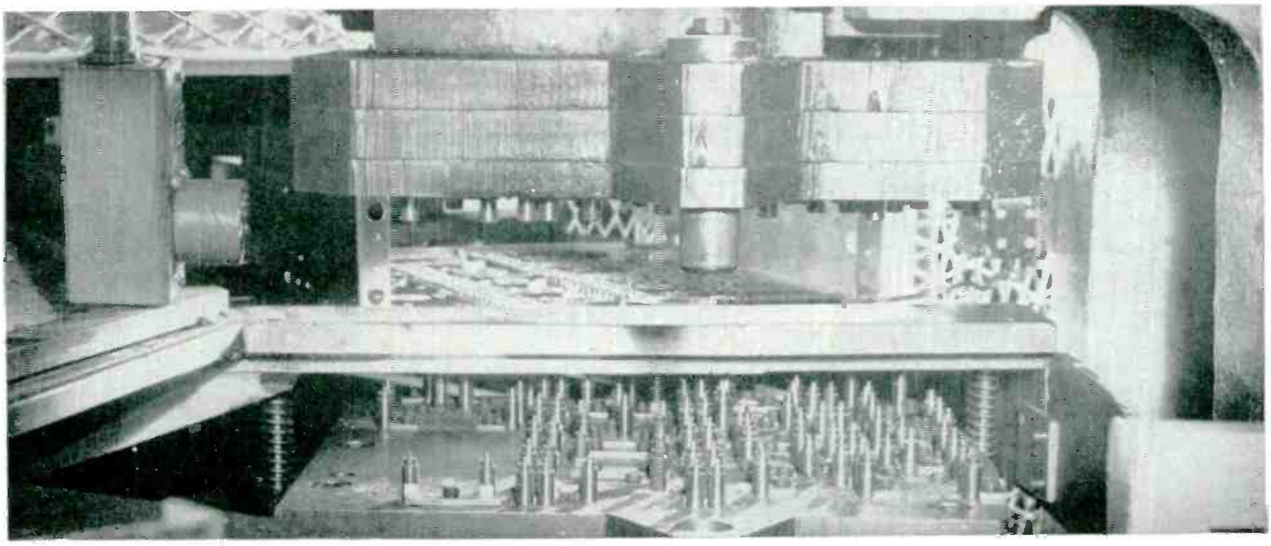
To take care of components which will be placed in the receiver after the chassis has passed through the



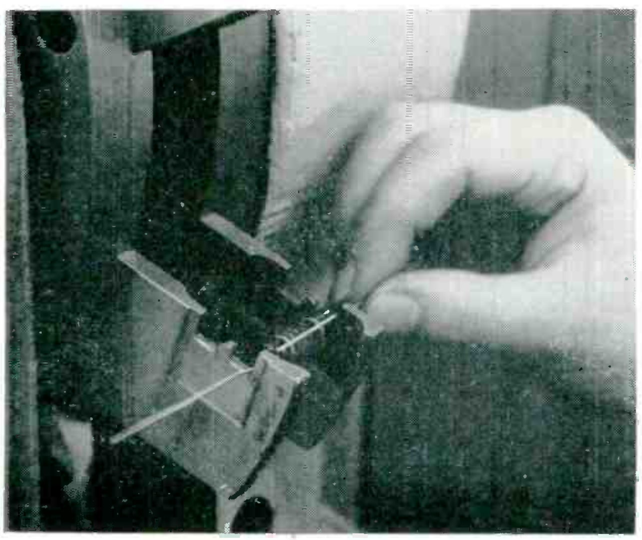
Rear of ground riveter, showing spring-steel washers in strip form and oscillating hopper for aligning terminal pins and feeding them down slide to chassis hole



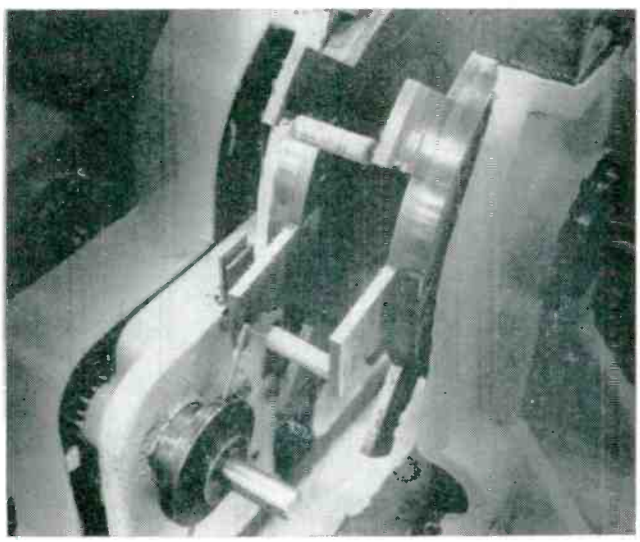
After ground riveter pushes tubular pin through cupped washer, upper anvil retracts and pin is pushed through chassis onto pointed anvil



Riveter dies do work of 93 individual riveting machines in one stroke. Phototube at left stops press if chassis is missing

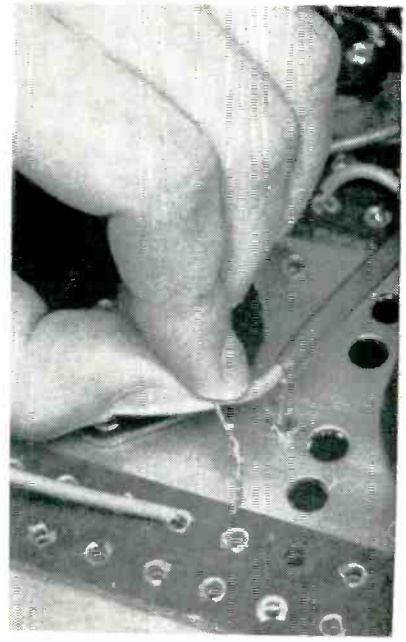


Loading molded paper capacitor on one of the eight pairs of die blocks of the ferris-wheel lead former and cutter

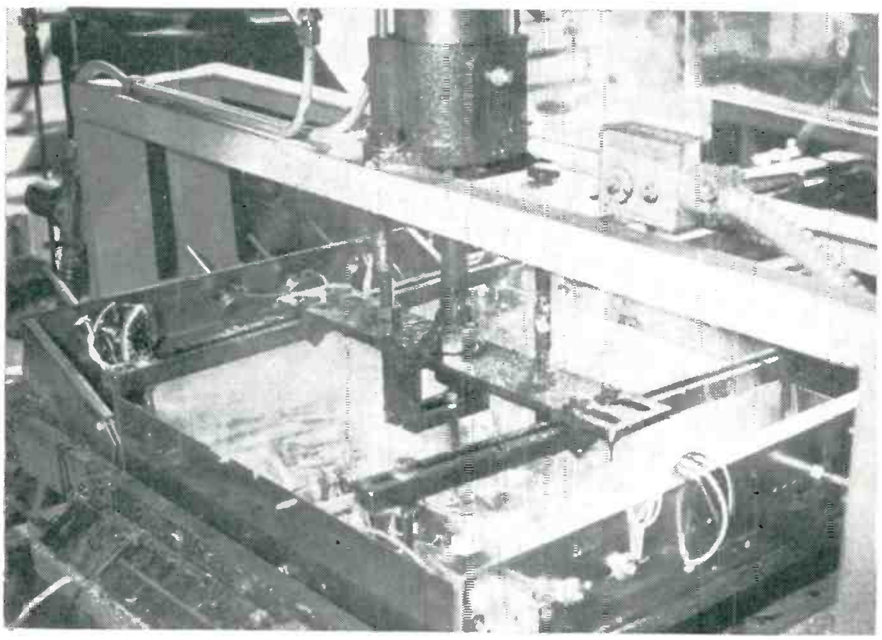


Rotating arm at rear, geared to main drive of ferris wheel, pushes processed components out of die blocks to chute below

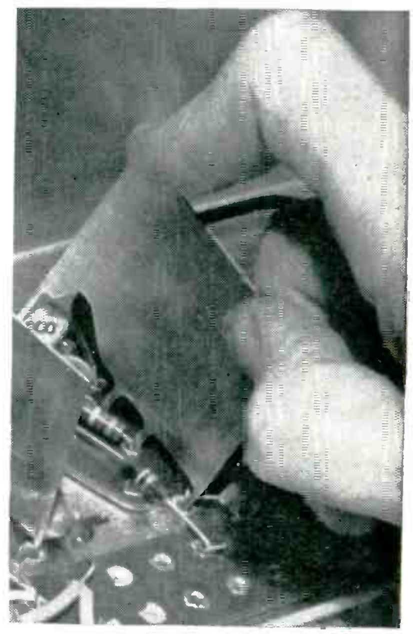
Parts boxes like these are placed under lead-forming machines for loading, and fit directly into metal dispensing bins on main assembly line. Elimination of handling operations insures that leads will be correctly bent for dropping into chassis pin holes



Method of inserting shielded wiring in pin strip. Braided shield has already been pushed into a ground pin



Television chassis in solder pool of machine, with rosin fumes rising in clouds. Air cylinder at top counteracts bellying of chassis with heat by lowering rods that hold chassis firmly down on bars projecting slightly above surface of solder pool



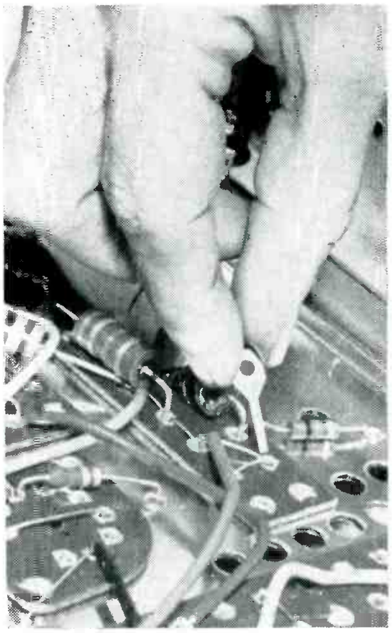
Tube socket shields have comb-like teeth that fit into ground pin holes for anchoring simultaneously with leads

dip-soldering process special loop-wire terminals are inserted in some of the terminal pins.

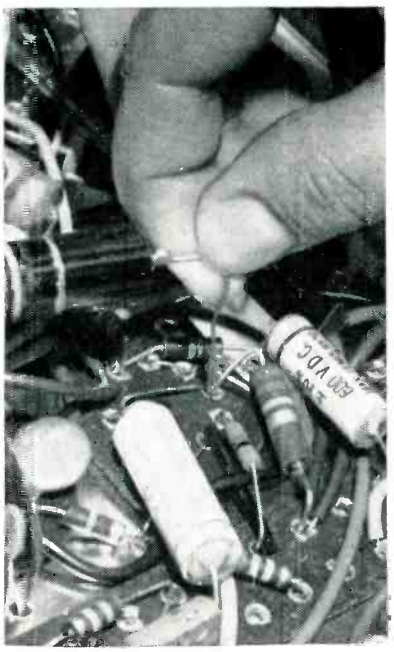
Other special connections are provided for by key-shaped punched copper terminals inserted in the ground pins. Even shields in a dip-solder chassis are specially designed. With a comb-shaped lower edge, the shields are securely fastened by inserting the teeth into grounded terminal pins.

Dip-Solder Machines

Finally, after its 424 terminal pins have received the components designed for them, the chassis reaches the dip-solder machine. Although this has a potential capacity of 350 chassis units an hour, actual production varies with the schedule of the assembly line which feeds it. On television lines, the machines are being used to flux and dip-solder a chassis measuring 13½ inches square and containing 424 terminal pins each having from one



Inserting punched copper strip in pin to which a lead of an above-chassis component must be soldered later



Inserting lead of molded paper capacitor in pin that already has three leads. Four leads are limit for easy insertion

to four leads. Similar machines are being used to solder 51 pins simultaneously in a terminal board and to solder 40 pins at once in a radio chassis.

A dip-solder machine consists of a flux tank, a solder tank, a sprocket-driven endless-chain conveyor which travels over the tanks, and auxiliary equipment.

Rods of cold solder, some of which have been recovered from the machine, are dropped into a pot at the rear of the machine. Here the solder is raised to the carefully regulated temperature needed and automatically fed into the solder pot at a rate designed to maintain a constant level.

Each television chassis in turn is removed from its assembly line and fitted into a rack on an endless conveyor which carries it through the automatic solder operation. The chassis is lowered first into the flux and then into the solder tanks by four air cylinders. The conveyor stops, cylinder stroke and return, and dwell time in the flux and solder tanks are controlled by a series of snap-action switches and time-delay relays. An automatic timing unit is used to preheat the elements in the solder tank before the start of a work shift and to turn off the heat at the close of the shift. A solder temperature of 600F is maintained by a thermostatic control.

Dross must be skimmed off the hot solder surface each time a chassis is dipped. Chrome-plated hinged wiper blades are built into the rear of each chassis-holding fixture to accomplish this as the fixtures pass over the solder tank.

Fumes from the operation are carried off by a hooded exhaust system installed over the machine.

As each chassis is lowered into its solder bath, capillary action draws the solder up into the tubular terminal pins. This provides uniform and complete solder connections at each terminal and little or no chance for excess solder to cause shorts.

After being removed from the dip-solder machine, the chassis is subjected to a violent vibration on a shake table. Imperfections in the dip-soldering job quickly show up under this unusual stress, as loose parts will come out. This rarely occurs in practice, but the shake table serves also to clear out scraps that fall into the chassis during assembly.

After the shake table operation, the television chassis is lifted back onto the main conveyor line. Here it passes through a series of stages during which it is prepared for installation of tubes, transformers and other above-chassis parts.

The tube socket pin plates and transformer pin plates which were secured to the chassis by the rotary riveter require adaptation before the tubes and transformers can be mounted. Separate tube socket adapters are used, while r-f and i-f transformers are mounted right on their adapters. These adapters fit over the male pins on the chassis and receive the male pins of the parts. The tube socket adapters are placed on the tube socket pin plates by using a tool called the wobble gun.

Before adapters are fitted on terminal pins, dip-soldered leads which may project through the tops of the pins must be cut off. If this were not done, the protruding leads would prevent the adapters from being properly inserted over the pins. This clipping job is performed by special air-driven cutters.

The wobble gun is a special adaptation of a standard electric drill in which the drill chuck is replaced by a rounded plate. Behind this plate is a single ball bearing. When the tool is applied to the socket adapter it agitates in such a manner as to vibrate the adapter down on the connecting pins.

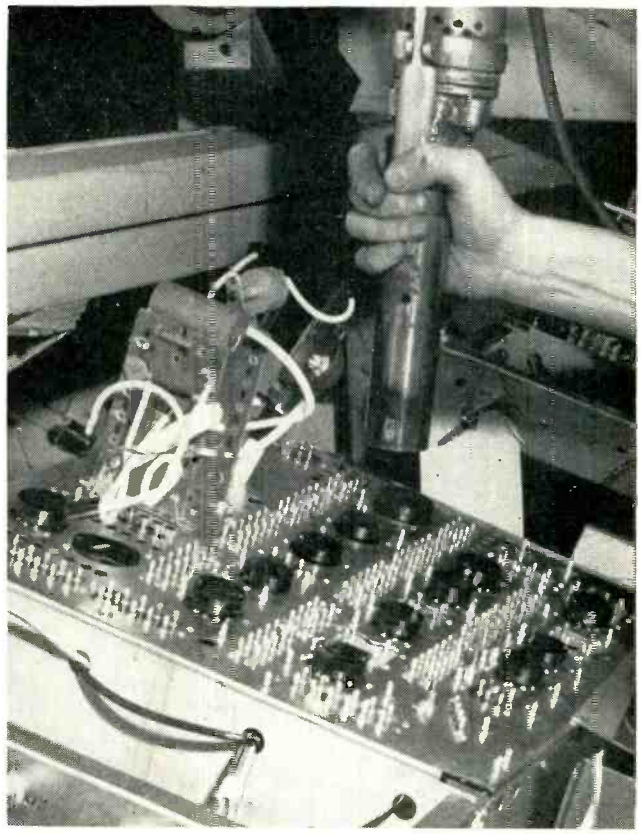
Before tubes are inserted in the television chassis, a final visual check is made to determine whether all connections have been made and all components are in proper position. So efficient has dip solder proved that only one repair station is operated for each television assembly line. At this repair station, any necessary adjustments are made by an operator using a conventional hand soldering iron, before the chassis passes on for completion of assembly.

Other Dip-Solder Machines

Mechanized dip soldering was first used in the assembly of television receiver terminal boards and is still being used for that purpose. In addition, dip soldering is used on all GE table model radio receivers made at the Utica, N. Y. plant, including clock radios. A more recent adaptation is in connection with mechanized fabrication of individual components.

A slight variation in the method occurs when it is applied to smaller


Shake table clears chassis of loose solder and scraps, and also shows up imperfect joints


Method of using motor-driven wobble gun to push tube socket adapters onto socket pin plates

subassemblies. Here, resistors, capacitors and wiring are hand-positioned in the same manner as is done on the television lines, but it is not necessary to remove the terminal boards or radio chassis units from the assembly line. Instead, the dip-solder machine is so installed as to form an integral part of the assembly line itself. The terminal board or chassis continues traveling in its assembly rack directly through the flux bath. The length of the tank and the speed of the conveyor determine the time the part is immersed in the bath. When the part is ready for its solder bath, the solder tank is raised and lowered to perform the dip-solder operation.

In redesigning for dip-soldering, the television chassis had to be increased in size by 20 percent over the former conventional hand-soldered model. No increase was necessary in radio chassis size.

Because the television receiver is equipped with an interlock which automatically cuts off power when the back is removed from the cabinet, no protection is needed for those terminals which might be exposed. However, the radio receiver has no such interlock and some method of covering exposed terminals around tube sockets had to be found. The problem was solved by installing a steel, doughnut-shaped shield around the base of each tube. This was later changed to a molded plastic cover fitting over almost the entire chassis.

A special tube socket is used in the dip-soldered radio chassis which eliminates the necessity of any adaptation to seat the tubes. Because the television receiver involves up to five times as many tubes as the radio receiver, these special more-expensive and bulkier sockets were found to be impractical. For that reason, adapter sockets are used in television sets.

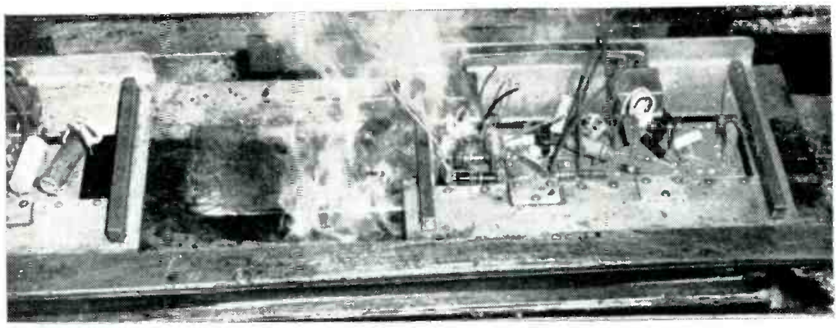
Many important advantages and benefits have been realized since the dip-solder method of assembly was begun. Perhaps the most important of these is the increased reliability of the finished products. The hundreds of connections involved in a modern television receiver are made with absolute uniformity in respect to the amount of solder used and the degree of temperature applied. This means a consistent, reliable chassis and superior performance. Because the possibility of damaging components by overheating is eliminated, component failure in finished receivers is sharply reduced.

Less wiring is required in a dip-solder chassis as compared to a conventional chassis. This minimizes problems of establishing and maintaining lead-dress and spacing in the closely packed and complex interior of the receiver.

Training Time

Dip soldering has meant a marked reduction in the time needed for training operators. The time required to train personnel on an assembly line has been cut by one week where that line involves dip soldering.

No tools are required in the manual positioning of components, in contrast to the need for using crimping pliers, soldering irons and other tools in assembling the conventional chassis. Because this mechanization reduces the degree of skill required for final assembly work, the labor force is now more flexible and its distribution within the over-all production pattern is simplified to a great extent.



Dip-soldering position on moving-conveyor line for a television subassembly terminal board. Here the solder tank is raised by air cylinders to come up to the panel

Breadboard mockups are mounted in front of each operator to show the wiring and component positioning assigned to her station on the television assembly line. Even a novice operator can quickly compare the work before her with that on the breadboard. These training devices consist of actual components mounted on a full-size pictorial layout diagram of the pertinent portion of the chassis.

Another example of simplified training techniques is operation of the ground riveters. By supplying the untrained operators with a metal template which indicates the exact positions for the terminal pins, it is possible for the trainee to reach a satisfactory point of efficiency and production almost at once.

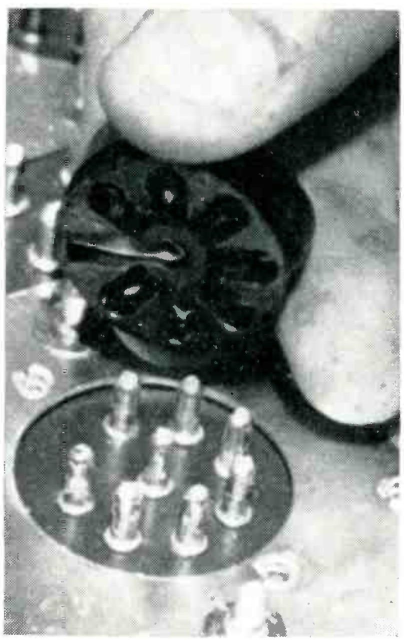
Since the installation of dip-solder machines on the television and radio assembly lines, a definite improvement in employee morale has been noted. This has been credited to several factors. With elimination of the hand soldering iron, the work is cleaner and much less tiring. Irritation from flux fumes which accompany hand soldering is completely absent because the entire dip-solder mechanism is enclosed and ventilated.

Those employees formerly engaged in the task of selecting, trimming, shaping, crimping and soldering each component are released from this work to be more efficiently used in the manufacture of component parts. This tends to streamline the entire assembly operation, shortens the assembly line and frees floor space for other manufacturing activities.

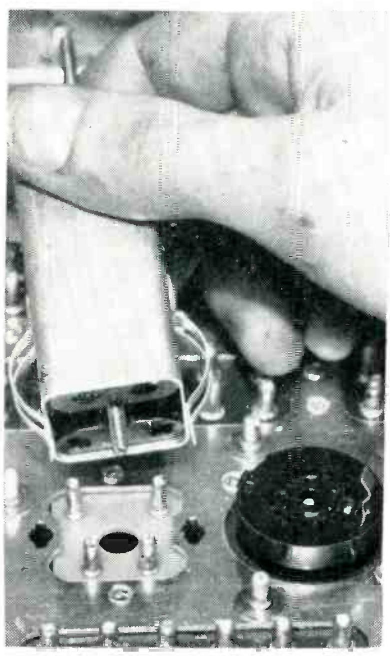
Manufacturing costs have been reduced through the lessening of the possibility of damage to components, and the margin of error in the assembly operation has been cut.

The reduction in the amount of wiring means an increase in the space available for components and aids immeasurably in parts standardization. This is of the greatest importance from a manufacturing standpoint but is, perhaps, of an even greater importance from a servicing standpoint. As an example, capacitors of equal value, supplied by different vendors, may show considerable variation in size. In a conventional chassis, oversize parts from one vendor might have to be wired outside the engineered pattern of the chassis. In the dip-soldered chassis, however, sufficient room is available to accommodate components of a different size than specified in the original design of the product.

Still another important advantage of the dip-solder technique is reduced service cost to the consumer. To break one connection in a hand-soldered television or radio receiver, the serviceman might find it necessary to remove three or more individually soldered connections with several applications of heat. In a dip-soldered chassis, the service operation can be accomplished with a single touch of the soldering iron. This, too, reduces the possibility of damage by heat to delicate components, speeds up the repair job, results in less repair cost to the owner and causes less disturbance to the basic balance of the circuit.



One of the molded adapters developed for use with special dip-soldered tube sockets. Projecting leads are sheared off before adapter is pushed on



This i-f transformer has a built-in adapter and spring-type mounting clips that make mounting and connecting a single quick operation

Broadcast Transmitter

Studio engineer dials control impulses in sequence then selects desired monitor function to check remote transmitter

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IN 1948, the Canadian Department of Transport amended its broadcast regulations to allow transmitter operation by remote control. The amendment specifically allowed two control systems, that of telemetering and marginal alarm relays, while provisionally allowing any other acceptable means. Telemetering is sending by telephone lines various voltage levels that are read on a meter at the studio to indicate the state of the transmitter circuits at any time. The marginal-alarm-relay system is a collection of relays at the studio that are actuated by sample voltages carried over telephone lines from the transmitter circuits.

It was felt by Canadian General Electric that telemetering would be superior operationally to the marginal relay system because in addition to indicating voltage levels of pertinent circuits, telemetering gives the amount of voltage drift should any circuit begin to fail. The marginal relay system can indicate only if circuit voltage levels have varied beyond certain preset levels. The alarm signal tells the studio operator only that the circuit voltage has varied but not how much.

In December 1949, the first remote control system was put into operation at CFAR, Flin Flon, Manitoba. The success of this venture resulted in equipping many other stations with remote facilities, 250 and 1,000-watt omnidirectional antenna stations as well as 1,000-watt stations employing two and three-tower directional antenna arrays.

In operation, the studio engineer starts the broadcasting day by first energizing the studio equipment. Then using the dial-and-control unit, he actuates the power-on switch to turn power on at the transmitting site as indicated in Fig. 1. After the equipment is sufficiently warmed up he presses the transmitter-on lever, placing the carrier on the air. With all the equipment operating the various telemetered circuits are checked. This is done by dialing one number after another and marking on the station log the meter reading corresponding to each number dialed. The operation usually takes less than a minute.

If a reading is slightly off normal the station engineer can assess the significance of the variation and investigate the cause. A simple alarm system, on the other hand, can only advise of trouble that has already taken place, and cannot help in assessing the seriousness of the fault. Nearly all circuit failures give unmistakable warning signs before actually occurring. Over-age tubes give less emission and therefore less r-f output; a failing transformer delivers less voltage to the high voltage circuits; a defective capacitor may intermittently bypass a circuit to ground. All these signs are revealed in the meter readings at the studio.

System Elements

Besides on-off control, indication at the studio of all important transmitter circuits, frequency deviation, percentage modulation and r-f output, the control system makes provision for operating from the transmitter site during emergency conditions. In addition to the alarm system, an electronic lockout prevents energizing the transmitter from the studio during normal and emergency service periods.

Control of input power, while useful for placing power on and off under normal conditions, becomes of utmost importance during extreme circumstances, such as air-raid warnings or natural disasters. As broadcast signals serve as an effective beacon for aircraft receivers, it is imperative that a station be completely shut down within seconds of an air-raid warning. On the other hand, a station may be required to broadcast information to outlying areas during times of fire, flood or earthquake.

Remote Control System

Telemetering system used since 1948 to control 1-kw Canadian a-m/f-m broadcast stations with omnidirectional or three-tower antenna arrays. Two pairs of telephone wires permit studio operator to start and stop transmitter at will or monitor various functions to avoid equipment breakdown

If the transmitter site is isolated at such times, remote control becomes vital to place the transmitter on the air during normal shut-down.

Another safety measure, is the automatic safe-failure feature. This instantly removes all input power from the transmitting facilities in the event power fails at the studio or the telephone control lines open up for more than 3 seconds. If ever commercial power, which may not be from the same source energizing the transmitter, should fail, or if the control lines are damaged due to wind, ice or snow storms, the station owner is safe in the knowledge that power is removed from the transmitter.

On-Off Control

When power switch S_1 is closed, line 1 is energized with 48 volts d-c and thereafter is never de-energized for more than 0.25 second while the equipment is operating. The 48 volts from rectifier CR_1 operates repeater relay K_1 energizing contactor-holding relay K_2, which in turn operates the main power contactor K_3. This contactor applies power to the transmitter and equipment in the station audio rack.

Because it is essential that the transmitter be under complete control when on the air, the equipment is designed to remove input power in the event of power failure at the studio, or the opening of control lines for more than 3 seconds. This safe-failure function results if the 48 volts is removed from K_1. In order that transmitter shut down shall not be caused by brief power interruptions from the studio, K_2 will maintain the coil circuit of K_3 for three seconds after its own coil circuit has been de-energized.

To place the transmitter on the air, transmitter-on key S_2 is operated and a reset impulse lasting 0.25 second is sent out over line 1. At the end of this impulse a voltage is applied to line 2 (line 2-2 positive) energizing the on relay K_4, which in turn operates the on circuits of the transmitter. The reset impulse is necessary to insure that line 2 is connected through stepping relay K_5 to relays K_4 and K_6. It is obtained as follows:

Transmitter-on key S_2 contacts 1 and 2 ground the coil of K_7. This relay then operates, opening the circuit of line 1, and at the same time de-energizing the coil of K_8. After the 0.25 second the armature of K_8 is released, completing the circuit of line 1 through its contacts 1 and 2, while contacts 3 and 4 apply voltage to line 2 via contacts 7 and 8 of S_2.

The transmitter-off control also utilizes reset impulses. When transmitter-off key S_3 is operated, a reset impulse is sent on line 1. At the end of this impulse a voltage is applied to line 2 (line 2-2 negative) from contacts 7 and 8 of S_3. This voltage energizes the off relay K_6, which removes the carrier from the air but leaves the filament and control circuits on.

Transmitter Indication

The status of the transmitter is indicated by three readings on the studio meter M_1. The first reading is obtained by applying input power to the transmitter. Rectifier CR_2 becomes energized and its current produces a 30-percent reading on M_1, informing the studio operator the transmitter filaments are on. The filament time-delay relay then starts to operate. When it has completed its cycle and the transmitter is ready for power, rectifier CR_3 produces current for a second reading of 70 percent on M_1. High voltage may now be applied to the transmitter, which in addition to placing the carrier on the air, energizes meter-multiplier resistors R_3 and R_4. These energized resistors supply current to produce the third reading on M_1 of approximately 95 percent. These percentages are adjustable by potentiometers R_1, R_2 and R_4. Status indications can only be realized when circuit selector relay K_5 is in the reset position. It is in this position when the equipment is first turned on and after each operation of the transmitter-on and off switches.

Telemetering Of Circuits

In addition to status indications, meter M_1 provides up to nine telemetered indications of transmitter and monitor equipments. Each circuit is automatically chosen by the selector dial on the panel of the dial and control unit.

When the dial is pulled away from normal at-rest position, its contacts 1 and 2 close and ground the coil of K_7. This opens line 1 and de-energizes the coil of K_8. After 0.25 second, contacts 1 and 2 of K_8 close to complete the circuit of line 1 through the impulsing contacts 1 and 2 of the selector dial. When the dial is released, contacts 1 and 2 are operated by the dial mechanism, producing stepping impulses that are 0.03-second-long interruptions of line 1. These impulses are produced at the rate of 10 per second, the number of impulses for one

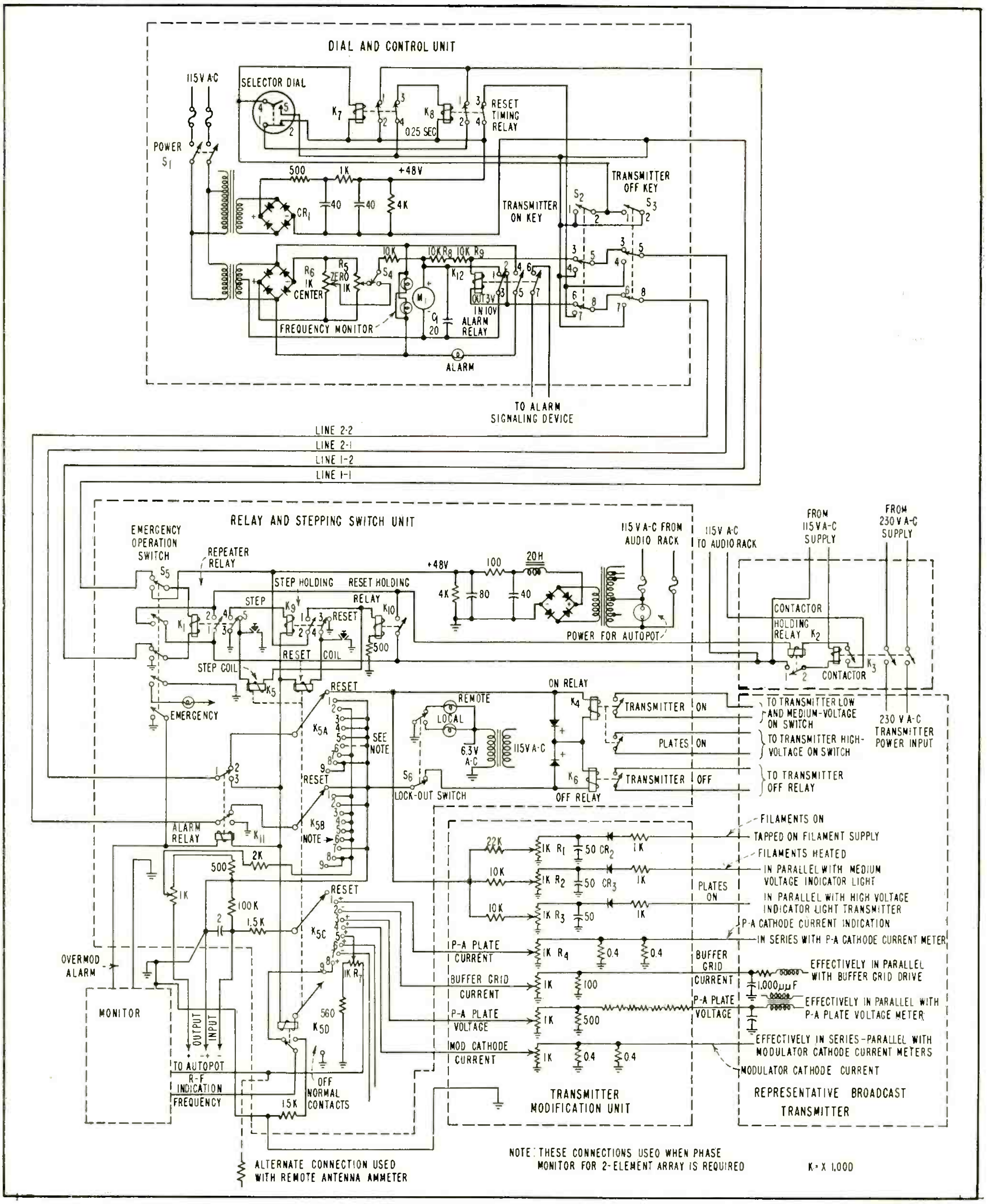


FIG. 1—Schematic diagram of Canadian GE remote-control equipment employing two telephone pairs and stepping switch for operating and monitoring 1-kw a-m broadcast transmitter

dialing cycle corresponding to the number dialed.

For each stepping impulse, repeater relay K_1 releases for 0.03 second and its contacts 3 and 5 close to energize the stepping coil of K_5. Each time this coil is energized, the armature of K_5 moves its wiper arms to the next contact until the ones corresponding to the number dialed at the studio are reached. The first and second set of wiper arms connect both sides of line 2 to the signal to be measured after it has been amplified by the Autopot or self-balancing potentiometer.

The third set of wiper arms picks off a sample voltage from the circuit to be telemetered. After each impulse the stepping coil of K_5 is released and its armature moves to the next notch in the wiper arms, ready for the next step. At the completion of the dialing cycle, dial contacts 4 and 5 open, releasing K_7 whose contacts 1 and 2 close and maintain the circuit of line 1. The control circuits remain as outlined above while the studio operator enters the desired reading in the station log.

When the next number is dialed the wiper arms first return to the reset position before connecting the circuit to be measured to the Autopot and thence to line 2. This is accomplished as follows:

Moving the dial interrupts the circuit of line 1. Repeater relay K_1 is then released, its contacts 3 and 5 close, energizing the step coil of K_5. At the same time K_1 contacts 3 and 4 are opened, de-energizing the coil of step-holding relay K_9. After 0.1 second, K_9 contacts 1 and 2 open, releasing the step coil of K_5 and de-energizing the coil of reset holding relay K_{10}. Simultaneously, K_9 contacts 3 and 4 are closed, operating the reset coil of K_5, which returns the contacts of this relay to reset position. Since the reset impulse is automatically timed by K_8 to last 0.03 second, this operation will be correctly performed even if step-holding relay K_9 or reset timing relay K_8 are not in precise adjustment. It is noted that at the start of the reset impulse, relay K_5 will step up one before the reset function is performed. This is of no operational significance and could be avoided only by adding another relay that would contributed little to the operation of the equipment.

The Autopot is a self-balancing potentiometer and amplifier used to amplify and partially isolate the quantities to be measured from the line. Since some of the quantities are of negative polarity, and since the input and output circuits of the Autopot have a common connection that must be grounded, it is necessary to provide automatic switching of polarity in the output circuit in order that M_1 will read in the same direction. This is done by wiper arms K_{5A} and K_{5B} and the Autopot, which accepts voltages of either polarity, reverses the negative voltages, and amplifies each separately. The step and reset buttons permit the telemetering function to be carried out manually at the transmitter site.

Meter Zeroing

Because meter M_1 is very sensitive, it is necessary to compensate for stray leakage currents that may occur in the metering line. This is accomplished by zero potentiometer R_5 in the dial-and-control unit, and it is adjusted so that with zero input to the Autopot, meter M_1 reads zero. There are two ways in which to do this, by dialing p-a plate current when the transmitter is off the air, then adjusting R_5; or if there is a spare position on the stepping switch, the spare would be dialed before adjusting R_5.

Telemetered indications extra to the transmitter proper are frequency deviation and r-f output level. In order to read the former, potentiometer R_6 must be adjusted so that M_1 is brought to center scale. This is done by operating frequency-monitor key S_4, dialing 9 then adjusting R_6 until M_1 is centered. This permits reading frequency drift in either direction, and also compensates for any drift in the monitor operating circuits and variation in line-leakage currents. Radio-frequency output is preset by adjusting R_7 after dialing 5 at the studio. Variations in reading on M_1 indicate variations in transmitter r-f output level. The remaining monitor indication, percentage modulation, is not telemetered, but warning is given of overmodulation through use of alarm circuits.

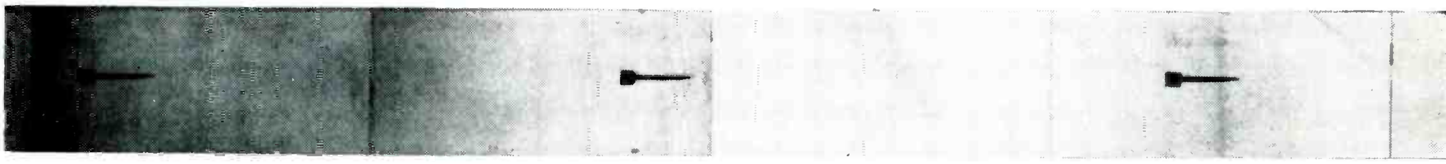
Alarm Circuit

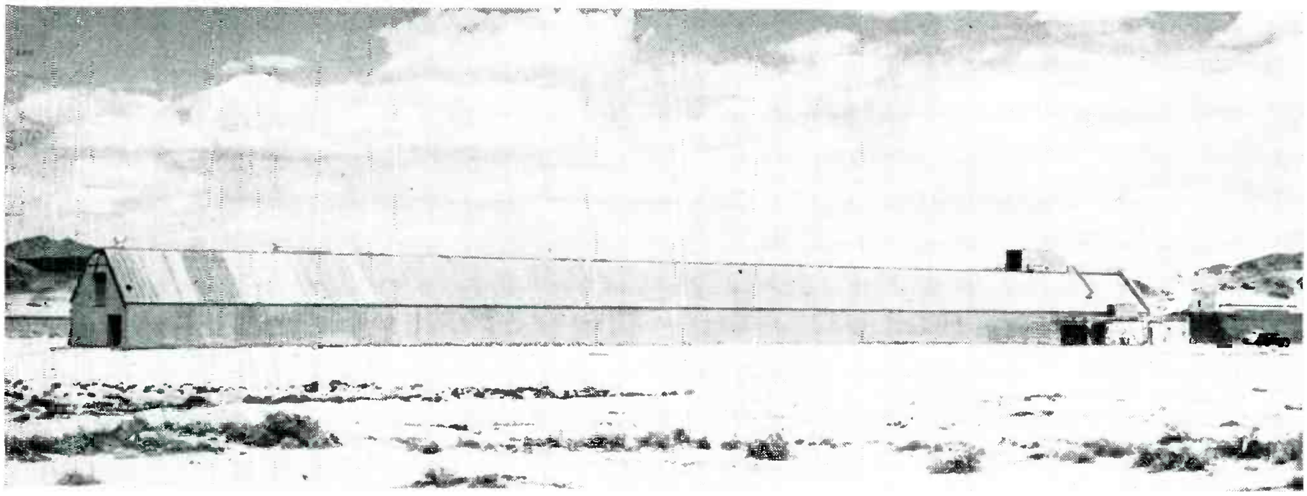
The alarm circuit is normally used only for extending the overmodulation circuit of the modulation monitor, but other circuits can be connected to it. When over 100-percent modulation occurs, K_{11} is operated, disconnecting line 2 from the telemeter circuit and applying 48 volts d-c across the line. This operates relay K_{12} in the dial and control unit, whose contacts 4 and 5 energize the alarm indicator light. At this time M_1 is protected from the initial application of the 48 volts by capacitor C_1 and resistors R_8 and R_9. Further protection is provided by contacts 1, 2 and 3 of alarm relay K_{12}, which disconnect the meter from the line and short circuit the meter movement when an alarm occurs.

In case of emergency such as a failure of the studio lines, the transmitter equipment is immediately shut down as outlined in safe-failure procedure, but it can be re-energized and operated from the transmitter site. Emergency operation switch S_5 permits operating the transmitter completely independent of studio control. Two studio signals are provided to show the switch is in use. A light indicates S_5 is in emergency position, and the alarm relay is operated at the studio when conditions are returned to normal. For matters of personnel safety, lockout switch S_6 prevents operating transmitter control relays K_4 and K_6 from the studio while an engineer is working on the equipment. It, however, does not prevent shutting down the entire equipment by means of the power switch at the studio.

WHO CAN USE REMOTE CONTROL

- Equipment described in this article fulfills requirements of the Department of Transport for Canadian a-m and f-m broadcast transmitters when they are operated by remote control.
- Effective April 15, 1953, the Federal Communications Commission liberalized its rules to allow somewhat similar remote operation for United States transmitters of 10 kw or less power employing nondirectional antennas.
- Broadcast station operators in Canada or the United States should check DOT or FCC regulations before putting into operation any remote control equipment to insure that it satisfies technical and legal requirements of the respective licensing authorities

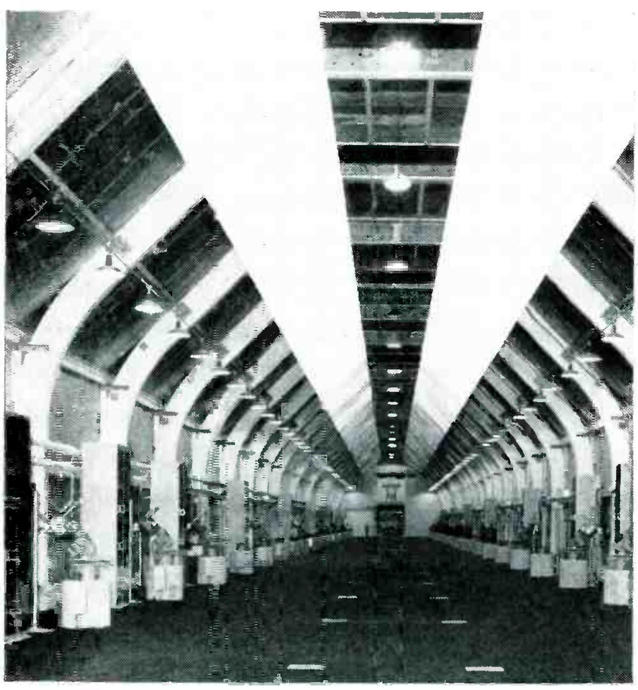




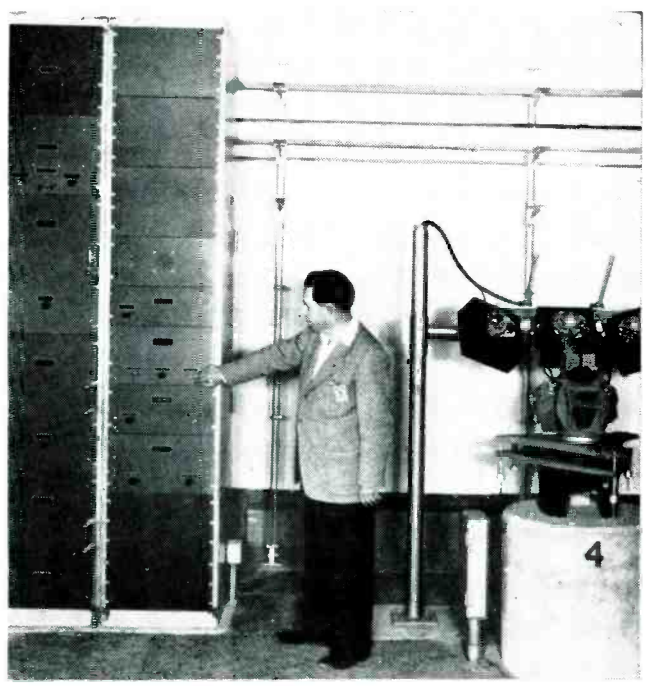
NOTS Aeroballistics Laboratory at Inyokern. Gun platform for firing rockets is at right end along with control room; missile stop is at left end of building

Microsecond Photography

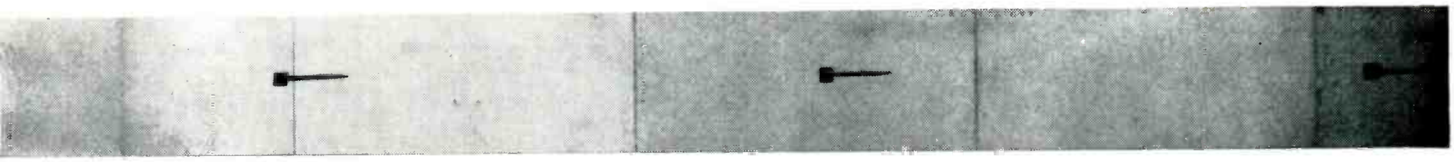
Electronically controlled flash lamps used in connection with 46 precision ballistics cameras provide up to 138 pairs of silhouette images of a rocket fired at sandbags in 500-foot indoor range, for determining aerodynamic and ballistic characteristics during flight



Interior of rocket test laboratory, as viewed downrange from station 3. White reflective strips on ceiling are required for silhouette photography. Sandbag missile stop is at far end. Camera takes six images in sequence, as at top of page



Instrumentation, lamp setup and ballistic camera at one station. Opposite position for station has only one vertical rack as photoelectric ungating equipment serves for both sets of flash lamps. Tubes to detect missile are set into floor of building



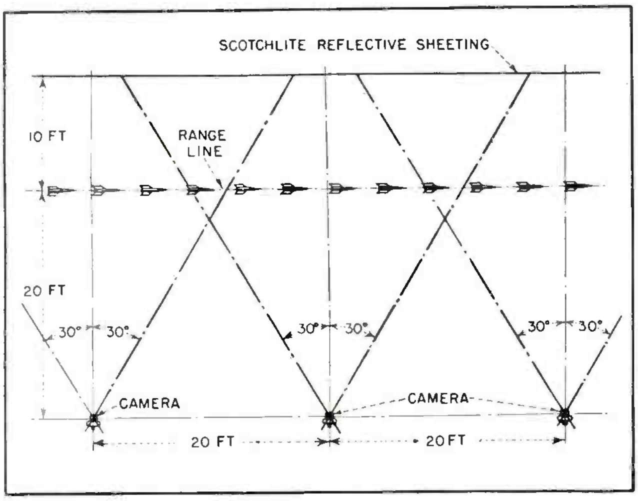


FIG. 1—Orientation used for cameras so each obtains six images of rocket

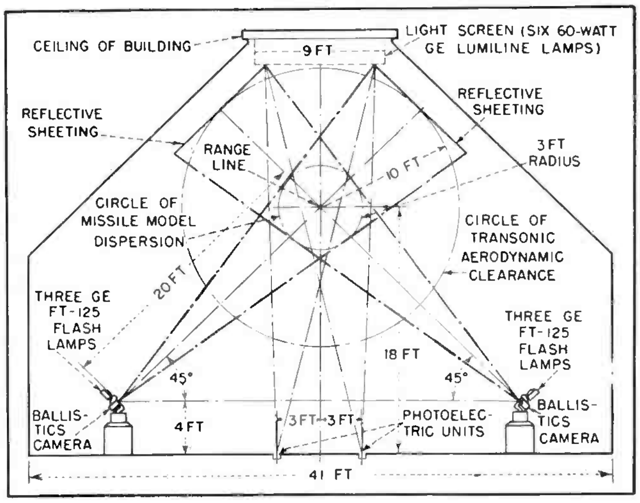


FIG. 2—Cross-section of range, showing one pair of cameras with lamp banks

# of Rocket in Flight

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ELECTRICAL-DISCHARGE photoflash lamps used as the sources of microsecond-duration illumination for photography of rocket models in flight demand the design and development of electronic instrumentation to meet specific performance and control requirements. The special requirements are imposed by the high accuracy desired in the experimental data and the physical size of the available laboratory.

The desired accuracy in the determination of the aerodynamic and ballistic coefficients of the free-flight rocket models requires that the transverse components of the center of gravity of the model at each instant of flash photography be determined to within 0.001 ft and the longitudinal component to within 0.01 ft. Each corresponding time coordinate must be known to within 1 μsec, hence the time of each light flash must be measurable with an accuracy of 10^{-6} sec.

Most of the electronic instrumentation directly associated with the flash lamps is located at intervals along each side of a 500-foot-long enclosed range which serves as an aeroballistics laboratory. This physical distribution of the instrumentation introduced problems in the control and monitoring of the equipment. Centralization of all instrumentation to provide remote control and monitoring from a single location was decided upon and governed the design of the necessary equipment.

Aeroballistics Laboratory

For experimental determination of the aerodynamic and ballistic characteristics of rocket models, inert models are launched from 40-mm and 3-inch guns. The rockets pass in free flight through the 500-foot-long range building and are photographed at 4-foot intervals during their flight. Photographic coverage is provided by 23 pairs of precision ballistics cameras arranged so that the fields of view of adjacent cameras are overlapping. This arrangement, shown schematically in Fig. 1, provides continuous coverage of the rocket model during its flight through the laboratory. Every camera photographs the model six times to give a total of 138 pairs of images.

Figure 2 shows the orientation of the pair of cameras at each of the 23 stations. Adjacent to each camera is an array of three electrical-discharge flash lamps, the sources of microsecond-duration illumination of the rocket models in transonic and supersonic flight. Each lamp is operated at 18,000 volts with a 0.02-μf or 0.04-μf discharge capacitor. Each bank of flash-tubes provides a series of accurately timed light flashes during the interval that the rocket model is in the field of view of the two related cameras.

The circle of 3-foot radius shown in Fig. 2 is the circle of maximum anticipated dispersion of the model; flash illumination is provided throughout the corresponding cylindrical volume, with reflex reflective sheeting serving as the background for silhouette photography of the rockets in flight.

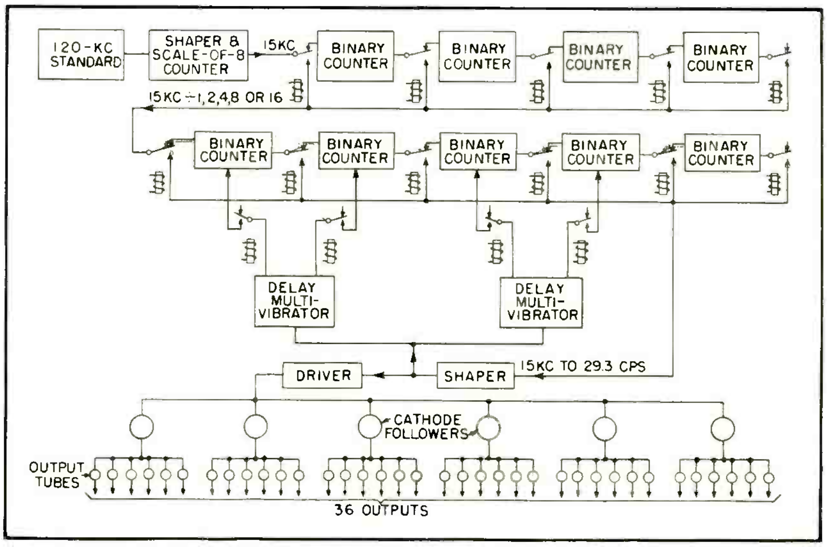

FIG. 3—Master timing system used to insure that time of each flash will be determinable to within 1 microsecond

Master Timing System

The master timing system in Fig. 3 continuously provides accurate timing signals to each of the stations of the laboratory. These signals are then gated in synchronism with the passage of the rocket model to produce the precisely timed light flashes. These expose negatives to give 138 pairs of photographic images of each rocket model, from which determinations of the corresponding position coordinates must be made.

A secondary time standard which provides a 120-kc signal is followed by a series of binary counters. This array of counters serves as a frequency divider to provide a selection of 96 frequencies in the range from 29.3 to 15,000 cps. Parallel outputs provide 1-microsecond pulses of 10 volts across 100 ohms.

Each of the binary counters may be switched from the frequency-divider circuit. The first four counters provide division by 1, 2, 4, 8 or 16, depending upon the number of active counters. Four of the remaining five counters in the chain are connected to feedback circuits. The possible combinations provide a selection of 32 integral division factors of 1 through 32, inclusive.

To obtain the desired accuracy of 1 μsec in determination of the time coordinates, it was necessary to take account of the time of transmission of the signal from the master timing system to the most distant station. A 500-foot-length of RG-22A/U Twinax cable carries the timing signal to station 23; the time delay over this distance is ¾ μsec. Compensation for this time delay is provided by using the same length of cable to each of the stations.

Station Triggering System

The electronic instrumentation associated with the electrical-discharge flash lamps at each station is shown in Fig. 4. The light screen and two photoelectric units constitute the triggering system which initiates the flashing of the electrical-discharge flash lamps. Two photoelectric units are needed to cover the circle of dispersion, as shown in Fig. 2. The light screen is a 9-foot-long linear array of six 60-watt GE Lumiline incandescent lamps. To provide a continuous-line light source, light from a 25-watt showcase lamp is reflected by a prism at each of the five gaps between the lumiline lamps. The light screen is operated with d-c voltage; flicker with a 60-cycle power source was found to be about 7 percent, far too great since the triggering system must respond to a modulation of 1 percent by a rocket model passing through.

The photoelectric unit utilizes a 1P21 photomultiplier tube followed by a 2-stage amplifier and a 2050 thyratron, connected as in Fig. 5. The 1P21 is operated with a total dynode voltage of only 408 volts (giving an amplification of 8,000) in order to obtain a good signal-to-noise ratio (10:1) with 1-percent modulation. The amplifier has a maximum gain of 300 and has half-power points at 30 and 10,000 cps.

This photomultiplier-amplifier combination was found to give a more favorable signal-to-noise ratio than was possible with greater gain in the photomultiplier tube and less in the amplifier. The thyratron is biased at −6 volts and when fired will deliver a 5-microsecond pulse of 60 volts across 100 ohms. This signal initiates action in the gating unit.

Gating Unit

The purpose of the gating unit is to pass six timing pulses of a preset frequency; this will result in the flashing of the electrical-discharge lamps in synchronism with the passage of the rocket model. A block diagram to illustrate the action of the gating unit is given in Fig. 6. The triggering signal from either or both of the photoelectric units trips the start thyratron of the gating unit. The thyratron signal in turn starts a cycle of the one-shot gate-forming multivibrator. The multivibrator pulse carries six of the timing pulses over the voltage barrier of the diode gate. The timing signals passed by the gate drive the blocking oscillator; the negative output of the latter is fed

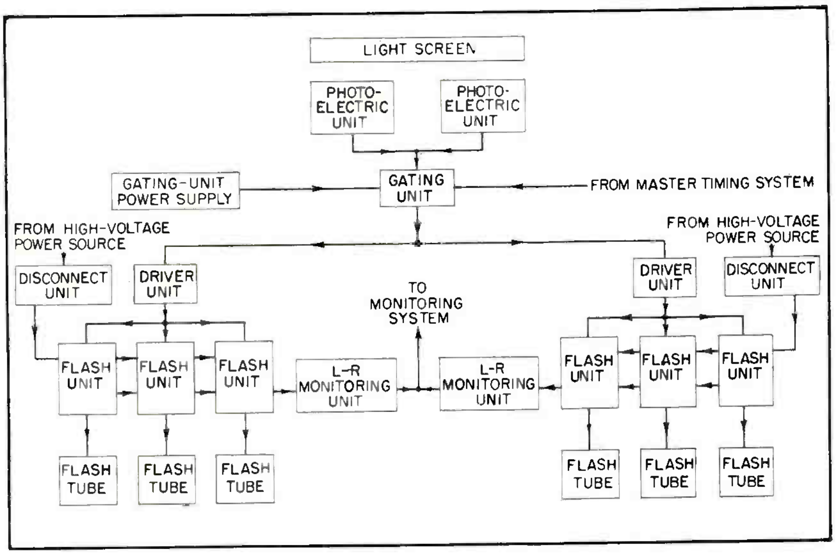

FIG. 4—Photoelectric system used for ungating precision timing signals at each station in sequence as rocket flies down the range

through parallel outputs to driver units of each station. The open gate is closed by the phantastron gate-width timing circuit.[1]

The phantastron action is started by the first of the six timing signals coming through the system; the period of the phantastron cycle is determined by the preset control voltage. The voltage-control dial is calibrated to read directly the gate widths equal to the time required for the rocket model to travel the photographic length of each station. It is expected that the velocity of the model can be predicted to within 1 percent; in fact, it is planned to fire identical models on an outdoor range to check their velocity and stability before launching them through the Aeroballistics Laboratory.

The range of velocities of the rocket models will be from 800 to 6,000 ft per sec. The corresponding gate widths are set somewhat greater than would be expected (25–3.3 milliseconds) for a station length of 20 feet, since the photographic fields of view are overlapping and hence longer than 20 feet. The gate widths are set for the time of travel of the model over 26 feet. In the event of a failure in the phantastron gate-width circuit, the gate-forming multivibrator will close the gate when it returns to its initial state in a natural period of 40 milliseconds.

The phase relation between the single triggering pulse of the photoelectric unit and the continuous timing signal is entirely arbitrary. Depending upon this phase relation, the start of the flashing of the lamps may occur immediately after the photoelectric signal or may be delayed as much as the period of the timing signals. The timing signal frequency is chosen to give one flash at each 4 feet of travel of the model, hence the first flash may occur with the missile anywhere between the plane of the triggering system and 4 feet farther down-range. This randomness is a small cost to pay for the gains from the use of the master timing system.

The schematic diagram of the gating unit is given in Fig. 7. When start thyratron V_1 is fired, it remains in a conducting state until it is reset by an external circuit which momentarily removes the plate voltage. This makes it impossible for the gate to be re-opened by the sabot which will sometimes follow the rocket model.

The negative pulse from the start thyratron is applied to the normally cut-off plate of gate-forming multivibrator V_3. Half of dual-diode V_2 isolates the multivibrator and prevents its being triggered except on firing of the start thyratron.

The positive pulse from the multivibrator opens gate diode V_4, thus permitting the timing pulses from transformer T_1 to pass. These pulses are amplified by V_5 to drive blocking oscillator V_6. The output pulses of this oscillator, of 1-μsec duration

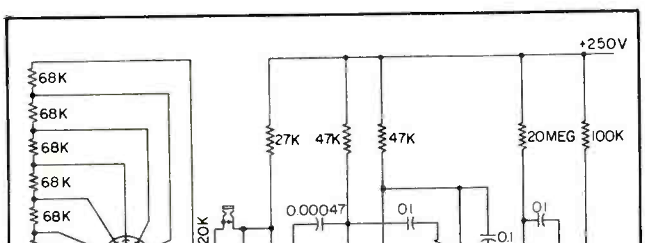

FIG. 5—Multiplier phototube and amplifier circuit arrangement

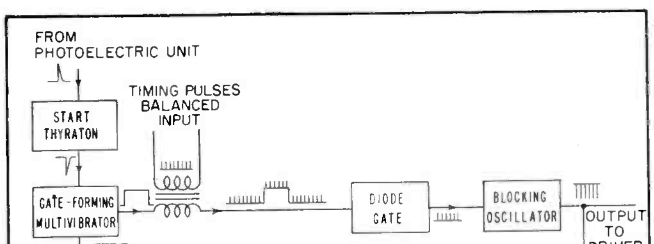

FIG. 6—Gating unit, showing timing signals on square-waves

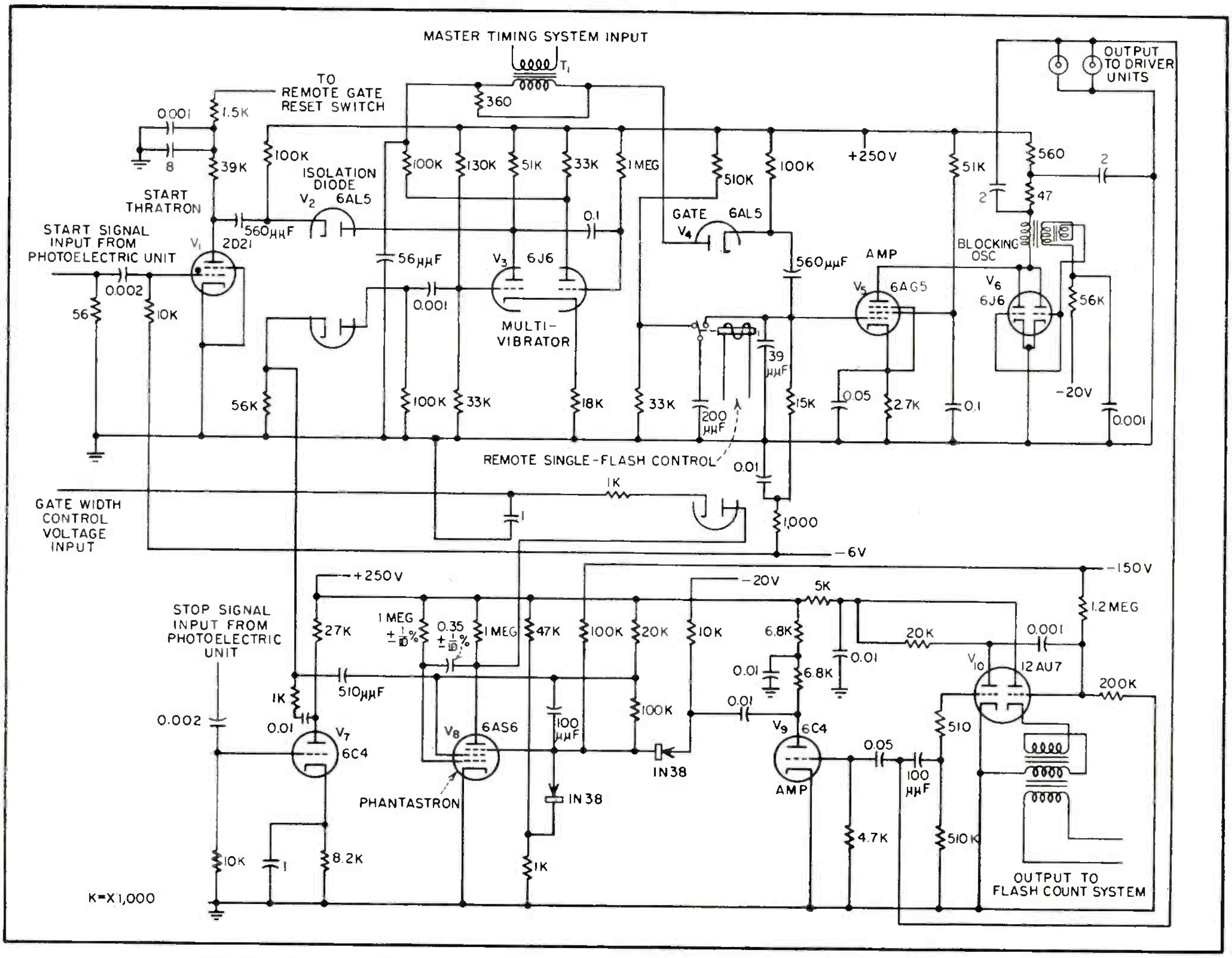

FIG. 7—Circuit of gating unit used to pass timing signals only when rocket is in camera range

with a negative peak level of 25 volts, are conducted to the driver units through output plugs. These negative pulses are also amplified and inverted by V_9, and the first of them starts the phantastron action of V_8.

The pulse output of the phantastron is differentiated by an R-C network. The trailing-edge pulse is passed by the lower half of diode V_2 and cuts short the action of the gate-forming multivibrator, thus preventing further timing pulses from passing through the diode gate. If it is desired to close the gate by means of the signal from the photoelectric triggering system of the next station, that signal is amplified and inverted by V_7 to cut off the gate-forming multivibrator.

Local or remote operation of the relay at V_4 results in a single flash of the lamps at the station. This gives a simple check of the performance of most of the circuitry of the station system.

Driver Unit

The driver unit serves to raise the level of the timing pulses from the gating unit and provide high-voltage, low-impedance outputs to drive the hydrogen thyratrons of the flash units. A circuit diagram of the driver unit is given in Fig. 8. The burst of six timing pulses from the gating unit is amplified by V_1 which in turn drives cathode follower V_2. The output of the latter drives buffer amplifier V_3, followed by three 807 cathode followers. The signals from these are 1-μsec pulses with a level of 400 volts across 500 ohms. These signals are passed by a coaxial cable to the flash units. The driver unit also provides a regulated negative bias of 150 volts for the flash-unit thyratrons.

Each flash unit contains the resonant-charge[2] and thyratron-discharge[3,4] for the capacitor of its associated flash lamp, as shown in Fig. 9. The 1.25-henry charging reactor is in series resonance at 1,000 cps with a 0.04-μf flash capacitor (used for the two outer lamps of each three-lamp array) and at 1,414 cps with a 0.02-μf capacitor (for the center lamp). A 5C22 hydrogen thyratron serves as the switch in the discharge circuit of each flash unit.

Flash Unit

The flash lamp is operated at the end of a 25-foot length of the 52-ohm RG-8/U cable and appears quite well matched. Tests were made with a rotating-mirror camera to measure the simultaneity of the flashing of the three lamps in each array; the flashes were found to occur within 0.25 μsec of each other.

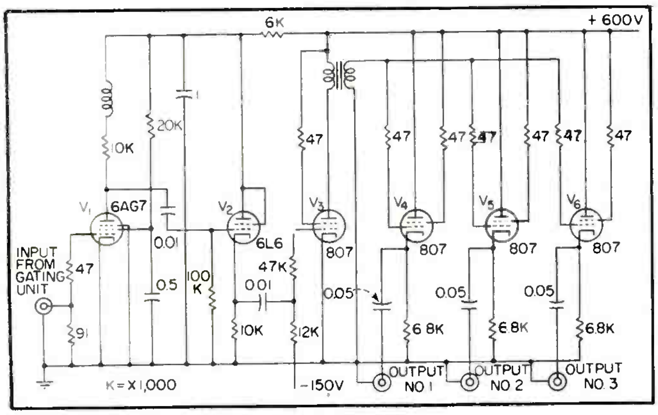

FIG. 8—Driver unit used to amplify timing-signal output of gate

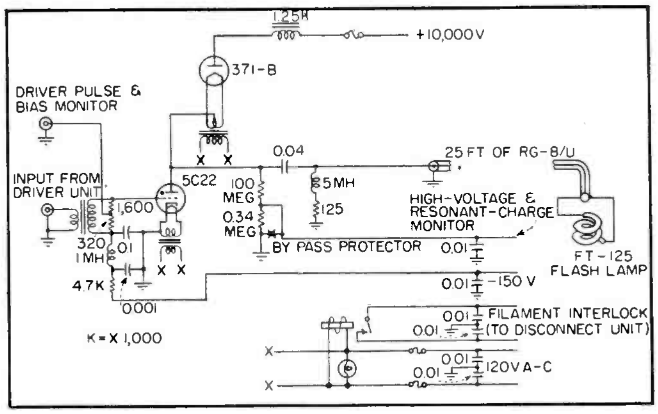

FIG. 9—Flash unit arrangement used for individual flash lamps

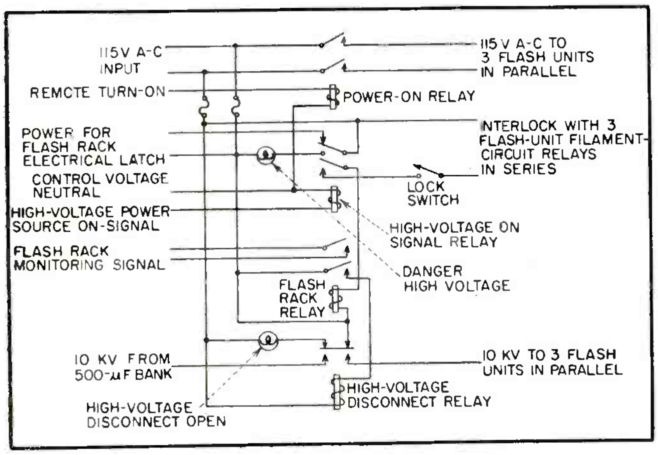

FIG. 10—Disconnect unit serving as safety system

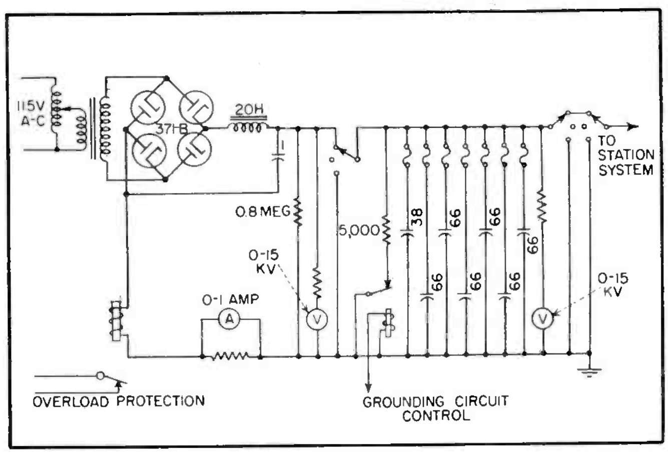

FIG. 11—Circuit of high-voltage power source for flash lamps

The flash units are connected to the high-voltage power supply through disconnect units, as in Fig. 10. An antenna transfer relay in the disconnect unit serves as the series switch between the high-voltage power source and the flash units at each station. The coil of this switch is so interlocked with other circuits that it is energized only when the filaments of the hydrogen thyratrons of the three associated flash units are turned on and the door of the rack housing these units is closed.

High-Voltage Power Source

The source of power for the flash lamps is a 500-μf energy-storage capacitor bank. Design studies proved it to be more economical to operate the lamps from a capacitor bank than to design and construct a high-voltage rectifier which would deliver the peak power required upon instantaneous demand. The reason for this is that even though the power demand for the fraction of a second required by the rocket model to pass through the laboratory is high, the total energy required is very small. The power requirement for six lamps flashing at any one time at the maximum planned rate of 1,500 times per sec is approximately 50 kw. The total energy for the six flashes at any one station is about 200 watt-seconds, and the total energy required by the flash lamps of 23 stations is 4,600 w-sec. The energy stored in the 500-μf capacitor bank at 10,000 volts is 25,000 w-sec. The efficiency of the resonant-charging cycle is 90 percent, hence the total energy drawn from the source is 5,100 w-sec or approximately 20 percent of the total available energy. This means that the last flash (the 138th) will be only 80 percent as bright as the first. This difference is hardly noticeable, however, in the logarithmic response of photographic emulsions.

The 500-μf capacitor bank is charged by a surplus radar power supply (RA-38 of the SCR-268), shown in Fig. 11. This supply can deliver one-half ampere at 10,000 volts and hence charges the 500-μf bank in a few seconds.

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Automatic Pinboy for

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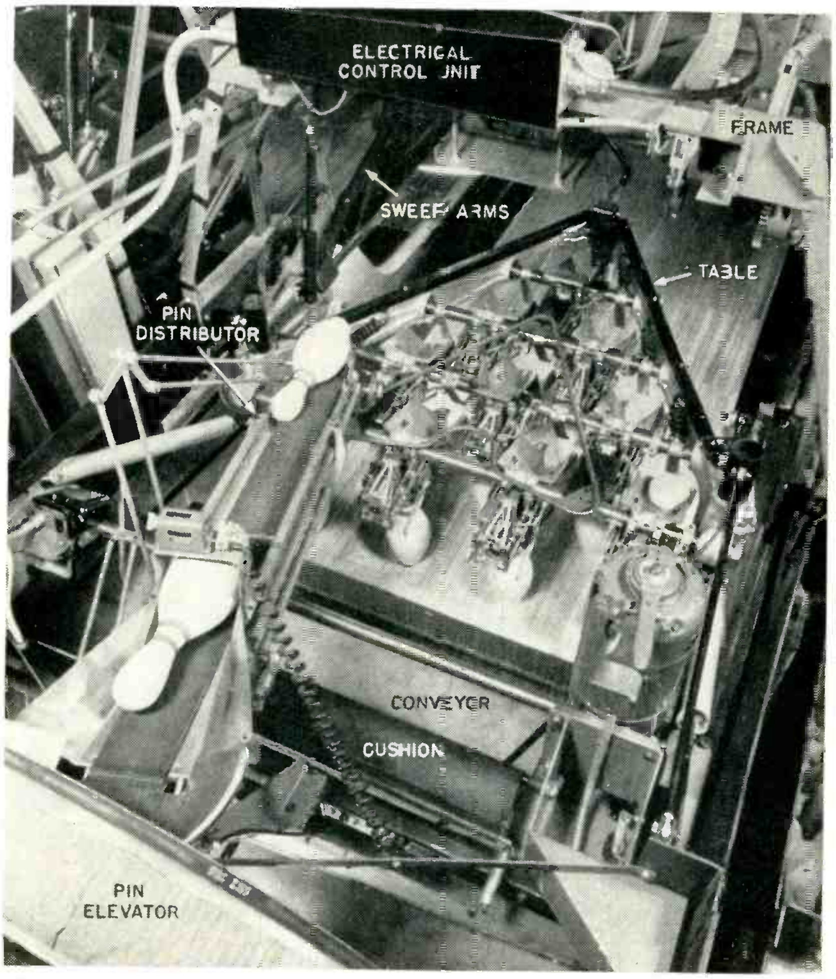


Major components of the automatic pinspotter. Electrical control unit determines proper operating cycles for sweep and table

THE AUTOMATIC PINSPOTTER is an electromechanical device that will perform the bowling functions usually performed by the pinboy. This includes setting up the bowling pins, clearing the alley of downed pins, returning the ball to the bowler and rearranging the pins for the next bowling cycle. The present unit uses electronic circuits for sensing and controlling the mechanical functions of the machine.

Operating Cycles

The functions of the automatic pinspotter are categorized into the following cycles: first ball, second ball, strike and foul. Two sets of standard ten-pins are employed. In a normal first-ball cycle, where some pins are left standing, a time-delay is provided to allow wobbling pins to either fall or stand. A table then descends, grips the standing pins, and raises them to allow a sweep to remove the dead wood. Standing pins are then replaced on the exact spot from which they were lifted.

After a second ball is bowled the sweep clears all pins from the alley. The table descends, spotting a new set of ten-pins and the machine is again ready for a first-ball cycle.

If the table descends in a first-ball cycle and finds no pins standing, this information is transmitted to the electrical control which changes the machine function to a strike cycle. The sweep clears the deck and a new set of ten-pins is set up.

If a bowler gets a spare in the tenth frame, he is allowed a third ball. If pins are left standing, the alley must be cleared and the machine returned to a first-ball cycle for the next bowler. A reset button, accessible to the bowler, cycles the machine to the start of a first-ball cycle.

The major components of the pinspotter are placed on the main frame mounted over the pin setting area. The sweep pushes fallen pins from the alley into the pit. As the pins and ball fall into the pit, they are conveyed by a continually operating conveyor belt toward the rear of the machine. A cushion allows the pins to pass under to the rear of the pit and guides the ball to one side of the pit where the ball is lifted by a vertical belt to a track which returns it to the bowler.

A large wheel, at the rear of the pit elevates the pins to a distributor belt.

The distributor is an extendable, movable conveyor which indexes from one pin location to the next placing the pins in the unoccupied pockets of the table. The bowling pins are held till the machine reaches its spotting cycle, at which time they are brought into a vertical position and place on the alley.

Offspot pins are replaced by free-floating clamping pads which adjust themselves to the pin position. They are then locked, holding the pin firmly during the up and down movement of the table

Control Chassis

The electrical devices associated with the pinspotter include drive motors, switches and solenoids which are interconnected, synchronized and controlled by the electrical control chassis. Operation at the correct time during the cycle is controlled by a bank of cams and miniature switches, relays and starters.

Bowling Alleys

Four distinct operating cycles allow the automatic pinspotter to handle all possible bowling situations including replacement of offspot pins. Electronic circuits are used as foul detector and to provide time delay to allow pins to settle.

Latch type relays perform the memory functions. These relays control the start of the machine cycle and determine whether a first or second-ball cycle is being performed. They also control the table and decide whether pins should be placed on their spots or whether the respot mechanisms should be brought into play. In addition, the memory unit controls the table cycle, regulates the number of pins being delivered by the distributor and overrides other machine functions in the case of a foul as determined by a photoelectric foul detector.

The memory relays are actuated by switches located in various components of the machine. Over-travel switches on the table connecting rods, turn the machine off if a pin jams under the table.

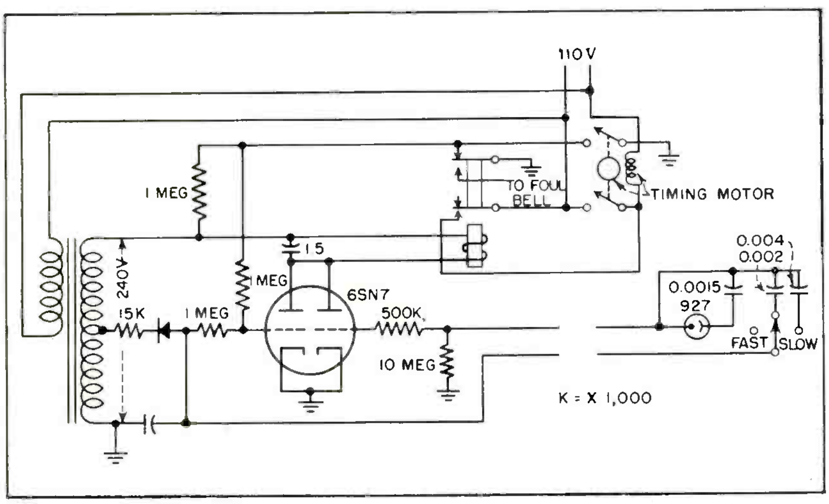
Time Delay

An electronic time delay functions on the first-ball cycle to delay the lowering of the table and on the second-ball cycle to delay the start of the sweep. A parallel-connected 6SN7 dual-triode is used. When the starting contact in the cathode circuit closes, the tube begins to pass current as the timing capacitor charge is dissipated. As tube current increases, a sensitive relay coil is energized, making circuits in the appropriate control centers. Principal design considerations in selecting an electronic timer centered around the simplicity, reliability and low cost as compared to mechanical, thermal, pneumatic or hydraulic delay systems.

Foul Detector

The foul detector automatically cycles the machine when a foul is committed by the bowler.

Both plates of a 6SN7 (see accompanying circuit diagram) are connected to the relay coil and both grids are normally negatively biased to approximately −40 volts d-c, preventing the tube from drawing plate current. The type 927 phototubes have low resistance when exposed to light and pass sufficient current to keep the grid negative. When the light beam is interrupted, the phototube resistance increases to a high value, practically stopping the current flow through the grid resistor. The grid then loses its bias through the 10-megohm resistor to ground and allows half the tube to conduct energizing the relay. The upper contact on the relay then opens the ground connection which normally keeps positive plate bias off the other 6SN7 grid, thereby making this half of the tube draw plate current also through the relay which then becomes locked in the energized position.



Circuit of the foul-detecting unit. Cam-operated switches control foul bell and light

The relay contacts in the energized position ring the foul bell and apply power to a motor operating a double cam. The cam closes a switch which lights the foul light and applies power to its own field coil. It then closes a second switch which unlocks the relay, stopping the bell in two seconds. The cam shaft turns exactly one revolution, near the end of which the grid control switch opens. At the end of the revolution, the motor switch opens, shutting off motor and foul light.

An unusual feature of the foul detector is the use of a high sensitivity amplifier operating 10 megohms above ground, controlled by a phototube some 60 feet away, without the need of shielded wiring when run alongside the 6 volt a-c light source line. Actually, the a-c line serves as a shield to the grid lead such that undesirable pickup in the grid lead is cancelled or eliminated by proper phasing and balancing of the a-c lines with respect to the grid lead.

A variable time delay provides adjustment for the phototube response time so that the unit can be set to discriminate between the short interruption of the bowling ball and the longer interruption caused by a bowler's foot.

Determining Properties

Resistance-temperature characteristics of bulk germanium and other semiconductors are determined oscillographically by pulse-heating method. Measurement from temperature of liquid hydrogen to 650 K takes less than a second to achieve

ELECTRICAL PROPERTIES of semiconductors are determined by the density of the carriers which transport the electric charges, the temperature dependence of the carrier concentration, and the mobility of the carriers. To determine these quantities, Hall and resistivity curves must be taken as functions of temperature.

Measurement Techniques

If the conventional method of obtaining resistivity-temperature curves is employed, a stable temperature is established within the semiconductor and the resistivity measurement is then made at that particular temperature. Successive temperature and resistivity measurements give the characteristics of the specimen under observation. The fact that thermal equilibrium must be established before each resistivity reading means that the process of obtaining this data may take many hours.

During the extended execution of these measurements, processes may take place within the semiconductor (such as oxidation, healing out of defects, and so on) which would substantially alter its resistance-temperature characteristics. This is tantamount to completing the experiment with a specimen different from the one with which the experiment commenced.

To overcome this difficulty one may employ a method[1,2] for the simultaneous ascertainment of the temperature and resistivity that is very rapid as compared with the processes which might cause changes in the electrical properties of the sample. Such a dynamic method was worked out by Ehrenberg and Hirsch[3,4] who applied it to the study of the electrical properties of thin films of such materials as lead sulphide.

Apparatus

The apparatus (Fig. 1) consists essentially of a circuit to measure the resistance of the specimen, a circuit to provide power to heat the specimen and a circuit to measure the temperature of the specimen as its temperature is increased.

A small, constant, nonheating, measuring current i_a of between

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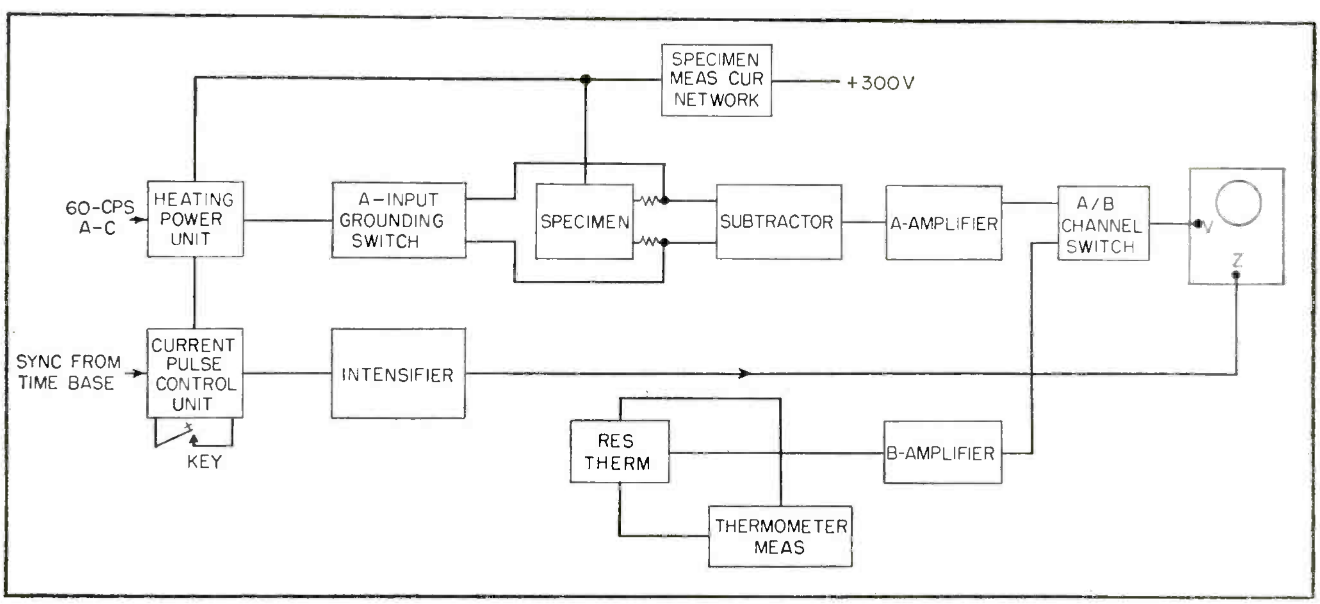

FIG. 1—Block diagram of equipment used in determining resistance-temperature characteristics of bulk semiconductors

# of Bulk Semiconductors

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0.05 μa and 25 ma is passed through the specimen. This range of current provides a voltage across the specimen which, when amplified, will be sufficient to produce a measurable deflection on the oscilloscope. This current develops potentials with respect to ground. A subtracting unit (Fig. 2) determines the voltage difference between the probes applied to the specimen. The resulting difference signal is amplified (in the *A* amplifier, Fig. 2) and applied to a switching arrangement (V_3 and V_7, Fig. 3). This switch applies the signal for one half of the switch cycle (switching frequency 60 or 120 cps) to the final amplifier (Fig. 3) from which the signal then goes to the vertical deflection plates of the cathode-ray oscilloscope.

Since the measuring current i_a is constant, the voltage developed across the voltage probes on the specimen manifests itself in a deflection of the crt beam proportional to the instantaneous resistance of the specimen.

Heating Circuit

Mercury vapor rectifiers, the power input to which is controlled by a continuously variable transformer, provide a rectified but unfiltered alternating current (60 cps) to heat the sample. To make the heating time shorter or longer, depending on the rate of the disrupting process taking place within the semiconductor, the length of time that the heating current passes through the specimen may be varied from 0.060 to 0.75 second by means

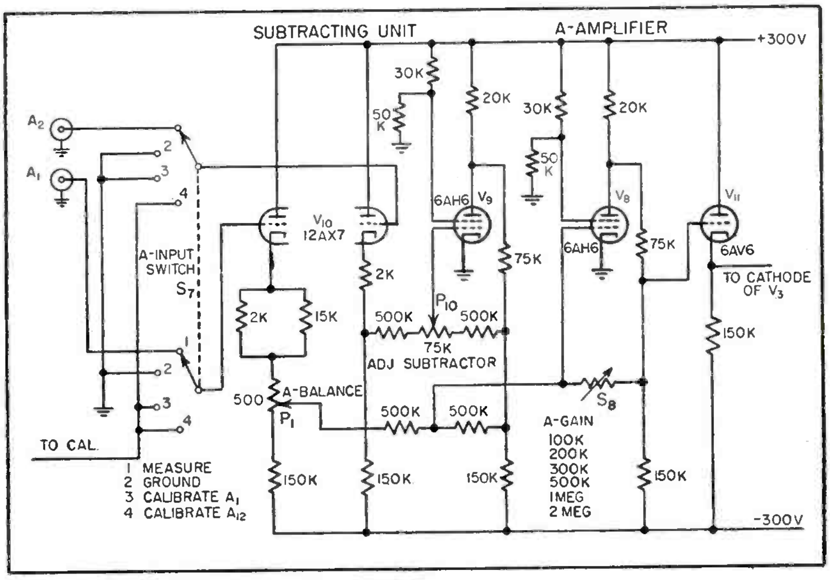


FIG. 2—Circuit determines voltage drop across probes on surface of semiconductor and provides amplified version for oscilloscope presentation

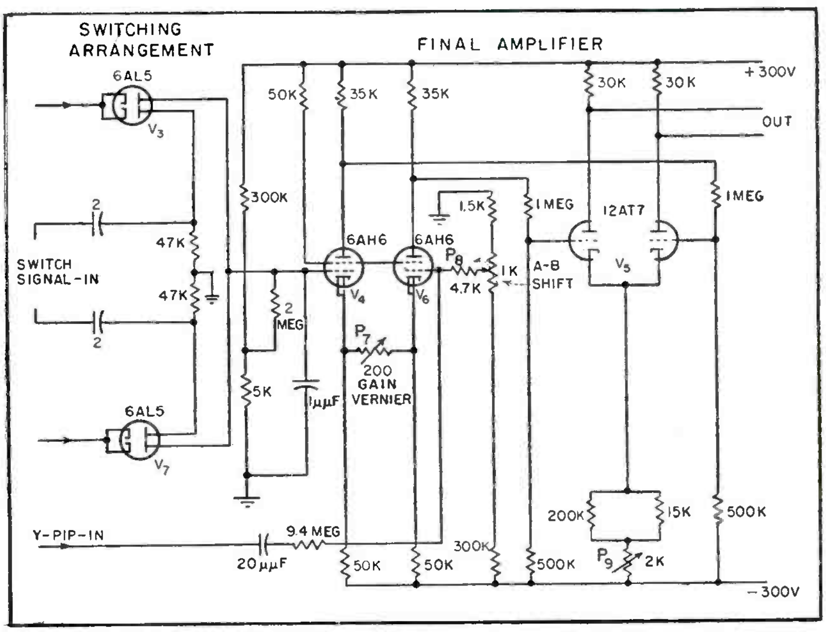


FIG. 3—Switching circuit alternately samples specimen resistance signal produced by circuit of Fig. 2 and signal from gold film resistance thermometer circuit (Fig. 5)

of the pulse width control P_1 (shown in the timer section of Fig. 4).

During the half cycle when there is heating current passing through the specimen, another electronic switch grounds the terminals of the A amplifier. If not grounded, the voltage developed across the specimen by the relatively large heating current might be sufficient to overload the A amplifier.

Gold Thermometer

The gold film resistance thermometer receives a constant current of 2 to 10 ma. The voltage drop across the thermometer is proportional to the thermometer resistance. The voltage necessary to return the temperature or B trace to fiducial zero can be read from the calibrated potentiometers P_3 or P_4 (Fig. 5). The change in voltage across the thermometer can be ascertained from the deflection of the B trace above the fiducial zero on the face of the oscilloscope. Referring to a thermometer calibration chart it is possible to obtain temperature as a function of relative change in resistance of the thermometer. Thus deflections of the B trace may be interpreted in terms of the temperature of the specimen.

The thermometer signal is applied through the same electronic switch as the resistance signal. During the half cycle when it does not apply the specimen resistance signal to the cathode-ray tube, the switch permits the temperature signal to be passed to the vertical deflection plates of the oscilloscope. In effect, the switch alternates every 1/120 or 1/240 second (depending on the switching frequency) the signal to be applied to the vertical deflection plates of the cathode-ray tube. The instantaneous temperature and resistance of the specimen may be ascertained because curves representing each appear as two discontinuous traces on the face of the oscilloscope.

A time base provides linear sawtooth sweep voltage for horizontal deflection plates.

Specimen Holder

Figure 6 shows a diagram of the essential parts of the specimen holder. The platinum potential probes and piano-wire springs are sheathed in pyrex glass and all are incorporated in a single unit. The pyrex glass extends down below the end of the piano wire for about $\frac{3}{8}$ inch. A small tip of the platinum wire extends through the bottom of the tip of the pyrex glass, and the other end of the platinum wire extends out the side of the pyrex, whence it goes to the appropriate terminal on the base of specimen holder. This arrangement is used to reduce the amount of heat conducted away from the specimen by the potential probes.

A wooden support is provided as a support for the thermometer against which it is pressed. Wood was chosen because its thermal conductivity is several orders of magnitude less than asbestos. The piano-wire springs that serve to press the potential probes against the specimen also serve to press the specimen against the thermometer that is backed by the wooden support.

The heating and measuring current electrodes consist of platinum foil interposed between the plated ends of the specimen and the mica supports.

The bakelite base of the specimen holder is circular in shape and fits a sealed container designed to hold the specimen and specimen holder for resistivity measurements starting at low temperatures. Brass is used for the container because it has a high thermal conductivity. Circular rings provide a seal for the top of the container. Electrical contact is made from the terminals on the base of the specimen holder through Sperti seals to the outside of the container.

To make measurements starting at the temperature of liquid nitrogen, the container with the specimen holder in it is submerged in the coolant bath.

To diminish the time lag between the actual temperature of the specimen and the response of the thermometer, the mica backing on which the gold film is painted was made as thin as possible by splitting the mica sheets under water with a steel needle. It was possible to obtain mica about 2.5 μ to 2 μ thick. From these thin mica sheets the thermometer blanks are cut, roughly in the shape of a T. The blanks are then painted with three layers of gold bright. After the first two layers, the thermometers are baked at 200 C; after the third they are baked for 3 hours at 400 C to insure that all the vehicle is driven off.

The resulting gold film is then scratched with a sharp stylus to provide a narrow, high-resistance electrical path. The room temperature resistance of a thermometer should be about 180 to 200 ohms.

The gold film resistance thermometer is calibrated in percent change in the resistance as a function of the absolute temperature. The average sensitivity of these thermometers is about a 10-percent change in the resistance for a change of 100 C in temperature.

Specimen Preparation

The semiconductor specimens used in these experiments were usually 3 or 4 millimeters wide, 12 to 14 millimeters in length, and less than 0.5 millimeter thick. A thicker specimen would bring about a time lag between the response of the thermometer and the transient temperature of the specimen, as the specimen will tend to be hotter in the middle. If the sample is thin and if the thermal conductivity is relatively high, the entire specimen will be at an almost uniform temperature.

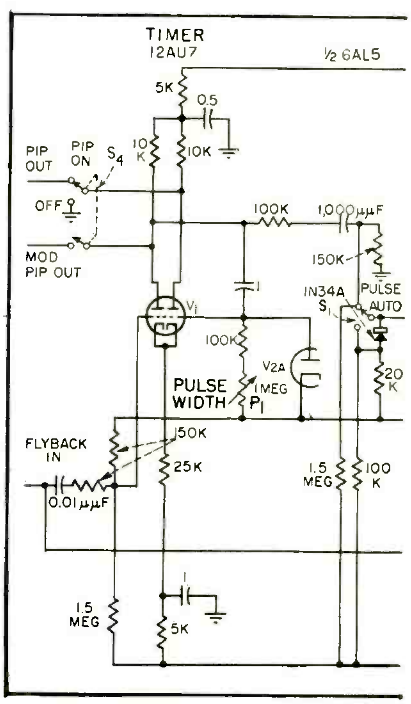


FIG. 4—Pulse unit

The specimen is ground to the desired thickness with carborundum powder and then etched. The specimen is plated on each end to facilitate better electrical contact to the heating and measuring current electrodes. If the contacts here are not good, there may be sufficient power dissipation in the contact resistance to burn holes in the platinum foil of which the electrodes are made. This danger is particularly evident when the specimen is heated to higher temperatures by a large current density.

Calibration and adjustment procedures are as follows: Assume that a semiconductor crystal has been placed in the specimen holder, the resistance channel or *A* circuit is connected and the gold film resistance thermometer is connected to the input terminal. Let the initial temperature of the specimen be room temperature. To heat the specimen to 500 C in 0.5 second, the procedure would be as follows:

With S_7 (Fig. 2) in position 2

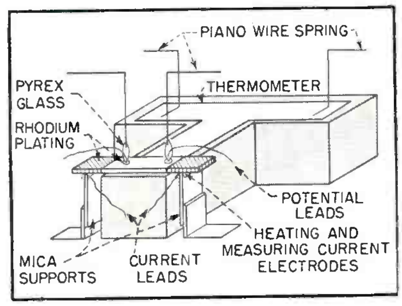
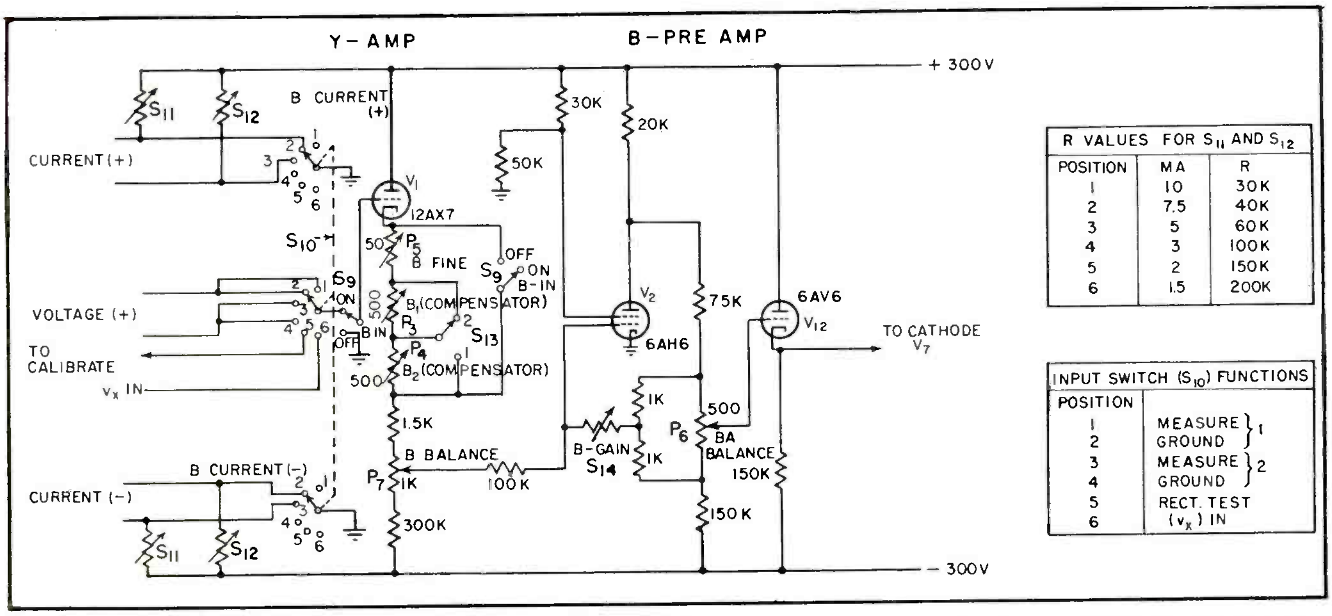


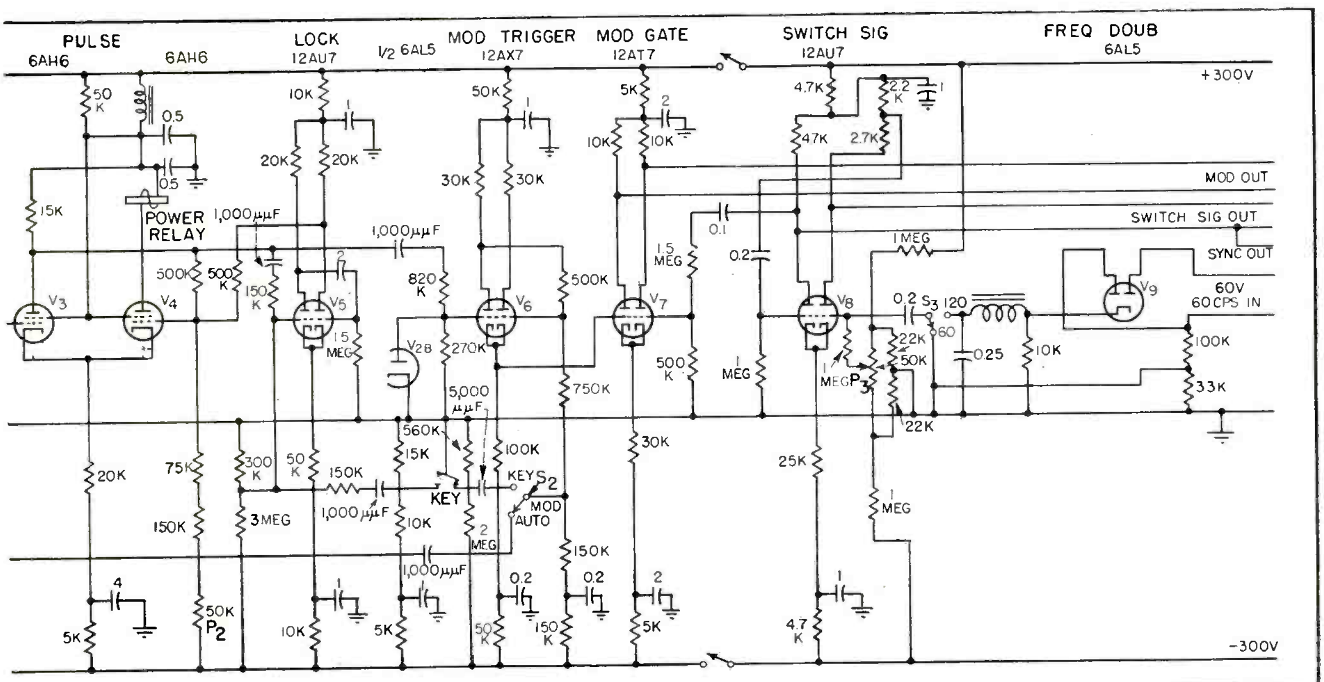
FIG. 6—Specimen holder design is largely responsible for versatility of bulk semiconductor resistance-temperature characteristic equipment



R VALUES FOR S_{11} AND S_{12}		
POSITION	MA	R
1	10	30K
2	7.5	40K
3	5	60K
4	3	100K
5	2	150K
6	1.5	200K

INPUT SWITCH (S_{10}) FUNCTIONS	
POSITION	
1	MEASURE } 1
2	GROUND } 1
3	MEASURE } 2
4	GROUND } 2
5	RECT. TEST
6	(v_x) IN

FIG. 5—Circuit permits scope presentation of specimen temperature by producing signal proportional to resistance of gold film thermometer



determines length of current pulse that is passed through semiconductor specimen to heat it to the desired temperature

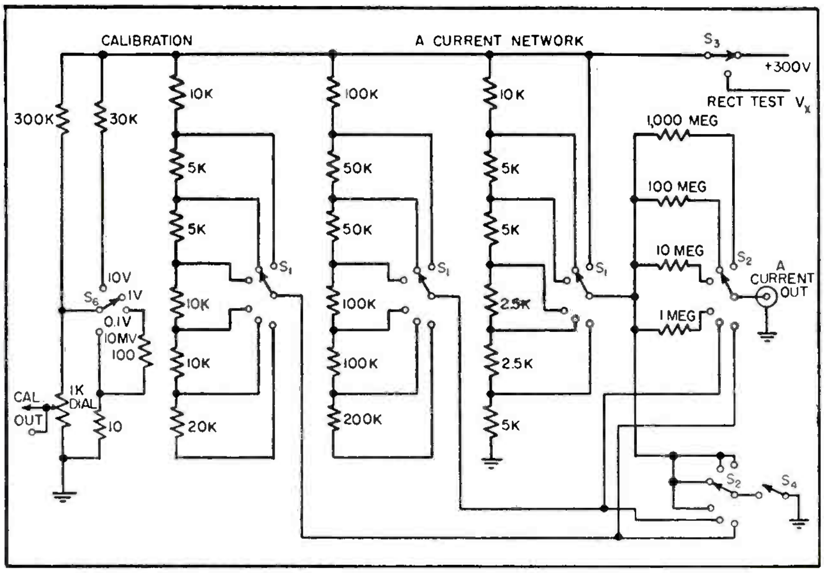


FIG. 7—Calibrator circuit. Precision resistors are selected by S_1

and S_9 (Fig. 5) closed, S_{10} (Fig. 5) should be in position 2 which is the zero position for the thermometer channel.

Resistance selector switches S_8 (Fig. 2) and S_{14} (Fig. 5) are set to the lowest gain position, and P_8 (Fig. 3) is adjusted to shift the A and B traces together to a fiducial zero (the horizontal line drawn at an arbitrary position on the face of the cathode-ray oscilloscope) after these traces have been brought into coincidence by means of P_6 (Fig. 5).

Switch S_8 (Fig. 2) is then set to maximum gain. If the A trace shifts substantially P_1 (Fig. 2) is readjusted to make the d-c level independent of the gain. Switching S_8 back to the minimum gain, and resetting the zero by means of P_6 and P_8, the procedure is repeated until there is no shift in the A trace as the gain is varied.

This procedure is repeated for the B trace using S_{14}, P_7 (Fig. 5), P_6 and S_8 for resetting the zero.

Either P_3 or P_5 (Fig. 5), depending on which channel is used, is then adjusted to reset the zero of the temperature trace. Current selector S_{11} (Fig. 5) is set so that when the B signal has been compensated for, P_3, which is a calibrated potentiometer, reads between 300 and 500 millivolts. Switch S_9 is closed and S_{10} set to position 2 to check the zero. If it is necessary to reset the zero by means of P_6 and P_8 one must first make sure that the specimen has returned to the original temperature.

Typical Values

As an example assume that P_3 (Fig. 5) reads 400 millivolts. The thermometer calibration chart shows that a temperature of 300 C, corresponding to 30 percent increase in the resistance of the gold film thermometer, is equivalent to an increase of 120 millivolts. Switch S_{10} is then set to the calibration position. Selecting 100 millivolts on the calibrator (S_6 Fig. 7), S_{14} is adjusted so that an increase of 120 mv from the thermometer produces a full-scale deflection of the B trace. If a round number correspondence is desired between the temperature of the specimen and the B deflection (for example 300 C $\approx$ 60 mm) to facilitate calculations. P_7 (Fig. 3) is used as a fine control; otherwise P_7 is on zero gain.

Next switch S_9 is closed and S_{10} set to ground. It is always advisable to keep S_9 and S_7 in the normal position when not actually making a measurement. In this way it is easier to see if the traces have drifted from the fiducial zero on the scope. With S_7 in position 4, and S_8 in position 6 (maximum gain), the calibrator (and S_6, Fig. 7) is adjusted to give 5 volts. The A trace should not change its position by more than a few millimeters. If the shift is substantial one can adjust P_{10} (Fig. 2). The adjustment should not be necessary more than once every few months or so.

Switch S_7 is then moved into position 3 and S_8 in the position of minimum gain. The A deflection is now calibrated in terms of millivolts per millimeter of deflection of the A trace. Turning switch S_7 to position 1 and selecting the A current by means of S_1 and S_2 (Fig. 7), a convenient deflection of the A trace at room temperature may be chosen.

If the specimen resistance is small it is better to increase the A gain by means of S_8 (Fig. 2) than to increase the A current to give a larger deflection. In this way a larger resistance is kept in series with the A current source, thus insuring a constant current for the specimen, even though the resistance of the specimen may change. Continuing with the procedure, S_7 is returned to position 2 which grounds the A channel. The horizontal sweep frequency is adjusted so that one complete sweep takes 0.7 second.

With S_4 (Fig. 4) closed the length of the timing pulse is set to 0.5 second by counting the 60-cps switch pulses between the beginning of the trace and the position of the timing pip until they run up to 0.5 second. With the heating current switch (not shown) open and the pulse switch S_2 (Fig. 4) on the automatic position, depress the key for a trial pulse. When S_7 is moved to the measure position there should be no change in the deflection of the A trace. If there is, the polarity of the d-c heating unit input should be reversed. This will change the phase of the shorting signal with regard to the electronic switch of the vertical amplifier.

If trial heating pulses are permissable, S_9 (Fig. 5) is opened (turned to ON) and a heating pulse is passed through the specimen.

As much resistance as possible should be left in series with the specimen to insure a constant measuring current. The heating current is adjusted to give appropriate temperature rise. Length of the heating pulse is selected by P_1.

If trial heating pulses are not permissable the proper setting of heating current must be estimated from previous experience.

Between observations S_7 is returned to position 2 and S_9 OFF (closed) to check for any drift of the traces from the fiducial zero. Before making another pulse measurement the specimen must be returned to the temperature from which it is supposed to start by checking the fiducial zero.

Figure 9 shows a typical oscillogram resulting from the pulse heating measurement of germanium. The points of the traces of the oscillogram are not straight lines because, the voltage activating the electronic switch which alternates the signal to the oscilloscope is not exactly square. This explains a slight hook at the start of each line. The reason the lines are not all of the same length is that the horizontal sweep voltage is not linear. Since there is slight cooling during that half of the cycle when there is no heating current passing through the specimen, each new line of the temperature trace starts at a little lower position (lower temperature) than the previous line.

Calculation

To interpret the oscillogram in terms of resistivity versus temperature, various adjustments must be recorded at the time the measurement is performed. Knowing the sensitivity of the A amplifiers and the sample measuring current, the resistivity may be obtained for each point of the curve. Knowing the compensating voltage in the thermometer circuit and the sensitivity of the B amplifier, the percentage change in resistivity of the thermometer may be obtained. From the initial temperature of the thermometer and the thermometer calibration, the temperature may be calculated for any time.

A plot of the logarithm of the resistivity of various germanium samples as a function of $1/T$ gives the typical curve observed with conventional methods. The following is a table of the energy gaps for germanium calculated from the slope of such curves in the intrinsic range obtained by the pulse heating method.

0.12 ohm cm	0.73 ev
1.2 ohm cm	0.76 ev
4.3 ohm cm	0.75 ev
5.7 ohm cm	0.73 ev
13.0 ohm cm	0.74 ev
21.0 ohm cm	0.75 ev

These values are in agreement with those obtained by the conventional method.

If it is assumed that the number of carriers is constant, and if the scattering is due to lattice vibration, in this temperature range the resistivity should follow the $T^{3/2}$ law.

In the temperature range between 110 K and 230 K the curve for the higher resistance sample follows the $T^{3/2}$ law. Below this temperature range the resistivity is higher than predicted by the $T^{3/2}$ law. This is to be expected because the resistivity resulting from impurity scattering can no longer be considered as negligible. Above this temperature the resistivity is lower than expected. In this range the intrinsic electrons and holes begin to make their contribution to the conduction process. Because the number of carriers increases, the observed resistivity is lower than predicted by the $T^{3/2}$ law. In agreement with this discussion, the traces for the lower resistivity sample show a narrower temperature range in which the $T^{3/2}$ law is fulfilled[5, 6, 7].

Similar results were obtained by pulse heating of silicon. Since, in general, silicon does not go into the intrinsic range until a much higher temperature than germanium, one must increase the heating current. Calculation of the width of the forbidden energy gap yields a value of 1.09 ev.

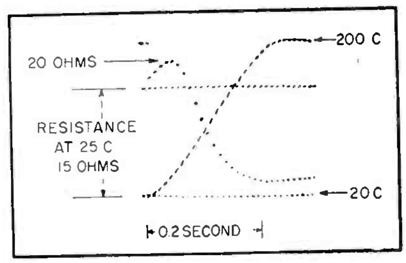


FIG. 9—Tracing of typical oscillogram of resistance-temperature characteristic for germanium sample

The results of the pulse heating of tellurium were as follows: the energy gap is 0.33 ev and two high temperature slopes are observed; the second slope gives a value of 0.58 ev and corresponds to an increasing number of defects at high temperature.[8]

The author is indebted to K. Lark-Horovitz of Purdue University for suggesting the pulse-heating method described in this article. The program that led to its development was supported by a Signal Corps contract. The mica sheets used in the gold thermometer were prepared by K. W. Meissner and the single crystal germanium specimens were prepared by Louise Roth.

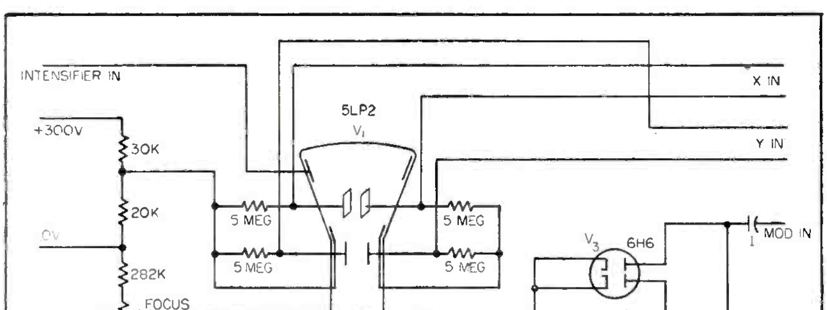


FIG. 8—Schematic diagram of display unit

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British TV Relay Uses

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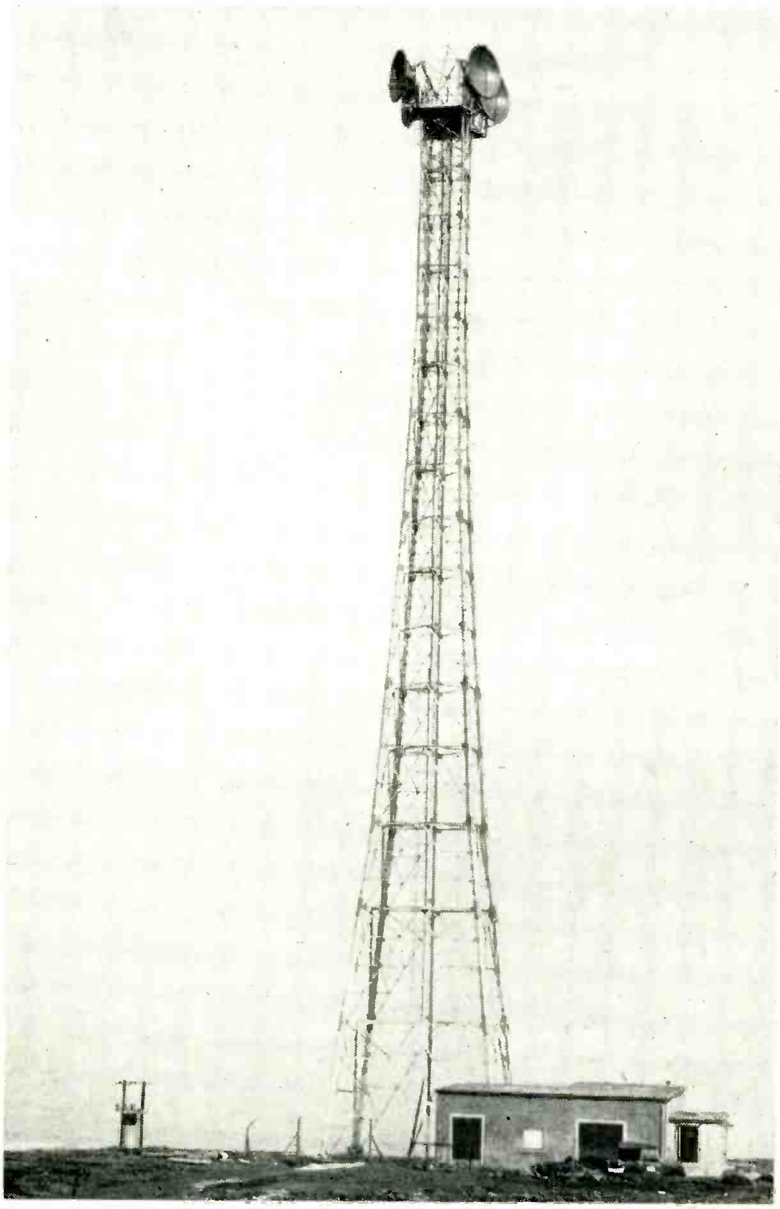


Antenna tower and repeater station on Britain's microwave television relay

SPANNING 250 miles from Manchester, England to Edinburgh, Scotland, Great Britain's new 4,000-mc television relay links the Kirk O'Shotts transmitter with the rest of the BBC network.

The relay, which includes seven repeater stations, is unique in that it marks the first use of traveling-wave amplifier tubes in regular service. Each repeater station uses four of the tubes, type CV-2188, one in each of the microwave transmitters and two on standby.

A 37-mc frequency difference is established at each repeater between incoming and outgoing carriers. The incoming 4,000-mc signal is converted to 60 mc by a silicon-diode mixer and amplified in a conventional wide-band amplifier. As shown in Fig. 1, the microwave carrier is restored in a germanium-diode mixer. The unwanted carrier and image frequency are removed by a waveguide filter and the mixer output, about 25 milliwatts, is increased by the traveling-wave amplifier to about 1.5 watts. The amplified microwave output is fed by waveguide to the parabolic antenna located on top of a tower, which may be from 20 to 200 ft high. One of the towers is illustrated, with its repeater station.

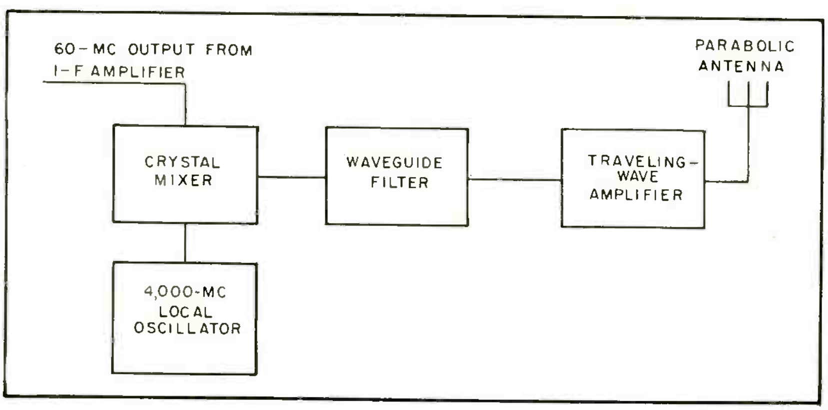


FIG. 1—Output stages of microwave repeater showing function of twt amplifier

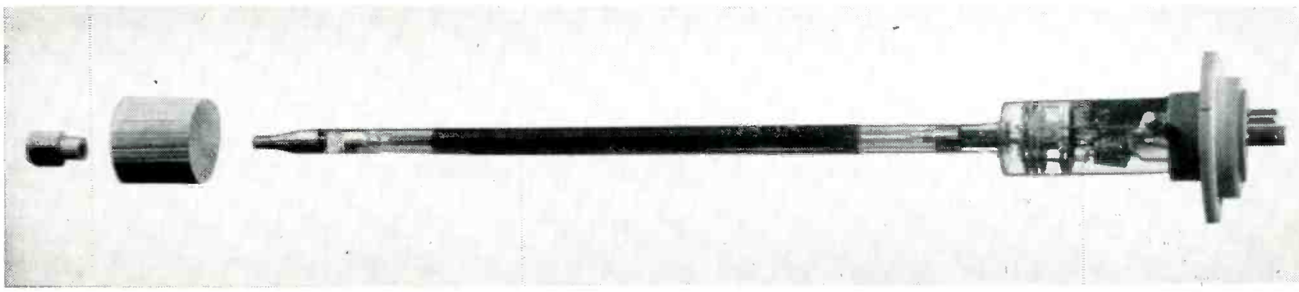
Traveling-Wave Tube

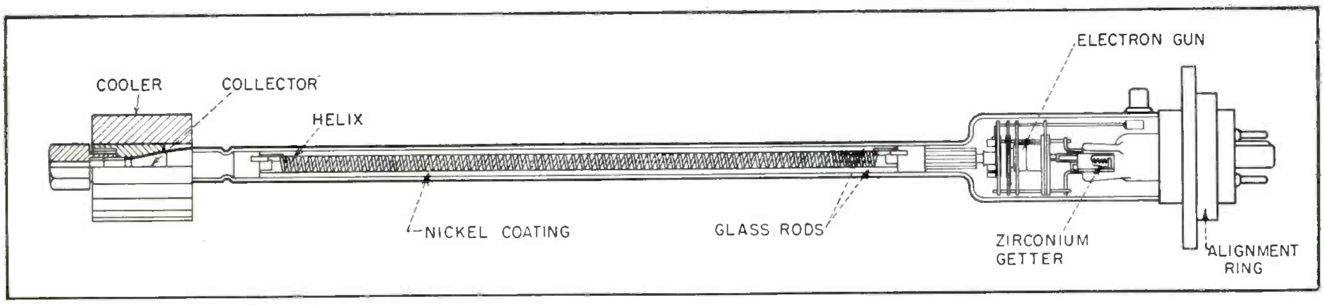
The CV-2188 operates at 3,000 volts and a current of 16 milliamperes. This provides a maximum power output of 2 watts as compared with the 100-milliwatt output of earlier tubes[1,2]. Ordinary manufacturing techniques have been used in production of the new tube, thus it can readily be made in quantity.

This paper is published with the approval of the Lords Commissioners of the Admiralty, but the responsibility for any statements of fact or opinions expressed rests solely with the authors.

Traveling-Wave Tubes

Traveling-wave amplifiers, designed for mass production, prove satisfactory in 4,000-mc television relay from Manchester to Edinburgh. Tubes deliver 2 watts maximum power output; gain is 20 db over 80-mc passband. Average tube life exceeds 3,000 hours





Principal features of traveling-wave tube, type CV-2188

The photograph and accompanying sketch of the tube show its essential features such as electron gun, helix and collector. The base connections are to heater and cathode, heater, and first anode. The helix lead is brought out to a side cap so that the full helix voltage is not applied between the base pins.

The tube fits into a waveguide circuit as shown in Fig. 2; the cooler mates with the tapered collector and is attached by a nut after putting the tube in the circuit. An air flow of 4 cubic feet per minute through the cooler dissipates 40 watts of beam power.

One illustration shows part of a repeater bay with the traveling-wave tube connected in its circuit. The tube is mounted vertically in the left-hand rack. The relative size of the unit may be judged from the waveguide dimensions: 2 in. × 0.667 in. The apparent bulk of the unit is due to the focus coils, as shown in Fig. 2.

Size of the focus coils is determined by the distance between them. A large gap requires larger diameter coils than a small gap in order that the drop in field remain unchanged. The relatively small narrow dimension of the waveguide is advantageous in that it allows the weight of the focus coils to be kept down. The magnetic field has an average value of 300 oersted.

Operation

The cathode is operated 3,000 volts negative, the helix at ground potential and the collector at 50 volts positive, to prevent secondary electrons returning to the helix. The exact voltage required for maximum gain and output varies from tube to tube, but lies between 2,800 and 3,200 volts.

The gun has two anodes, a first, whose voltage is adjusted to give a collector current of 14 milliamperes, and a second operated at helix potential. The first anode works at about 1,100 volts and draws less than 250 microamperes. Helix current is usually less than 1 milliampere but can be as high as 4 milliamperes without damaging the helix. A typical tube operating under these conditions will give a gain of 20 db at low power levels and 16 db at maximum power output of two watts. Figure 3 shows the variation of gain and power output with frequency, helix voltage and input power.

The large bandwidth of this type of tube can be seen from the curves;

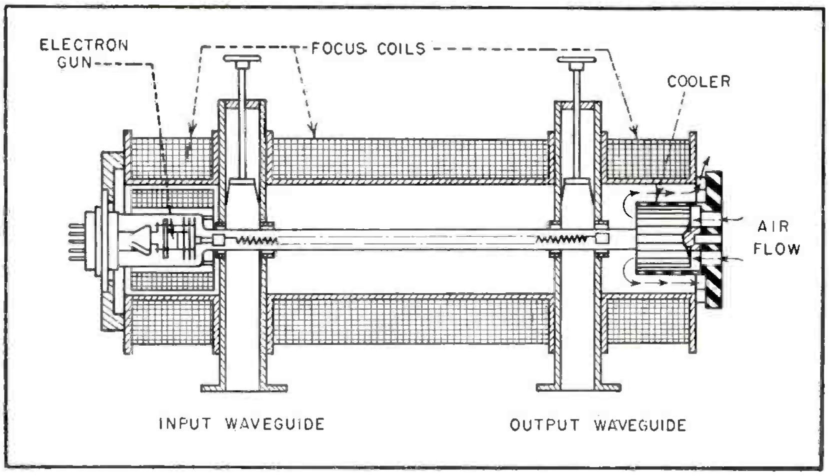
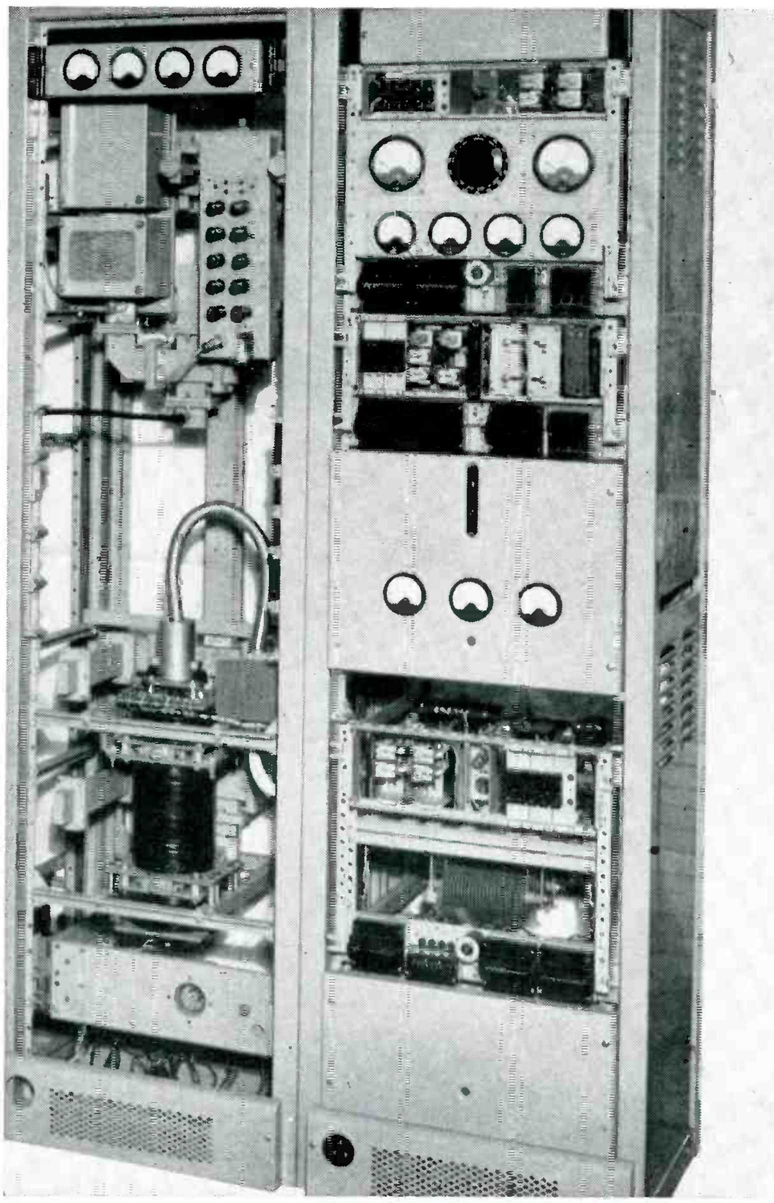


FIG. 2—Cutaway sketch showing traveling-wave tube connected in its circuit



Part of repeater bay with traveling-wave tube mounted in its circuit

it is more than 800 mc between points 3 db below the maximum value of gain. Operation at a current higher than 14 milliamperes is not recommended as the life may be reduced. The maximum variation in gain between tubes operated at optimum voltage and 14-ma collector current is about ±2 db. The variation in power output is somewhat less.

Construction

The electron gun is designed to produce a parallel beam of electrons of the same diameter as the cathode, 0.090 in. The magnetic field insures that there is only a small increase in beam diameter upon entering the uniform potential region following the gun anodes.

The cathode is mounted on a mica insulator, sandwiched between two ceramics to prevent buckling, and surrounded by a focusing-cup held at cathode potential. The two anodes are also mounted on mica insulators, and the whole gun assembly is held together by support rods passing through the insulators as shown in Fig. 4.

It is essential to construct the tube with helix and gun in line if satisfactory focusing is to be obtained. This is achieved by centering all parts from the bulb, which is made by joining a piece of precision-bore hard glass, 0.394 in. ±0.001 in. diameter, to tubing just over an inch in diameter.

This tubing is then shrunk on to a mandrel to an accurately known diameter collinear with the precision-bore glass. The copper collector is also sealed on centrally, using a conventional feather-edge seal. The helix is wound of 0.028-in. wire on a 0.131-in. mandrel at 19 turns per inch. When inserted in the precision-bore tubing it is held tightly by three glass rods centerless ground to an accuracy of 0.0002 in.

A connecting-tube from the helix slides into the second anode of the gun. The gun elements are mounted centrally on their micas, which are a good fit in the lower part of the bulb. The gun, mounted on a stem, needs only to be inserted and drop-sealed to be aligned with the helix.

After pumping and basing, an alignment ring is cemented to the base on the center line of the bulb. Thus when the tube is in its circuit, it is held centrally by the ring and a pin supporting the cooler nut. No movement of the tube is necessary to focus it.

A system of deflector coils mounted around the gun provides a transverse field of a few gauss to correct residual errors in tube construction and in winding and assembly of the circuit coils.

Tube Life

The high current density at which the oxide-coated cathode works and the high anode voltage mean that any gas in the tube would quickly destroy emission. Every precaution must be taken to remove gas. For example, the helix is vacuum-annealed before assembly. The processing time has been kept reasonably short. It takes only about two and a half hours to pump a tube, including glass-baking. The tube has a continuously-operating zirconium getter in parallel with the heater. The getter consists of a tungsten spiral coated with zirconium that absorbs any gas evolved during life. To prevent its emitting electrons, there is a shield surrounding the getter.

In unattended operation, as in microwave relay use, the circuit of Fig. 5 is used to keep the cathode current constant, correcting any fall in cathode activity by increasing the first anode voltage. The anode voltage is allowed to rise from about 1,100 to 2,000 volts during life. If any sudden failure occurs, the repeater is switched over to standby. Any tubes having a high anode voltage, which indicates that they are soon to fail, are replaced on regular maintenance visits. An average tube life of over 3,000 hours is obtained.

Matching

Figure 6 shows a typical coupling arrangement. The probe extending across the waveguide picks up the wave and excites the helix. The cup, flush with the internal waveguide face, is a choke roughly a quarter wavelength long. The susceptance of the junction is cancelled by the adjustable piston. It is possible to get a voltage-standing-wave ratio of less than 2:1 from 6.5 cm to 8.5

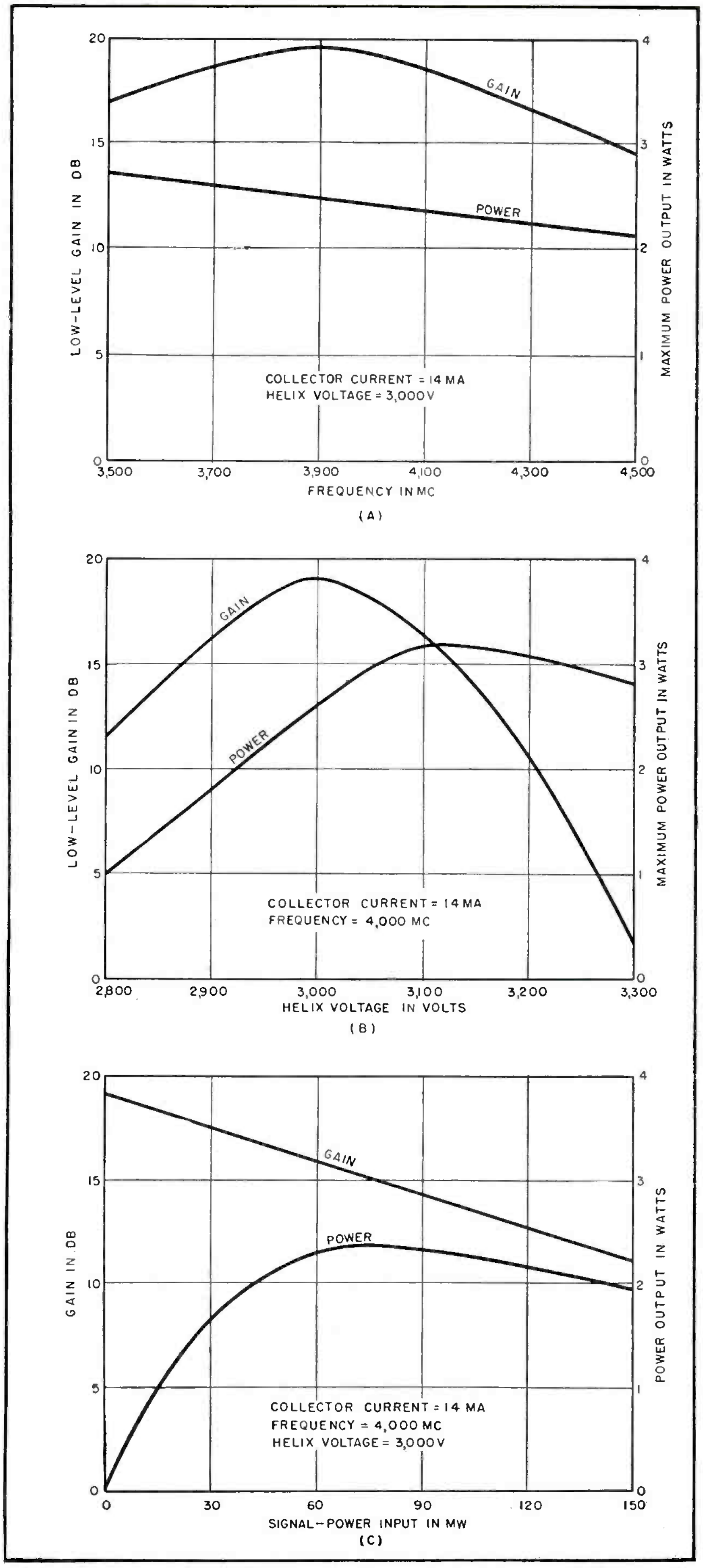


FIG. 3—Electrical characteristics of traveling-wave tube showing variation in gain

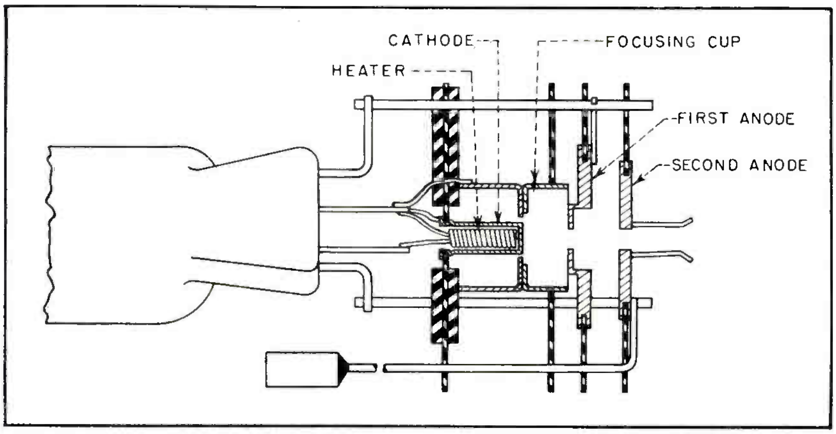


FIG. 4—Details of electron gun used in the traveling-wave tube

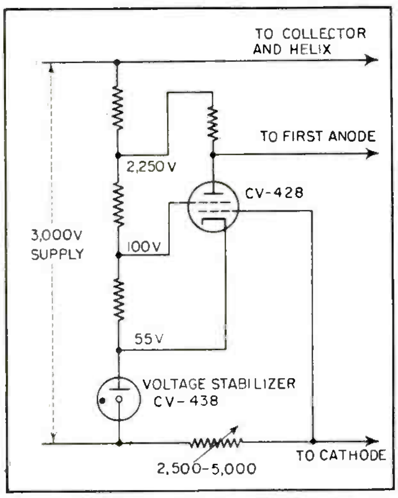


FIG. 5—Circuit used to stabilize twt cathode current

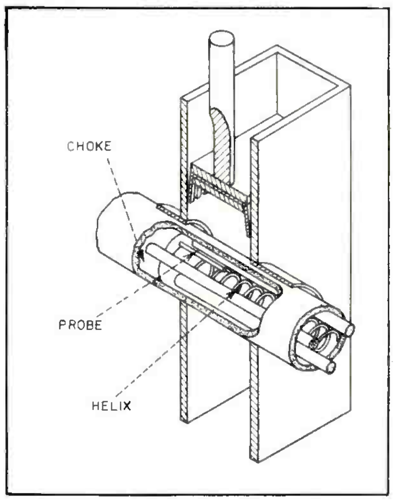


FIG. 6—Method for coupling waveguide to twt helix

cm with the piston set in one position.

It is necessary to have a better match than this in radio-relay use because of the long length of waveguide between the traveling-wave amplifier and the antenna. Frequency-modulated signals suffer harmonic distortion in such a long line if it is not well matched at both ends, as a reflection from the output end will travel down the line and be reflected at the input before being transmitted. Such signals will have a time lag behind the original signal[3]. The distortion will be proportional to the length of line and the product of the reflection coefficients at the two ends. The possible height of the antenna tower and the match at the antenna are such that the vswr, looking into the traveling-wave tube, must be less than 1.1:1.

It was considered impossible to design the tube to meet this requirement everywhere between 3,600 and 4,200 mc. Therefore the admittance has been given wide limits, to eliminate the need of a precise test in manufacture. A tuning device has been incorporated in the circuit to give as good a match as required. This gives a bandwidth of approximately 80 mc, which is quite sufficient for one-channel use. The tuning is simple; only one control is necessary.

Attenuation

It is essential that the tube shall not oscillate under normal conditions, and this requires that the loss backward along the helix, which is equal to the cold attenuation, shall be greater than the forward gain at every frequency where considerable reflection occurs at output and input. In fact, the attenuation needs to be greater than this to provide adequate buffering between crystal-mixer and antenna. The time-delay between mixer and antenna is large, since it includes the electrically-long waveguide filter, the traveling-wave tube, and the waveguide feeding the antenna. The delay distortion mentioned previously can occur if there is appreciable reflection at the mixer and the antenna. This distortion is reduced by having a net loss in the mixer-antenna-mixer path. Such a loss is contributed by the difference between the attenuation and the gain of the traveling-wave tube. The CV type-2188 tube has a minimum attenuation of 32 db and thus gives a net loss greater than 12 db.

Part of this attenuation is provided by the resistive wire used for the helix, but most is due to a region of lumped attenuation placed about a third of the way along the helix from the gun end. This lossy material must be in intimate contact with the helix, as the short wavelength associated with the low wave velocity causes the electric field to fall sharply with distance from the helix. Nickel coating evaporated on the inside of the bulb for about 7 in. prevents propagation outside the helix, which could otherwise give rise to feedback. Nickel is preferred to Aquadag, as it is less readily scraped off on inserting the helix assembly.

Conclusion

The tube described utilizes conventional techniques and several hundreds have been made with a shrinkage as small as that encountered with ordinary tubes. The tube has been found to meet the requirements of unattended operation and has shown the practicability of traveling-wave tubes in microwave relays. Since this tube was designed, the art has progressed rapidly towards providing greater power at a lower voltage, and there seems every likelihood that, with its inherently wide passband, the traveling-wave tube will prove preferable to the klystron or the triode as the output amplifier in microwave relay stations.

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Magnetic Amplifier With Reset Control

Simplified explanation of revolutionary circuit developed by Ramey is presented. Permits design of miniature magnetic amplifiers with very high gain and speeds of response of the order of one-half cycle at the operating frequency

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PRIOR to the introduction of the reset circuit to be discussed, the magnetic amplifier was considered by many engineers to be a complex device heavily based upon empirical data. Since the announcement of the reset circuit several years ago[1], the correspondence between theory and experiment has been greatly strengthened, and the design problem simplified considerably.

The new circuit offers a further advantage in greatly improved performance. Time delay, an inherent disadvantage in magnetic amplifiers, has been reduced to a negligible minimum for many applications, including moderately high-speed servo systems. Using the new circuit intrinsic time delay is reduced to a half cycle at the operating frequency, and since 400-cps power is commonly used in servo systems, the response of the amplifier is ordinarily faster than that of the mechanical elements of the system.

To set the stage for the simplified explanation of the new circuit that follows, a brief review of previous magnetic amplifier concepts will be presented.

M-A Progress

The simplest magnetic amplifier is the saturable reactor. Though very useful in many applications, it suffers from limited gain and slow response. To improve its performance, the self-saturation feature has been developed[2]. This consists basically in placing rectifiers in series with the load windings. Load current can flow in only one direction and the core is no longer demagnetized by the negative load currents. In both circuits, output power is varied by a d-c current in a control winding which establishes a level of control mmf that in turn sets the flux at the start of each cycle and determines the conduction angles and hence the load power.

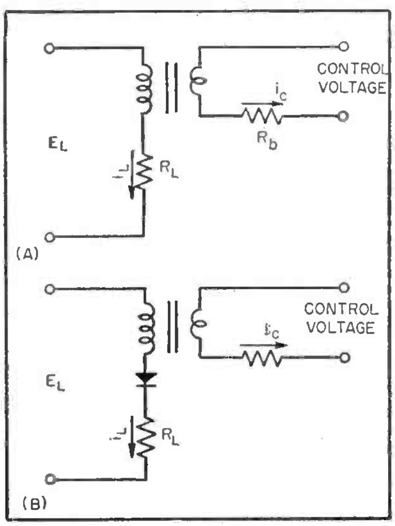

FIG. 1—Simple saturable reactor and self-saturating magnetic amplifier circuits

The self-saturating circuit has greatly improved performance, yet it is not nearly adequate for many automatic control systems. Its shortcomings stem directly from the use of the same control scheme as that of the saturable reactor. In both cases, a d-c current level must be established in a control winding of appreciable inductance. There is the usual L/R time constant associated with this current when the control voltage is changed, and this becomes the major constituent of the magnetic amplifier's delay.

The second difficulty concerns the voltages induced in the control winding from the load circuit. The control-circuit impedance to these voltages must be high, or circulating currents will flow and reduce the load-circuit impedance before firing. Special core structures will, in some instances, buck out these voltages, but the problem is always present with the more common toroids. It is especially serious in half-wave circuits, some of which are very useful for reversible control amplifiers.

To reduce these circulating currents, the control coil must often be padded with a series resistance or mismatched to the driving source. Control power is dissipated in the resistor, and the power gain of the amplifier reduced.

The twin problems of slow response and control circuit induced voltages present in both the saturable reactor and its self-saturating improvement appear because of the method of control: current or mmf is the independent variable. Figure 1A is the simple saturable reactor, and Fig. 1B the self-saturating circuit. Identical cores are used for both circuits each with a control winding and a load winding. The load is R_L and R_L is the padding resistor. The a-c line voltage is symbolized by E_L.

Ramey's Circuit

The new magnetic amplifier to be discussed has an intrinsic time delay of one-half cycle of line frequency, no analogous induced voltage problem and very high gain. The chief virtue is its simplicity, and the remarkable characteristics that follow from the adoption of a realistic control scheme.

Optimum core materials for these circuits are nickel-iron alloys with rectangular flux-current loops. Because of their high retentivity, the core can store a flux level nearly equal to the saturation value. This flux storage with no applied mmf is a necessary feature of the amplifier with reset control.

The basic theoretical relationship pertinent here is that between the flux in a coil and the voltage across it. Magnetic theory states that the flux linkages in a coil at any instant are exactly equal to the value of the integral of the voltage across the coil at that time. For the application under consideration, with sinusoidal line voltages, this can be restated in simpler form: the flux change in the coil at the end of a half cycle is proportional to the volt-time integral, or the area under the voltage waveshape across the coil during that half cycle.

The fundamental difference between the new circuit and the saturable reactor and self-saturating scheme can be stated as follows: here voltage integral, flux and flux density are the independent variables in the control scheme, as compared to current, magnetomotive force and magnetizing force in the earlier circuits.

A half-wave, nonreversible reset circuit is shown in Fig. 2. The load current flows thru path *abce* while control action is established through *abde*. A single winding on a rectangular-loop core is active for both the load and reset half cycles. Current can flow in the load R_L only during the positive half cycle of line voltage because of the polarity of the rectifier in the load path. Similarly, control current can flow only during the negative half cycle. The resistance R_C adjusts the duration of current flow in R_L and hence is the control element for the amplifier.

The circuit reduces to simpler configurations with extreme values of R_C. When it is very large, the control path disappears, leaving the self-saturating circuit of Fig. 1B with no control mmf. This is the condition of maximum output.

When R_C is very small, the resistances in series with the coil during both half-cycles are very small in comparison to the self impedance of the winding. Hence, for all practical purposes, the coil is connected directly across the line, and only a small magnetizing current can flow. This is the condition for minimum output. Varying R_C between these two limits controls the load power in the manner described below.

Control Action

Just before the start of the negative half cycle of line voltage, load current has been flowing, and the core completely saturated. Operation is along path 3, 4 on the flux-current loop of Fig. 3A. At the voltage reversal at 1 load current ceases, but the high retentivity of the core material maintains the flux just slightly below the saturation value at 1. In the following negative alternation of line voltage, current flows only in the reset or control

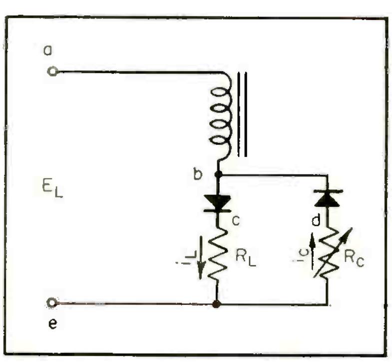

FIG. 2—Magnetic amplifier with reset control. The core is reset by current flowing through R_C during each half cycle when load current is blocked by rectifier in series with load

path, *abde* (Fig. 2). The drop across the rectifier is very small, so that the line voltage divides between the coil and the control resistance, the actual voltage waveshapes depending on the magnetic characteristics of the core and the value of R_C. This reset current is very small compared to the load current, and its peak value equals the maximum horizontal coordinate of the left flank of the flux-current loop.

The flux in the core must change by an amount proportional to the area under the coil-voltage curve during this reset half cycle. It moves from point 1 to point 2 (Fig. 3A), a change equal to ϕ_C. The value of R_C determines the division of reset line voltage between itself and the coil, and hence the flux change ϕ_C. Thus its function is to set the flux in the core at the end of reset and the start of the load half cycle.

At 2, the line voltage reverses, the reset rectifier blocks, and conduction starts in the load path with the current at first limited to a small value by the width of the flux-current loop and the magnetic characteristics of the core. All the line voltage appears across the coil, since its instantaneous unsaturated impedance has been chosen very much greater than R_L. The volt-second area of the coil voltage from 2 onward grows, and the flux rises proportionately with it.

At some instant, point 3, enough area has accumulated to bring the flux back to the saturated level. Since no further flux change is possible, the coil impedance drops abruptly, and all of the line voltage appears across R_L. Load current flows during the rest of the positive half cycle, and the average load power depends on the conduction angle θ_L. At point 4 the line voltage again reverses, load current is blocked by the rectifier, and the action repeats itself.

Conduction angle θ_L depends on the degree of reset, and the initial value of flux at the start of the load alternation. If ϕ_C decreases, point 3 will be closer to 2, the coil will fire sooner, and the load power is increased. Thus an increase in R_C brings about a corresponding, though not proportional, increase in the load power. Figure 3B shows

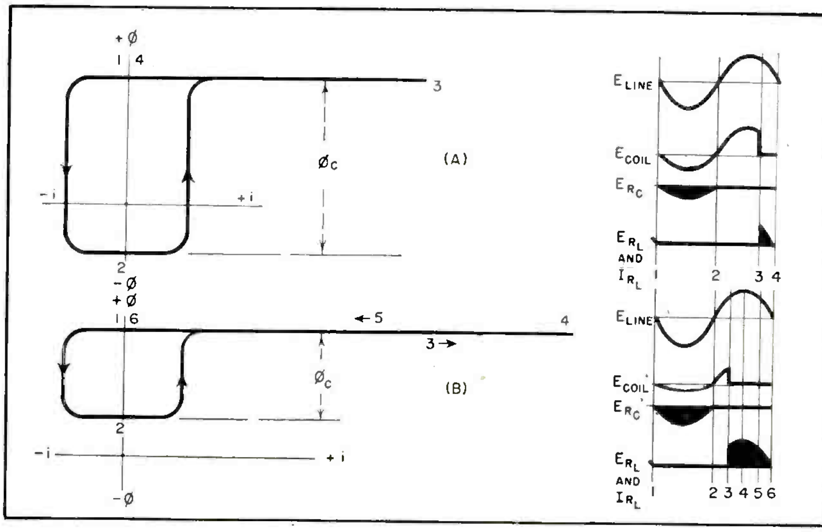

FIG. 3—Voltage waveforms and flux-current curves show effect of variation in control resistance on output

the conditions for a higher value of R_C. The flux-current loop for this case is similar to Fig. 3A, but with a smaller value of flux change ϕ_C'.

Another comparison can be made between mmf and reset-control amplifiers. In both, load rectifiers permit output current to flow during one half cycle only. Also, the conduction angle θ_L is determined by the flux in the core at the start of the load half cycle. The two differ only in the method by which this initial flux level is established.

With mmf control, ampere-turns is the independent variable which sets the initial value of flux at a point just to the left of point 2 on the flux-current loop of Fig. 3A. In reset control, voltage-integral is the independent variable, and the initial flux is set by controlling the coil-voltage area during the reset. Thus the load circuit action is the same in both schemes, and the load conduction angle θ_L is controlled by the initial flux level at the start of the load cycle, regardless of its derivation.

Since the flux changes during load and reset periods are exactly equal, the equivalent coil-voltage areas must also be identical. The positive and negative half-cycle areas of line voltage are the same; hence the area of the voltage across R_C must equal that across the load R_L. This establishes a basic identity; for this circuit, the average (d-c) control voltage equals the average load voltage. Therefore, if the control voltage is known, the load current, voltage and power can be predicted (shaded areas, Fig. 3).

Control Resistance

The characteristics of R_C can be established fairly simply. Its value can be specified for chosen maximum and minimum conduction angles in terms of the unsaturated coil impedance. As an example, current practice with Deltamax and Orthonol cores, for a range of conduction angles from 30 to 170 degrees, requires a variation of R_C between 0.02 and 2.5 times the coil impedance. The latter is obtained by dividing the peak line voltage by the peak coil current flowing with the reactor connected simply across the line. This, however, is an empirical relationship. Its analytical confirmation requires data on the volt-ampere and flux-current characteristics of wound cores not presently available. The resistance R_C must be able to withstand the peak line voltage (full output) and the peak coil magnetizing current (full reset). It must absorb a varying amount of power from the circuit, which maximizes at approximately half output.

Although a variable resistance is required as the control parameter, this amplifier can be controlled by practically any form of waveshape of voltage. It was shown that the average control voltage must equal the load voltage. This must hold whether the control voltage is externally derived, or merely the voltage drop of a magnetizing current across a control resistance. The one requirement for voltage control is that the internal impedance of the control source be low, otherwise, with no control voltage full reset and minimum output will be impossible.

Using the figures cited above, the control-source resistance would have to be 0.02 times the coil impedance or less, if a minimum conduction angle of at least 30 degrees were required. This may require a mismatch between control source and amplifier. It should be noted that the source will always absorb, rather than deliver, power from the amplifier, because of the direction of flow of the reset current.

This discussion has purposely assumed ideal circuit elements. This will not be the case in practice. Rectifier leakage may prevent full output if the sum of the leakage and the control circuit current has peaks exceeding a value established by the d-c coercive force of the core material. The saturated inductance of the coil delays reset and load current commutation. With wrapped-core toroids, typical values are 10 to 15 degrees. Stacked laminations give larger delays. Available core materials only approach the rectangular loop, and load-current voltage drops in the rectifier and coil must be considered.

The load circuits of these amplifiers can be connected in the same configurations previously developed for the self-saturating or mmf-control amplifiers. The reset circuits must be determined by the nature of the control impedances or voltages available. It is expected that study of available active impedances will result in composite control amplifiers far superior to presently available cascaded magnetic amplifiers with mmf control.

The author wishes to express his thanks to W. J. Dornhoefer and Harold G. Eicher, Jr. for their help in this work.

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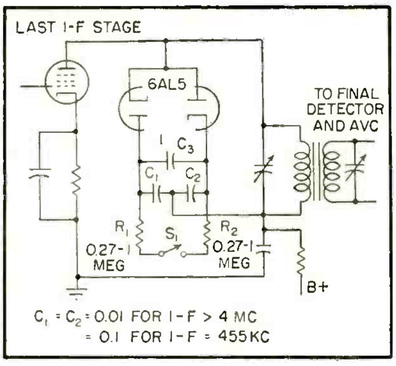

FIG. 1—Shunt-type diode limiter with self-rectified bias is connected across last i-f plate circuit

Noise Limiter

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USE OF amplitude modulation for mobile vhf services such as civil and military aircraft, civil defense and civil air patrol imposes intelligibility limitations in the presence of strong impulse interference. Such receiving conditions occur when stations are located in areas where automobile traffic is heavy and relatively close to the receiving antenna.

Amplitude-limiting devices of many types[1] have been designed into vhf receivers to minimize the effects of impulse interference; and many of them do a creditable job if the noise voltages appearing at the receiver input are not excessive. When the impulse noise increases, however, many noise limiters fail to maintain intelligibility of the incoming signal.

Although noise-reduction circuits have been suggested that do not depend upon amplitude limiting for their operation, amplitude limiting is the noise-limiting technique having widest application. Only amplitude limiting will be considered in this article.

Interference

Impulse noise, as generated by an ignition system, is a train of highly-damped oscillations, the repetition rate of which varies with the rpm of the motor. The waveform of each impulse and the amount of radiated energy depend upon the electrical characteristics of the ignition system. In general, the duration of each impulse is extremely short and its energy is spread over a wide range of frequencies. If a receiver of limited bandwidth is subject to such impulse noise, the duration of each noise wave train is progressively increased as it passes through each succeeding tuned circuit on its way to the final detector. After detection, the pulse is further integrated by the i-f filter and the audio system.

I-F Limiters

Since all intelligence carried by an incoming a-m signal is lost during the limiting of a noise pulse, the shorter the duration of the limited pulse, the lower the loss of intelligence. Optimum impulse-noise reduction is obtained by limiting the amplitude of the noise pulse at a point in the receiver where bandwidth is maximum commensurate with selectivity requirements.

The desirability of limiting impulse noise before excessive integration by receiver selectivity has been pointed out.[2] Nevertheless, many vhf receivers in use do not take full advantage of their overall bandwidth when they use noise limiters following the final detector. Integration by the i-f filter is largely responsible. In addition, such limiters do not prevent the avc system from responding to a train of noise pulses, thereby desensitizing the receiver.

What is needed is an effective i-f limiter requiring a minimum of parts and capable of effective noise limiting prior to the final detector. Such a limiter, if it is to be used in mobile receivers, must be capable of adjusting itself to variations in the received signal and must allow the designer to choose the degree of limiting desired. If such a limiter can automatically adjust itself to the degree of modulation of the incoming signal at a roughly syllabic rate, its effectiveness can be increased. The limiter to be described is designed to improve intelligibility of a-m speech signals in the presence of strong impulse interference, when retention of speech quality is of less importance than intelligibility. Effective noise limiting under such conditions requires some degree of flattening of the positive modulation peaks by the limiter and such distortion is not conducive to maintenance of speech quality. The designer, however, may make his own compromise between the degree of noise limiting desired and the distortion produced by limiting.

Circuit Details

The i-f limiter illustrated in Fig. 1 is a conventional full-wave shunt-type diode limiter with the added provision of self-rectified bias. Each diode assumes a bias roughly equal to the peak value of the applied i-f voltage. The time constant of the bias circuit is largely determined by C_3 and the shunt resistance consisting of R_1 and R_2 in series. The R_p of the last i-f amplifier and the value of C_3 determine the charging rate. Limiter bias rises with positive modulation of the incoming signal and tends to follow the modulation level at a syllabic rate; i-f voltage variations not ironed out by the avc are accommodated in a like manner.

Opening S_1 allows the bias to rise to the peak value of the applied i-f voltage and stay there, thus in effect removing the limiting action. Crystal diodes have been used in place of the 6AL5, but their comparatively low back resistance acts as a finite shunt across C_3, limiting

For Mobile VHF

Shunt-type diode limiter in last i-f plate circuit reduces impulse noise in mobile vhf receivers. Circuit is applicable in civil defense, aircraft, airport-control-tower and other vhf a-m equipment operating in heavy ignition-noise areas

the flexibility of control over the degree of limiting.

The limiter circuit is used across the primary circuit of the last i-f transformer as circuit parameters are more favorable for effective limiting at this point. A shunt limiter of finite forward resistance performs best when working out of a high-impedance source into a high-impedance load, and such conditions are best met by the indicated circuit. Impulse-noise pulses are limited to a level determined by the limiter bias which in turn is determined by the average peak level of the applied i-f voltage.

For effective limiting, the receiver must have sufficient gain up to the limiter to assure proper limiter action on weak signals. The requirements in this respect are quite similar to an f-m receiver equipped with a limiter. Unfortunately, diodes do not look like a low resistance until the input voltage is measured in volts.

Receiver Application

This limiting circuit has been incorporated into two vhf receivers with excellent results. The first receiver, designed for civil-defense operation in the 144 to 148-mc range consists of a cascode r-f stage, triode mixer and three stages of 4-mc i-f having a bandwidth of approximately 60 kc. A block diagram is shown in Fig. 2A. In this receiver, R_1 and R_2 are replaced by a 2-megohm variable resistor to allow adjustment of the limiting level. This provision for adjustment of the limiting action is not necessary once the designer has chosen the desired degree of limiting.

Switch S_1, indicated in Fig. 1, may be eliminated if limiting is desired at all times, and the two fixed resistors R_1 and R_2 may be combined into one. Delayed avc is used in this receiver to allow maximum gain on weak signals for better limiting.

The second receiver is a double-conversion unit with a similar r-f and mixer arrangement. Figure 2B shows its block diagram. One stage of 10.7-mc amplification is used between the first and second mixer with two stages of 455-kc i-f following the second mixer. The gain up to the limiters in both receivers is comparable, but the bandwidth of the second set is approximately 6 kc as opposed to 60 kc for the single-conversion unit.

The noise-limiting performance of this circuit arrangement, in both mobile and fixed operation, has provided a degree of performance not obtainable with the conventional type of noise limiter. While the narrow-band receiver provides better intelligibility in the reception of very weak signals in the absence of heavy impulse noise, the wide-band receiver is more effective in preserving intelligibility under conditions of heavy impulse interference.

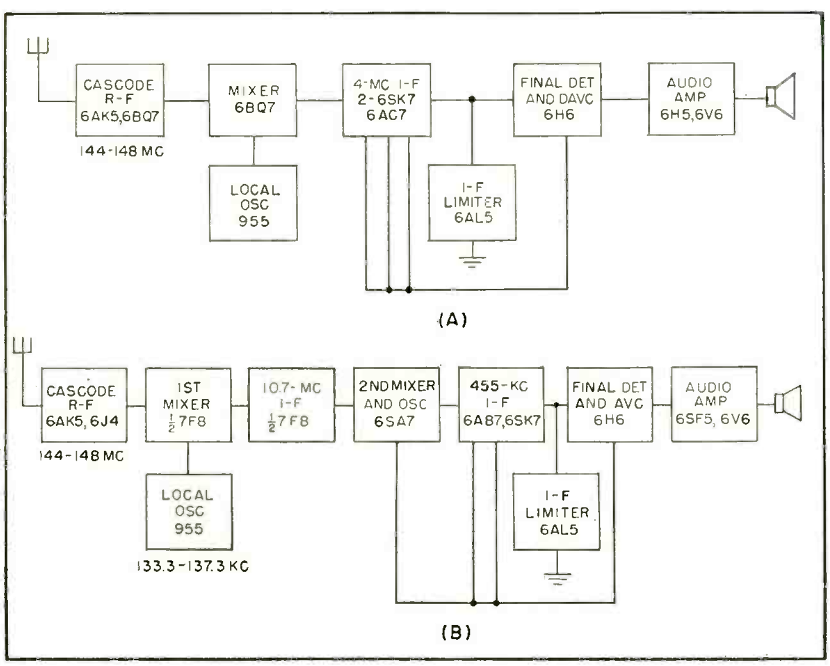

FIG. 2—Limiting circuit has been successfully used in civil defense receivers using both single and double conversion arrangements

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Transistor Action

Part IV

By ABRAHAM COBLENZ and HARRY L. OWENS
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Fort Monmouth, New Jersey

IN THE FIRST three articles of this series concepts particularly appropriate to transistor theory and not normally encountered in the study of vacuum tubes have been discussed. A superficial view of transistor operation was given[1], and some simplified principles of quantum mechanics were considered which will assist in a deeper understanding of transistor action[2]. In addition, special aspects regarding the nature of the electron have been reviewed[3] for use in the analysis of the microscopic structure of the solid materials used in transistors.

In this article the application of these very general theorems is made to the study of germanium and silicon to provide better insight into the nature and structure of semiconductors.

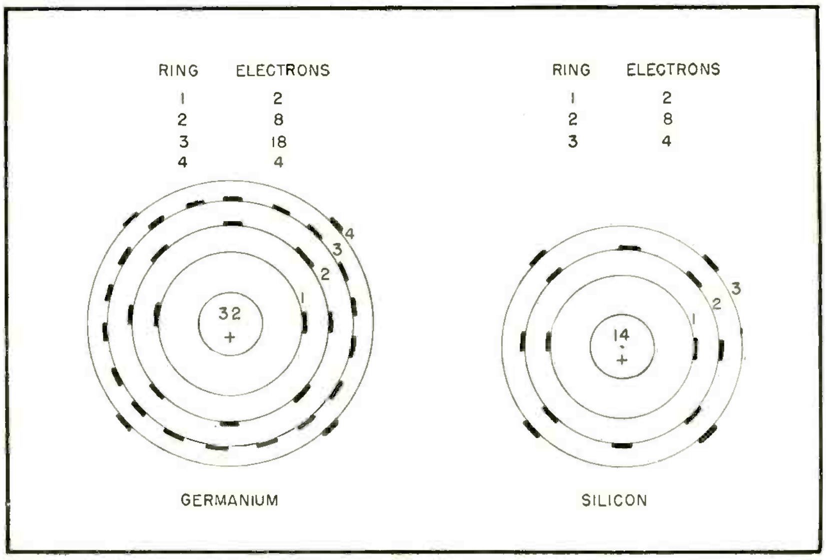


FIG. 1—Schematic representation of germanium and silicon atoms shows electron rings surrounding nucleus. Note the 2-8-18-4 arrangement for Ge and 2-8-4 arrangement for Si. First three rings for Ge and first two for Si are complete rings.

Atom Structure

This section concerns primarily the Ge and Si atoms. Mention has been made that the present theory of the structure of matter envisions a nucleus containing protons (+) about which are distributed electrons (−) in sufficient quantity so that the total charge of the atom is zero. It is essential to bear in mind that the normal atom, if not disturbed or ionized, is neutral or has zero charge.

The electrons outside the nucleus are arranged in shells or rings as indicated diagrammatically in Fig. 1. The atomic number of germanium is 32; this means that there are 32 electrons rotating around the nucleus as indicated. From previous discussion,[3] it is not to be inferred that these electrons are at any time physically distributed as shown—the positions of the electron shown may, for convenience in thinking, be regarded as the most probable locations.

An electron shown in the sketch as being in the outer ring of 4 has a fairly large probability at various times of being just outside the nucleus and even closer to it than the two electrons of the inner ring. Similar remarks apply to all the other electrons. For electrons we always speak of probability with regard to their position and only for convenience in discussion do we draw ultrasimplified sketches like Fig. 1. More correctly, we should show a smeared-out picture as in Fig. 2 where the shaded portions show areas of high probability.

For discussion, consider that an atom consists of a nucleus surrounded by one or more concentric rings of electrons. A ring is regarded as complete if it has a particular number of electrons associated with it. The ring nearest the nucleus, or ring No. 1, requires two electrons to be complete. The next outer ring, ring No. 2, has eight electrons, and ring No. 3 has eighteen electrons (eight for argon) when complete. Both the position of the ring and the number of electrons in it must be known to de-

SEMICONDUCTORS

This is the fourth in a series of articles on transistor electronics written for engineers and technicians with limited experience in solid-state physics. A list of previous articles in this series appears at the end of this article in the references

In Germanium and Silicon

Study of physical properties of common transistor semiconductor materials and impurities. Conduction by holes and electrons is explained to provide working knowledge of principles for following articles on transistor electronics

termine whether a particular ring is complete.

Energy Levels

It is possible to knock out one or more electrons from any of the rings about the nucleus. In the case of the incomplete rings such as the outer rings of four electrons shown for the two elements in Fig. 1, it is possible to cause an additional electron or more to become attached to the atom in the incomplete ring. In either case, whether the atom gains an electron (or more), or loses an electron (or more), the atom is said to be ionized.

To knock out electrons from the various rings of the atom requires energy. This energy may be obtained, for example, from heat in the form of thermal agitation, by bardment by some other particle, or particle, or by subjecting the atom to electric fields.

One of the ways of determining in which ring of an atom a given electron exists is by measurement of the amount of energy required to ionize the atom with respect to an electron in that particular ring. The study of ionization of atoms is quite complex and actually is of little concern here. It is essential, however, to bear in mind: (1) The ionization energy for an electron in an inner ring is greater than that for an electron in an outer ring. (2) For a given position of a ring with respect to the nucleus, say the second ring, more energy is required to remove an electron from a complete or full ring than from an incomplete or unfilled ring.

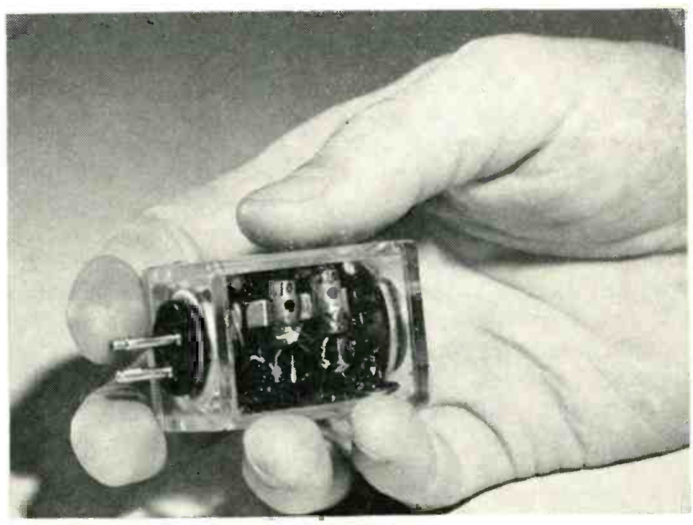
In general when an electron is at a given energy level there is a greater probability that it may move or jump to a lower level than to a higher level because, to jump to a higher level, energy from some outside source must be supplied. On the other hand, due to random processes, there is a finite probability that an electron will jump to a lower level.

The point of interest here is that in consequence of this oversimplified picture, electrons in the states of higher energy have a greater probability of change or transition to new levels than electrons in the lower energy levels. If an electron changes its energy level frequently, or the probability of such change of energy is large, we say that the electron is in an unstable state, and contrariwise, if the probability for an energy transition is small, the electron is in a stable state.

Stable Electrons

The fact that electrons in completed rings are more stable than those in the incompleted rings is actually the crux of the matter of interest to us. If a certain state of a system is more stable than another, the probability will always be greater of finding this system in the stable state. Because the stable condition is the one of high-

TRANSISTOR AMPLIFIER IN QUANTITY PRODUCTION



The tiny amplifier shown has the distinction of being among the first transistorized devices to be produced in quantity. Designed and manufactured by Sapan Engineering Co. for Bell Laboratories, the amplifier uses two point-contact transistors and provides 30 to 40 db gain when inserted in a high-impedance line such as a microphone cable. Several hundred of these units will be manufactured for demonstration purposes

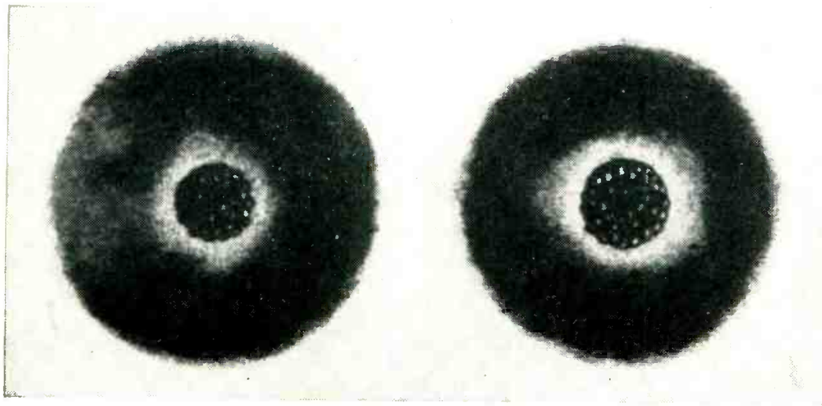


FIG. 2—Artist's conception of germanium and silicon atoms showing smeared-out region about nucleus which represents probability of finding an electron in this region. Lighter regions both near the nucleus and at outer edges indicate regions where probability is small

est probability in certain substances, some natural and some artificial, the atoms tend to adjust themselves and their electrons into a state of stability.

Whereas the atoms of the elements are frequently found in an ionized condition, ionization is restricted to the incomplete rings, normally-full rings seldom, if ever, being found in an ionized condition. As a result, simple chemical compounds involve interactions among the electrons in the incomplete rings only, and for this reason these electrons are called the valence electrons. (Latin: valeo, to be worth, or to be strong.) Because only the valence electrons enter into chemical combinations under normal circumstances, diagrammatically only the valence electrons are usually shown and the complete rings are understood and omitted. Subsequent diagrams for the germanium and silicon atoms show only the four valence electrons.

In Fig. 3 are shown several atoms of carbon. Carbon is tetravalent (four valence electrons), atomic number 6, and the two electrons of the inner ring are not shown, as per the convention mentioned. Note that for the inner or first ring two electrons constitute a completed ring. In the particular substance whose atomic structure is shown by this crude sketch, the valence electrons of atom 1 are shared, as it were, with the valence electrons of atoms 2, 3, 4 and 5. With this arrangement atom 1 behaves as though its second or outer ring were now complete and had 8 electrons in it.

Admittedly this is over-simplified, but the observed fact is that an electron in an incomplete ring, and having an energy level E_1, is actually found to occupy a lower energy level E_2 when it is part of an electron-sharing arrangement, such as shown in Fig. 3.

Whatever is said about a single atom and its electrons in reality applies to the countless myriads of such atoms and electrons which constitute the semiconductor material. Each electron of an atom such as No. 1 is shared with a suitable nearby valence electron such as from atom 2, and this pair of electrons thus may be said to form a bond which, because it involves valence electrons, is called a valence bond. This term is part of the basic terminology in semiconductor theory and is frequently encountered in the analysis of transistor action.

The four valence bonds shown for the carbon atoms give rise to a type of substance which the reader knows as diamond. Of particular significance in transistor work is the fact that the atomic structure for pure germanium and silicon is exactly as shown for diamond in Fig. 3 One need merely write Ge or Si in the place of the C in the figure to have the correct picture.

Semiconductors

Interesting and useful information about silicon and germanium can be deduced from the simple picture of the valence bond structure. First, to have electric current there must be carriers of electric current. Except for special cases when the carriers may be holes[1] the carriers are negatively-charged electrons.

As a corollary, if large numbers of electron carriers are available, the current may be large and other things being equal, we say the circuit involved has low resistance or high conductivity. Contrariwise, if the number of available or free electrons is small, the circuit has high resistance or low conductivity.

A free electron is one that is not in the sphere of influence of the nucleus or that is not in a circumnuclear ring. When an electron is in a valence bond it is in a stable state of low energy and is considered to be bound in the valence bond, and not free to take part in conduction.

From the preceding we may reason as follows: (1) Most of the electrons in a material whose structure involves valence bonds are bound. (2) Hence very few electrons are free to take part in the conduction process. (3) Since the number of electrons free to take part in conduction is small, the material is not a good conductor. Since the three preceding statements are applicable to germanium and silicon, these materials fall into the category of part conductors, or semiconductors.

Forbidden Band

Because energy must be imparted to the electron to get it out of its orbit about the nucleus, it is fairly clear that free electrons have, in general, a higher energy level than electrons in a ring whether the ring be completed or not. As has already been defined in Part II a series or ensemble of adjacent energy levels is called an energy band.

In Fig. 4A is shown a sketch indicating a conduction band or the levels of energy of free electrons. The ensemble of energy levels for the electrons in the valence bonds, or covalent bonds as these are sometimes called, forms a band of energy levels which is called the valence bond band. As indicated in Fig. 4A the energy levels in the valence bond band are lower than the energy levels in the conduction band.

The interesting point about this picture of the structure of germanium or silicon is that between these two bands is a series of energy levels which, for a given material, is never observed to exist. These form an energy gap which is also called the forbidden band.

An insight into the importance of this concept of forbidden bands, conduction bands and valence bond bands is obtained from the consideration that it is feasible to classify the conductors, the semiconductors and the insulators by this means. In the case of conductors (Fig. 4C) there is no forbidden band or energy gap at ordinary temperatures. There is an overlapping of the conduction and valence bands, and valence bonds may or may not exist.

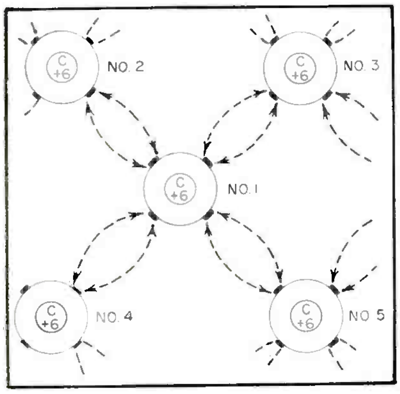


FIG. 3—Covalent bond structure in a tetravalent atom lattice. Such valence bonds may involve atoms of carbon (diamond), germanium and silicon, among others. Note how each electron is bound by valence bond and not free to take part in conduction process

This implies that very large numbers of electrons whose energy falls in the conduction band are always present. If this situation exists in a given material, the material is a conductor by definition.

In the case of insulators the energy gap is very large, perhaps of the order of twenty electron volts.[2] The number of electrons which at room temperatures will acquire sufficient energy by thermal agitation alone to jump the gap and make the transition from the valence band to the conduction band will be small (Fig. 4B).

Bearing in mind from previous discussions that the most probable state of the electron is in the lower energy levels or in the valence band, it may be seen that if the energy gap is large the number of electrons which will be found in the conduction band is small, and by definition the material is an insulator.

Semiconductors have a conductivity in the range between conductors and insulators, and have an energy gap of the order of one electron volt. For the semiconductors germanium and silicon, the width of the forbidden band is 0.7 and 1.11 electron volt respectively, and by comparison the energy to remove an electron when covalent bonds are not involved is of the order of 0.05 electron volt. Thus a useful criterion for classifying conductors, semiconductors and insulators is on the basis of the width of the energy gap.

Because the energy gap for germanium and silicon is small, even at room temperatures some electrons are available for conduction, having broken from their valence bonds. While the number of electrons raised to the conduction level by thermal agitation is sufficient to place these two substances in the category of the semiconductors, it is insufficient to support a satisfactory degree of transistor action. Impurities such as arsenic (As), antimony (Sb) and boron (B) are frequently present in germanium and provide additional carriers to alter the conductivity. These and other impurities, gallium (Ga) and indium (In), for example, may be added in controlled amounts to produce a desired value of conductivity. Even the purest germanium now available contains sufficient impurities to provide free electrons or holes which materially increase the conductivity. In Fig. 5 is shown a basic arrangement consisting of an impurity atom, such as arsenic, in a matrix of germanium atoms. Arsenic is a pentavalent element which means that its outermost and incomplete ring has five electrons. The closed rings of arsenic are three in number, consisting of two, eight, and eighteen electrons respectively, and do not enter into the picture, as mentioned earlier in this article, but their presence must be understood.

The atoms in a solid are arranged in a definite order or pattern and this specific arrangement of atoms is called a lattice (Fig. 7). The positions of the atoms are called the lattice sites, and when one atom displaces another from its normal lattice site, it is said to enter the lattice structure substitutionally. On the other hand if an atom assumes a position within the volume generally enclosed by the lattice structure without being located at a lattice site, it is said to enter interstitially.

The important characteristic of certain types of pentavalent impurities, such as arsenic or antimony, is that they exhibit a greater affinity for certain lattice sites within the structure of the germanium than the germanium atoms normally at those sites. Arsenic may be added when the germanium is in a molten state and upon solidification it is observed that arsenic atoms have entered the germanium lattice structure substitutionally. The electrons in the outer ring of the arsenic atom then form their own covalent bonds with adjacent neighbors, as the figure shows, and thereby form a stable structure for the electrons of both arsenic and germanium which are involved in the valence bonds. But arsenic is pentavalent and there is one electron

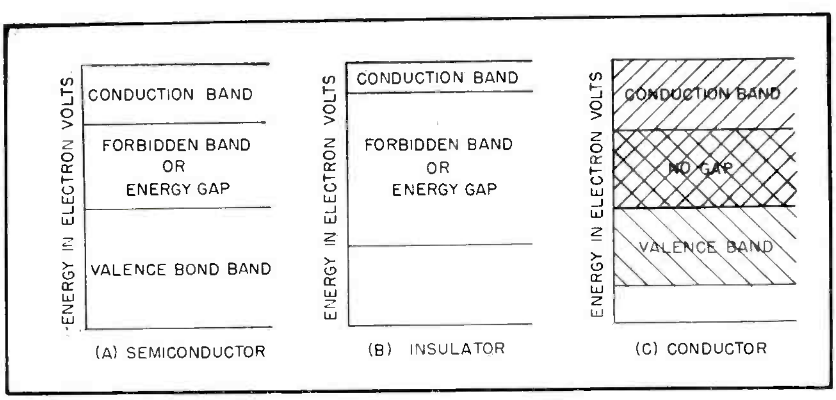


FIG. 4—Energy level diagrams show differentiation of semiconductors, insulators and conductors by presence and width of various bands

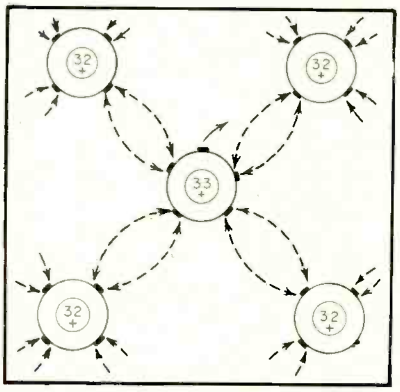


FIG. 5—Germanium crystal structure, showing an atom of arsenic replacing one of germanium to form its own valence bonds with adjacent atoms and leaving one electron to add to the possible current carriers. The fifth valence electron of the arsenic does not enter into a valence bond. A small amount of energy will bring it up to the conduction band of energy levels where it can act as a carrier of current

left over. There are no adjacent electrons for this excess electron to form convalent bonds with and in accordance with the stability picture described this electron is very easily ionized from the sphere of influence of the arsenic nucleus. It readily enters the conduction band to act as a free electron and a carrier.

To remove such an electron from its ring, only about 0.05 electron volt is required and this energy is readily available from thermal agitation at room temperature. By comparison, 0.72 volt would be required to remove this electron if it were in a covalent bond.

Donors

Thus the impurities provide additional carriers for this semiconductor at room temperature. Because these impurity atoms contribute an electron they are called d*o*n*o*rs, and it is a convenient mnemonic to italicize the *n* to show that d*o*n*o*rs give rise to *n*-type semiconductor material.

This is an important concept: *n*-type germanium is due to a donor impurity and the majority carriers of electric current are negative particles or electrons.

The discussion here refers to a typical or prototype reorientation in the material, and in the germanium pellet used in the transistor there are myriads of such impurity atoms contributing corresponding numbers of electrons. In a sample of high-purity germanium, one impurity atom per 100,000,000 germanium atoms is a typical ratio. Controlled amounts of impurities are added in the manufacture of transistors to obtain an optimum impurity concentration. In such purposely contaminated germanium samples a comparable figure is one impurity atom per 10,000,000 germanium atoms, or roughly ten times that of the high-purity germanium.

A trivalent impurity such as boron may be added to germanium when in the molten state and upon solidification the atoms of boron replace atoms of germanium in their lattice sites. Each boron atom robs an electron from a neighboring valence bond, bringing to four the number of electrons in its valence ring. Having robbed this electron, as shown in Fig. 6, the boron atom forms its own covalent bonds with adjacent germanium atoms and thereby enters into a stable arrangement in the lattice structure. But the valence bond from which an electron has been taken now has a deficiency of one negative charge.

Holes Redefined

At this point it is suggested that the reader review the introductory definition of a hole given in the first article of this series.[1] It was stated that when an electron is removed from a neutral atom a positive charge is created and this is of the nature of a hole. However, this is a preliminary definition.

In an accurate definition, the particular net positive charge remaining when an electron is removed from a covalent bond is a hole. Strictly speaking, holes are an attribute of atoms whose electrons enter into valence bonds; merely removing electrons from a neutral atom does not create a hole in the semiconductor sense of the word.

In this respect we are not talking about two tiny balls of fire spinning about the nuclei of which one has been removed to the boron atom. We are speaking of wave packets whose descriptive wave functions define the probability of finding these wave packets in the region of the germanium nucleus and whose quantum states are described by different quantum numbers when in a valence bond, compared to the quantum numbers when not in a valence bond.

The redistribution of the quantum states of the electrons in the system when one has been removed from a valence bond is for physico-mathematical purposes conveniently described in terms of the positive net charge remaining and this convenient abstraction is called a hole.

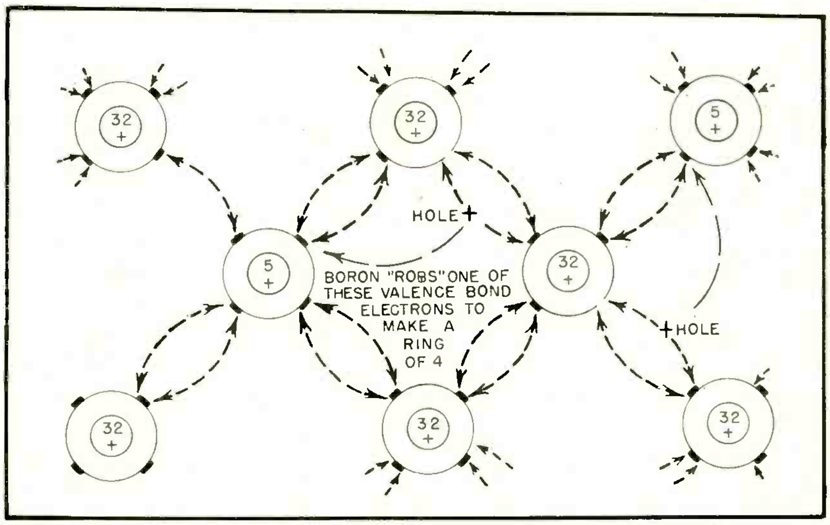


FIG. 6—Germanium crystal structure showing an atom of boron replacing one of germanium, adding an electron to its valence ring of 3 and forming covalent bonds with nearest neighbors. A hole is created in the valence bond where the "robbed" electron had been

When so regarded the hole is endowed with a true positive mass, a true positive charge, a real velocity, and a real energy, and the system acts as if such a positive particle exists.

The ball of fire picture is inadequate for such an analysis and if heedlessly applied on a microscopic level within the atomic structure of the solid will give inconsistent and inadequate explanations of observed phenomena.

Acceptors

Returning to the action of the trivalent impurities, because the boron atom has taken on an additional electron it is called an acce*p*tor and the impurity which acts in this manner is called an acce*p*tor impurity. The word acce*p*tor is written with an italicized *p* as a mnemonic for the fact that the material thus created is said to be a *p*-type material because the majority carriers of current are the *p*ositive charges or holes.

Holes are regarded as true carriers of electric current because observed conduction phenomena in semiconductors can be explained only by the assumption that holes may play the same role in the conduction process as do electrons. Normally both electrons and holes are present in a semiconductor material and both may act as current carriers in the conduction process.

In *n*-type germanium, electrons greatly outnumber the holes, and are therefore referred to as the majority carriers; the holes are then called the minority carriers. In *p*-type material where the holes outnumber the electrons, holes are the majority carriers and the electrons are the minority carriers.

Normally *n*-type germanium is used in point-contact transistors. Both *n* and *p* types are used in junction transistors. These types of germanium are the only two that are known and used in transistors at present.

Lattice Structure

In Fig. 7 is shown the lattice structure or array for the germanium and silicon crystals. A crystal may be regarded as the fundamental building block or iterative unit of which certain materials such as germanium and silicon are made. When silicon and germanium freeze from their molten state they invariably freeze as a series of small repeated units called crystals.

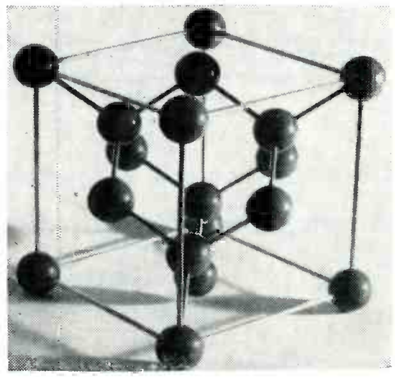


FIG. 7—A three-dimensional representation of the crystal lattice of germanium. Note the hexagonal arrangement of the atoms. Corner atoms are considered as shared by eight similar cubic crystals with a common vertex, and the total contribution of all the corner atoms to a unit crystal is one atom. Crystal refers to the entire cubical structure; lattice refers to the arrangement of atoms within the crystal volume

In Fig. 7 the lines that outline a cube show the fundamental unit to be a cubical solid or volume. It is not necessary for all the atoms which form the crystal to be entirely within this cubical volume. For instance, each of the corner atoms is shared by the eight crystals which have a common corner at that lattice site. The eight atoms which actually compose the crystal are arranged in a regular geometric pattern of three dimensions which is called the lattice. It is not necessary that for every such cubical unit or crystal all the atoms be at their lattice sites nor that the arrangement always be as regular as the figure implies. The existence of interstitial atoms has already been mentioned, but in addition irregularities in the form of dislocations of various kinds are the rule rather than the exception. References to order and disorder in the literature refer to the irregularities in the crystal structure.

In speaking about crystals, it is particularly important to distinguish between the word crystal as used by the physicist and as used by the metallurgist. When the physicist says single crystals he means the microscopic iterative units each consisting of atoms arranged as discussed previously. Regular and regularly-arranged crystals as defined by the physicist which are formed without creating boundary planes or so-called grain boundaries compose a single crystal in the sense of the metallurgist.

The crystal of the metallurgist is a large single piece of metal which may, in some cases, weigh several pounds. In examining a crystal, the polycrystalline structure is recognized by the presence of lines on the surface of the material. The single crystal is recognized by the complete absence of such boundary lines or grain lines on its surface. The use of single-crystal germanium has contributed materially to the development of uniform and reproducible transistors.

Summary

(1) The fundamental structure of germanium is crystalline and the crystal is cubical in shape.

(2) The electrons belonging to these atoms in the crystal enter into stable configurations known as valence bonds. The breaking of a valence bond produces a free electron and a hole.

(3) Pentavalent impurities such as arsenic displace atoms of germanium in the lattice structure to form four covalent bonds with the nearest neighbors allowing the fifth valence electron to be readily removed. In this way the arsenic impurities act as do*n*ors giving rise to *n*-type material.

(4) Trivalent impurities such as boron enter substitutionally into the lattice structure of germanium, acquire an additional electron into the valence ring and form four covalent bonds with the nearest neighbors. In this way the boron impurity atoms act as acce*p*tors giving rise to *p*-type material.

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(2) Abraham Coblenz and Harry L. Owens, Energy Levels in Transistor Electronics, Part II of TRANSISTORS: Theory and Application, ELECTRONICS, p 138, Apr. 1953.

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Audio Impedance and

Modified bridge technique permits measurement of a-c circuit values with minimum of components. Impedance and phase angle are read off directly, eliminating calculations, from this simple meter that requires no standard of inductance or capacitance

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ALTERNATING-CURRENT circuit parameters can be measured over a range of 0 to 100,000 ohms impedance at frequencies between 30 and 15,000 cycles using the circuit shown in Fig. 1. The value of the measured impedance is given as a complex impedance in polar form. A null method of indication is used for both the magnitude impedance and phase-angle indications. Calibration is independent of frequency and magnitude of the applied signal voltage.

The operating principle involves a comparison of a voltage across a calibrated resistance with respect to a voltage across an unknown impedance where the resistance and impedance are in series. When the voltages are equal the impedance of the unknown will equal the value of the calibrated resistance. If two equal arms are added to form the bridge circuit shown in Fig. 2, the sum of the unbalance voltage E_d as it is related to the voltage across the calibrated resistance will be proportional to the phase angle of the measured impedance. The result is given in terms of magnitude impedance and phase angle.

By means of a system of balanced rectifiers and a switching arrangement, the voltages are converted to direct current and compared by a null indication method.

Operation

When the voltage across the calibrated resistance is equal to the voltage across the unknown impedance then equal voltages will be applied to the grids of the cathode followers.

For equal input voltage from the cathode followers the output of the balanced diode rectifiers is zero. Thus, a null is obtained when the value of the calibrated resistance is equal to the value of the unknown impedance.

After the magnitude impedance has been determined, the ganged switches shown in Fig. 1 transfer one side of the balanced rectifier from the output of V_2 to the output of the cathode follower V_3, the grid of which is driven by voltage that may be present at the junction of the right-hand arms of the circuit. The voltage at the cathode of this tube is proportional to the function of the phase angle of the measured impedance and is compared with part of the voltage appearing across the calibrated resistance.

The voltage across the calibrated resistance is impressed on the grid of V_1 and appears across the potentiometer R_2 forming part of the load in the cathode circuit of V_1.

The other side of the balanced rectifier is now connected to the arm of the potentiometer rather than directly to the cathode of V_1. By this means a part of the voltage across the calibrated resistance is made available for comparison with the unbalance voltage. The resistance R_1 connected between the cathode of V_1 and the potentiometer is necessary to drop the voltage across the potentiometer to a value equal to that appearing at the cathode of V_3 when the phase angle of the unknown is 90 deg.

The relative value of these voltages and the ratio of the resistance of the potentiometer to resistance of R_1 is explained by reference to the vector in Fig. 3, where

$$E_d = \frac{E}{2}\tan\frac{\theta}{2} \text{ and } E_{R_S} = \frac{E}{2\cos\frac{\theta}{2}}$$

If the unknown is a resistance, the junction of the A and B (Fig. 2) will be at zero voltage; therefore the arm of potentiometer R_2 will be at zero voltage and at a position corresponding to zero phase angle. Conversely, if the unknown is reactive, the arm of the potentiometer will be at a position determined by the value of the unbalance voltage E_d. The potentiometer can thus be calibrated in terms of phase angle. The dial graduation in degrees is nearly linear. It should be noted that a balance for magnitude impedance is made before the phase angle is measured. Except for this requirement there is no interaction between the controls used for magnitude impedance and the phase-angle measurement.

The sign of the phase angle can be determined by changing the frequency of the signal source slightly in a known direction and observing its effect on the impedance. Since a variable frequency oscillator is usually available as a signal source this method has been used. However, the sign of the phase angle could also be determined by connecting suitable values of capacitance across the standard or unknown arms of the bridge circuit, thereby adding to or subtracting from the value of the reactance of the unknown with its resultant effect on impedance.

The high input impedance of the cathode followers reduces the loading effect on the bridge circuit, which is the principle source of error. The low output impedance of

Phase-Angle Meter

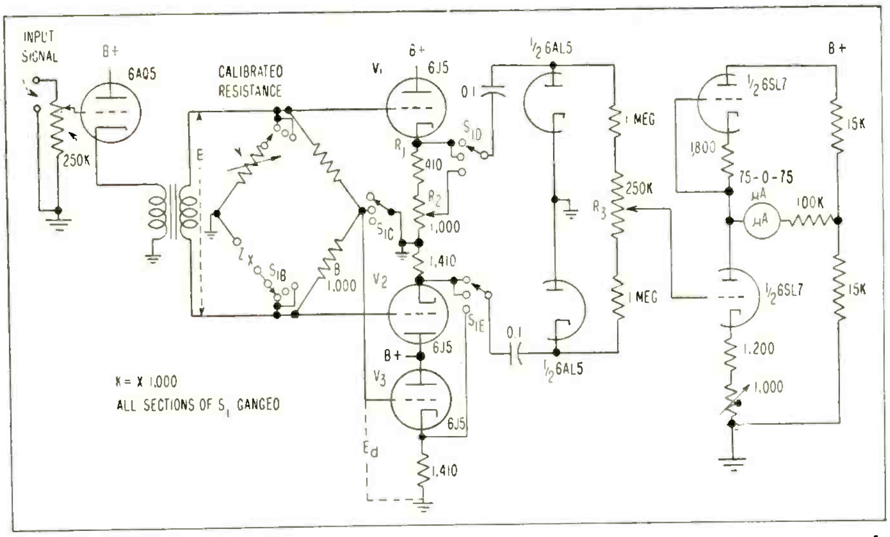

FIG. 1—Circuit of the bridge, balanced rectifier and indicator. To save space in actual equipment, phase and calibrated resistance are mounted coaxially

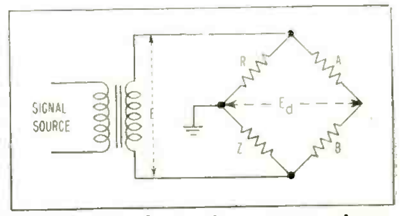

FIG. 2—Simple bridge circuit shows derivation of voltage E_d

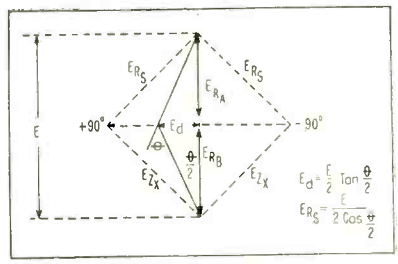

FIG. 3—Relationship of voltages shown above is described in text

the cathode followers reduces the loading effect of the stray wiring capacitance as well as loading caused by the diodes. This also permits the use of a low-resistance wire-wound phase-angle control.

Potentiometer R_3 connected as part of the load resistance on the diodes is used to balance the diode rectifiers. It will also compensate for slight gain differences in V_1 and V_2.

Zero Check

In addition to the switch positions necessary for the impedance and phase-angle measurement, a third position checks zero setting of the vacuum-tube voltmeter. This is accomplished by disconnecting the calibrated resistance and unknown arms from the circuit and at the same time grounding the junction of the *A* and *B* arms. Since these arms are of equal value they can function as an accurate voltage divider to provide identical voltages to each of the cathode followers. While the primary function of the check is to eliminate error owing to drift of the vacuum-tube voltmeter used for null indication it also checks the electrical symmetry of the cathode followers V_1 and V_2 and the balanced diodes.

The voltmeter used for null indication is a series-balanced d-c amplifier[1] with a microammeter for a load. Its stability is good and a regulated power supply is not required. Zero adjustment is by means of the 1,000-ohm variable resistance in the lower half of the 6SL7, in Fig. 1.

The value of the calibrated resistance that determines the range of the instrument is 0 to 100,000 ohms, made up of a combination of decade steps and a continuously variable control of 0 to 1,000 ohms. The reactance of the resistance should be held to a low value. The control calibrated in phase angle has a value of 1,000 ohms.

It is necessary to give the bridge transformer special consideration. The capacitance between the secondary and ground should be held to a low value. If this is not done the accuracy of the instrument will be affected at the higher frequencies. It is also necessary that the primary have a d-c resistance of such a value as to provide proper bias for the 6AQ5 input tube.

The impedance ratio of the transformer is a compromise value because the load impedance is variable. Load impedance is fixed by the value of the unknown impedance being measured. The compromise ratio decided upon was approximately 200 to 1. The transformer is driven by a cathode follower to minimize the effect of this variable load impedance and to reduce waveform distortion.

The transformer was constructed from an audio driver type with a turns ratio of approximately 1 to 1 of which the inside winding has a d-c resistance of about 500 ohms. The outside winding of the transformer was removed and an electrostatic shield placed over the inside winding. Wood spacers support the secondary with an air space between it and primary and between secondary and core, minimizing capacitance to ground.

Suitable combinations of resistance and capacitance were used to calibrate the phase-angle dial. With a variable-frequency source a minimum of such combinations is necessary to complete the calibration.

The author is indebted to Duane E. Beecher, formerly with radio station KSL and now with Hughes Aircraft Co, for his helpful suggestion leading to improved linearity of the phase-angle dial.

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(1) M. Artzt, Survey of D-C Amplifiers, ELECTRONICS, p 112, Aug. 1945.

Analog Computer Solves

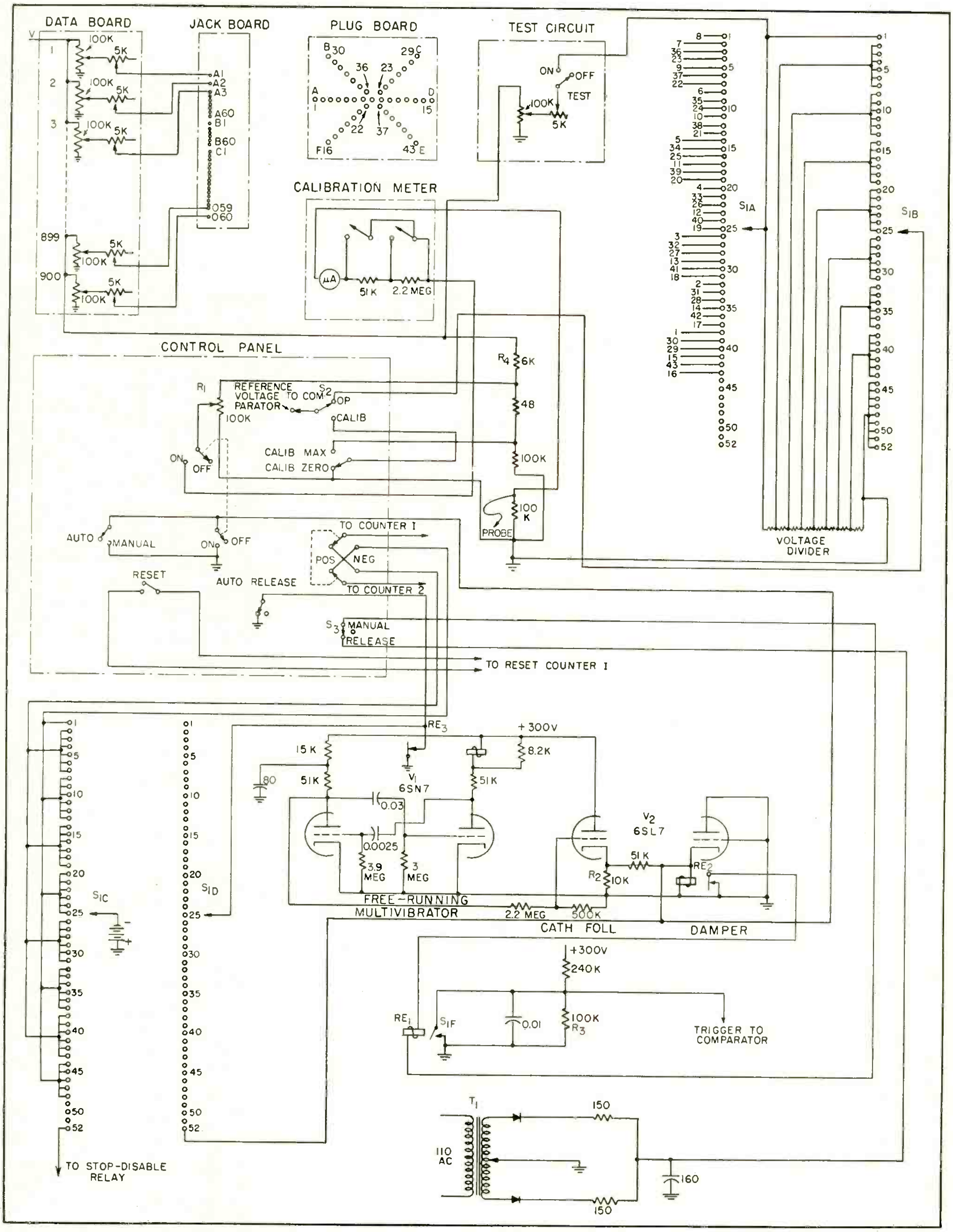

FIG. 1—Stepping switch in control unit governs analog multiplication of initial data values by proper coefficients. Free-running multivibrator is basic timing unit

Geophysical Problems

Subsurface features can be studied from measurements made on earth's surface but interpretation of data is laborious and time consuming. Specially designed analog computer saves time and effort. Digital read-out enhances accuracy and stability

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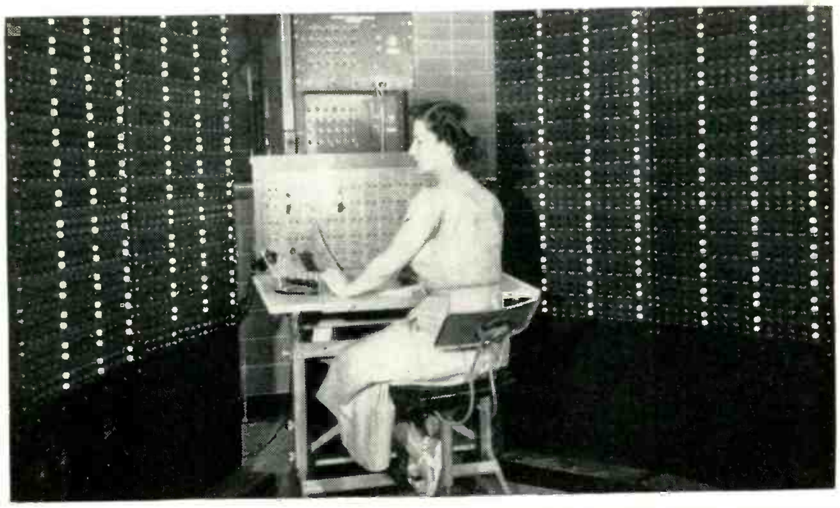
GEOPHYSICAL EXPLORATION is often carried on by making magnetometric or gravimetric measurements on the surface of the earth and interpreting them in terms of subsurface features. The analog computer to be described was devised to perform rapidly the arithmetic operations required to interpret potential-field data.

The need for rapid computation of geophysical data arises from the large number of calculations required. A typical region of interest may be 1,000 square miles, which for half-mile grid spacing contains 4,000 values of initial data. For every value of initial data a separate computation is required that consists of summing as many as 43 terms, each term being a product of one of the initial values by one of a set of predetermined coefficients. Since, as many as five different sets of coefficients may have to be applied separately, analysis of a typical area may require more than 20,000 lengthy calculations.

Other Applications

The computer, however, is not restricted to geophysical problems since the operations performed are of a more general type where, given a large set of values of initial data and a smaller set of coefficients, it is desired to pair each coefficient with a selected member of the large set of numbers, multiply each pair of terms, and sum the products. The coefficients are then repeatedly paired with different groups of numbers from the large set, and multiplication of pairs and summation of products continues.



Computer operator reads answers on counter-chronograph (center), initial values are set up on data boards, left and right

General Description

Initial data is stored on a large jack board arranged in the desired grid pattern. An array of voltages, is presented, each voltage proportional to the measured value of the field at the corresponding field grid point. A movable plug board whose plugs are arranged to select a desired set of grid voltages engages the jack board.

Selected voltages from the plug board are fed separately to the fixed contacts of a stepping switch whose rotating arm samples each contact in succession. The arm is connected to a precision resistive divider whose output taps are arranged so the included resistance is proportional to the coefficients required in the computation. Several sets of coefficient dividers are incorporated in the computer and are readily chosen by a selector switch.

The taps of the voltage divider connect to a second bank of fixed contacts of the stepping switch. Sampling the jack-board voltages in synchronism with the proper tap of the voltage divider makes available a succession of voltages, each proportional to the product of a measured field value by a predetermined coefficient.

Read-out is initiated by feeding the voltages to a voltage comparator, which produces a pair of pulses for each voltage input, whose time spacing is determined by the magnitude of the voltage. These pulse pairs activate one of two electronic counter-chronographs, the choice depending upon the algebraic sign of the coefficient. Here successive time-interval measurements are accumulated. Subtraction of negative-term accumulation from

This article is based on a paper presented at the 1952 National Instrument Conference. The complete paper will appear in the conference proceedings.

positive-term accumulation occurs at the end of each sampling cycle, and the final answer is read out directly.

This type of read-out is accurate because it does not require appreciable power from the voltage source nor does it upset any voltage relations. Its circuits can be designed to make it relatively independent of variations, with resultant long-time stability.

Fundamental timing of the system, which controls the rate of operation of the stepping switch, and hence the rate of accumulation of partial products, is adjusted for about five operations per second. Once data are set into the jack board, the process of 43 multiplications and final summation is accomplished in about 10 seconds.

Layout

A front view of the apparatus is shown in the photograph. The panels at either side contain input-data controls to adjust the voltages at the jack board located at desk level in front of the operator.

The computer has a storage capacity of 900 values, corresponding to a grid region of 60 columns by 15 rows. The jack board contains 1,740 jacks, so interwired that the computation of each row of points, after the first, requires resetting only 60 input-data values per row. One series of 3,300 computations made twice for checking purposes, was performed at an average rate of slightly less than one minute per computation.

The plug board is shown inserted in the upper portion of the jack board. Two counter-chronographs are located above the jack board. The answer is obtained from direct-reading neon-light indicators on the lower counter-chronograph. All operations are controlled from the control panel in the operator's left hand.

Data-Input Circuit

The data board, jack board and plug board comprise the data-input section shown schematically in the upper left portion of Fig. 1. One 100,000-ohm shunt potentiometer and one 5,000-ohm series potentiometer on the data board are connected to each jack of the jack board making any voltage from zero to V independently available at each jack. Jacks are arranged in a two-dimensional hexagonal array. The plug board, with plugs also arranged in a hexagonal pattern, engages the jack board. Each fixed contact of S_{1A} connects through a correspondingly numbered plug to a selected jack.

The arm of S_{1A} is always loaded by a resistive voltage divider. One of several dividers may be selected. Total resistance of each divider is 100,000 ohms but the amount of resistance across each tap is preset in accordance with the desired calculation. The arm of S_{1B} selects in succession each voltage presented to S_{1A} by the plug board, multiplied by one of the factors determined by the voltage divider. This succession of voltages is led to the voltage comparator through S_2, the calibrate-operate switch located on the control panel.

Inserting Input Data

Each input-data control is set by a comparison scheme using only one precision element. Data insertion consists of adjusting the voltages at the jacks of the jack board so that when the jacks are loaded by a 100,000-ohm resistor, the voltages present are proportional to the initial input data.

Use is made of R_1, a 10-turn potentiometer, with better than 0.1 percent linearity, and a direct-reading dial. It is connected, in series with R_4, between the primary voltage source V and ground. If all the initial input data in the region of interest are in such units that the numerical values lie between zero and 1,000, then the voltage appearing at the arm of the R_1 which is proportional to the dial reading, can readily be adjusted to be proportional to any initial input value.

Control Unit

The control unit governs the motion of the rotating arms of the stepping switch. Relay RE_1 controls the motion of the rotating arms of $S_{1A,\ B,\ C\ and\ D}$ and the make-break contactor S_{1F}. The switch is so designed that each interruption of current through RE_1 causes the switch to move one step.

Power from T_1 is rectified, passed through S_3,RE_1, and the normally closed contacts of RE_2. Dual-triode V_1 is a free-running multivibrator, with a period of about 0.2 second; V_{2A} is a cathode follower; V_{2B} is diode-connected and is used as a damper.

Rise in voltage at the plate of V_{1A} causes increased conduction in V_{2A}; the resulting rise across R_2 activates the relay RE_2, opening its normally closed contacts. Opening the contacts of RE_2 interrupts current flow through RE_1 causing arms A, B, C and D of S_1 to move one step. This motion causes S_{1F} to close momentarily, shorting out R_3 and a negative-going trigger synchronized with the stepping of the

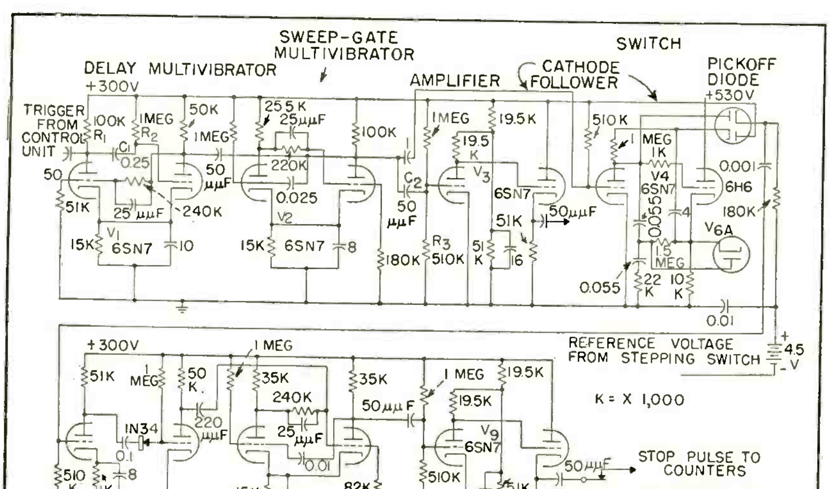


FIG. 2—Voltage comparator converts voltage product from analog unit to corresponding time intervals that are summed by counter-chronographs

rotating arms of S_1 is fed to the delay multivibrator in the voltage comparator.

Scale Factor

Since voltage source V is common to the data board and the potentiometer (R_1) used for data insertion, the reference voltage obtained at the arm of S_{1B} is always proportional to the desired computation, independent of the value of V. However, it is advantageous to set voltage V so that the time interval determined by the voltage comparator for voltage V input is a round number, such as 10,000 microseconds.

Voltage Comparator

Conversion from voltage to time is accomplished in the voltage comparator. For a given voltage input, the output is a pair of pulses whose time separation is a linear function of the magnitude of the reference voltage. Since the reference voltage is obtained from a series of switching operations, sufficient time delay is incorporated in the voltage comparator to allow transient voltages to disappear.

A linearly rising voltage waveform synchronized with the insertion of a reference voltage is produced. The start of this rising voltage is coincident with the first, or start, pulse. When the rising voltage is equal in magnitude to the reference voltage, a second pulse is produced. This pulse pair is fed to a counter-chronograph and the time interval accurately measured.

The circuit diagram of the comparator is shown in Fig. 2. The trigger input is obtained from S_{1F}, hence is synchronized with the motion of the stepping switch S_1. Dual triode V_1 is a biased multivibrator, with V_{1B} normally conducting. The negative-going trigger changes the state of V_1, but recovery is automatic. The time between triggering signal and recovery is determined by the values of R_1, R_2 and C_1.

Pertinent waveforms are illustrated in Fig. 3. Figure 3A is the waveform seen at the second plate of V_1 (Fig. 1). The waveform at the first plate of V_1 (Fig. 1) is exactly synchronized with this waveform, but is positive-going instead of negative-going. Thus, at zero time, RE_2 is opened and the stepping switch moves. Because of mechanical linkages between the motion of the stepping switch and the activation of S_{1F}, the negative-going trigger to the comparator does not start until time A. Its waveform is shown in Fig. 3B. This trigger activates V_1 whose output is seen in Fig. 3C. The negative-going recovery at time B becomes the delayed input signal to V_2, the sweep-gate multivibrator.

The sweep-gate multivibrator is a biased multivibrator. Its output waveform, shown in Fig. 3D, has a duration of about 12,000 microseconds, so chosen to be slightly longer than the maximum single count. It is differentiated by C_2 and R_3, and amplified by the biased amplifier V_{3A}; V_{3B} is a direct-coupled cathode follower whose output is the start pulse. This pulse is about +75 volts in amplitude, with a rise time of 0.2 microsecond. Its occurrence in time is coincident with the leading edge of the sweep-gate waveform. The sweep gate is also used as a gating pulse for switch tube V_{4A} that initiates the linearly rising waveform from which the stop pulse is derived.

Counter-Chronographs

The counter units are commercial electronic counter-chronographs. Each counter chronograph consists of an oscillator, a switch and a counter. The oscillator is crystal-controlled at 1 mc and operates continuously. The switch can be opened by a start pulse and closed by a stop pulse. Only while the switch section is open does the oscillator signal enter the counter and the reading of the counter, therefore, indicates the number of cycles of the crystal oscillator produced during the interval between the start and stop pulses.

For present purposes, several modifications have been made: (1) The lock-out circuits of both counters have been removed. Thus, the elapsed times between the start and stop pulses of successive pairs of pulses can be accumulated. (2) Either counter can be made inactive by application of a disabling voltage. While in a disabled condition no count is indicated, even though start and stop pulses are applied.

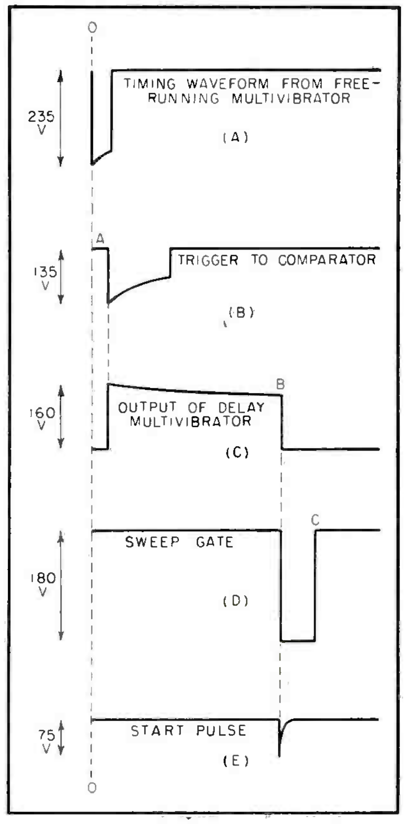
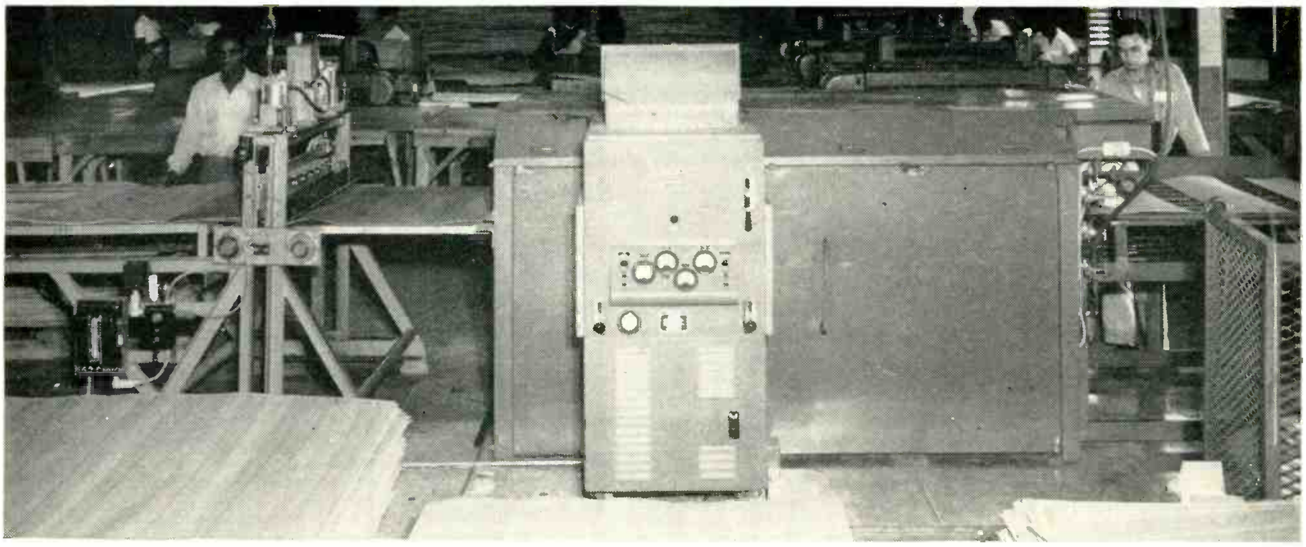


FIG. 3—Waveforms from voltage comparator

(3) The counters have a storage capacity of 10^6 counts, or 6 decades, before the final decade delivers an output pulse. A self-stop circuit has been added so that the output pulse of the sixth decade of the second counter furnishes a stop pulse to both counters.

Test Circuit

The purpose of the test circuit is to check the electronic portions of the system by introducing an artificial problem whose answer is know and observing the machine-calculated answer. The circuit, shown in Fig. 1, is similar to one of the data-input units. With the plug board removed from the data board and the test switch in on position, a constant voltage is applied to the arm of S_{1A}. The test problem, therefore, is the artificial problem of a uniform field distribution. The magnitude of the test voltage, hence the magnitude of the uniform field, can be adjusted to any desired value between zero and maximum. Because the coefficients for the computation are known, the correct answer is easily calculated and the overall performance of the computer can be checked.



VENEER EDGE GLUER—Conveyor brings small sheets of veneer stock into machine at right, where rollers apply glue to edges and hold edges together during passage between electrodes of electronic generator. Continuous glued sheet emerging at 45 feet per minute is cut automatically into large sheets by air-operated clipper at left in this Northwest Syndicate, Inc. installation

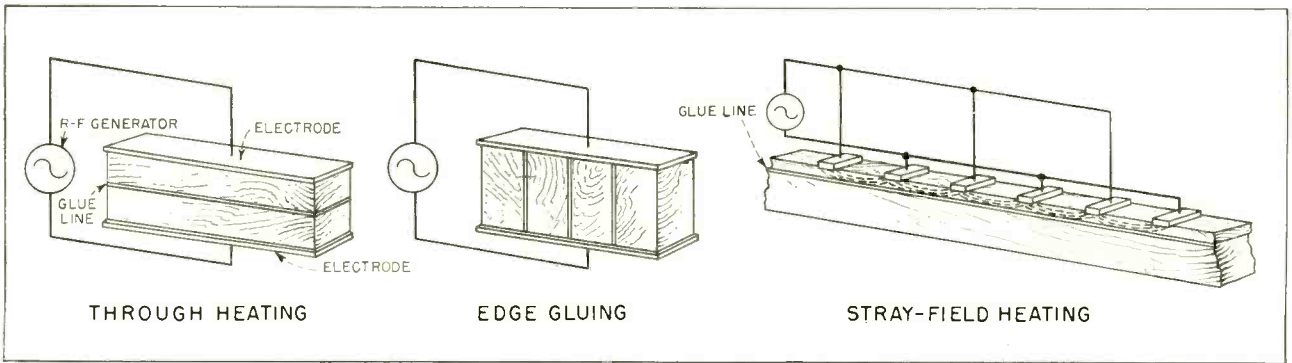


FIG. 1—Three basic production techniques employed by woodworking industry for electronic curing of glue lines

Dielectric Heating Cuts

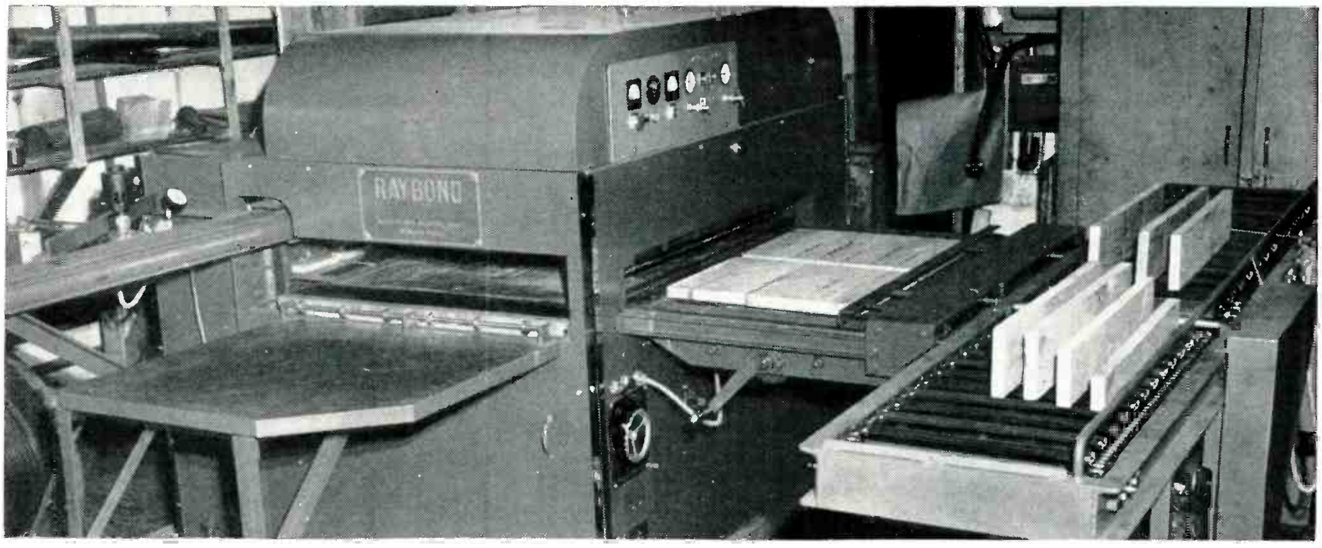
Case histories of successful applications in which electronic glue-curing improves quality and speeds production of wood products as well as cuts costs. Included are continuous edge-gluing of veneer and core stock, curing all glued joints simultaneously in television cabinets, forming veneers into curves, and gluing entire freight car walls

DIELECTRIC heating is the quickest way to get uniform nondestructive heat into electrically and thermally nonconducting wood. It makes possible a complete glue-curing cycle in wood-bonding of less than one minute, compared to the conventional 30 minutes of oven glue-heating and nine or more hours of glue-drying in woodworking applications. The speed and uniformity of heating provide as further advantages a greatly improved quality of product, economy of operation, minimized space requirements and an efficient production-line setup.

In general, dielectric heating gives a glue-curing production rate of 100 to 250 square inches of glue-line per kilowatt-minute for wood bonding, with power in terms of heater output.

Methods Employed

Electronic wood-gluing is generally performed by one of three basic methods—through heating, edge-gluing or stray-field heating, as shown in Fig. 1.



PANEL EDGE GLUING—One-man edge-gluing machine setup developed by Electronic Heating Corp. for producing large panels and core stock used in furniture. Glue is applied to edges of pieces by conveyor-type applicator at right, after which operator places them on bed of machine to start sequence of moving into press, applying pressure, heating for about 40 seconds, opening press and ejecting

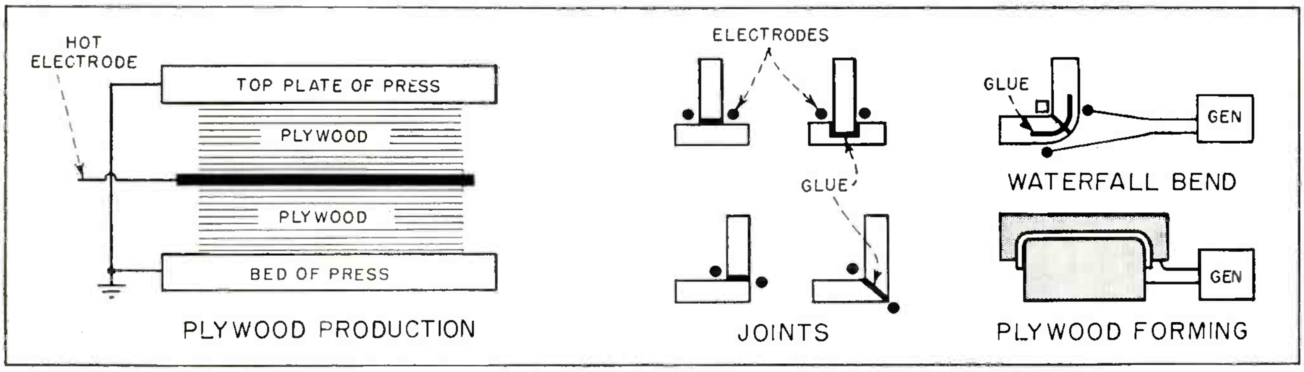


FIG. 2—Examples of electrode shapes and locations used for some of the commonest types of joints in wood materials

Woodworking Costs

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The electrodes are parallel to the glue lines in through heating, this method being used where laminated sections are glued together to make plywood sheets or curved panels; it is also used in many assembly operations.

In edge-gluing the dielectric heater electrodes are perpendicular to the glue lines. This method is used for core stock and panel-gluing, veneer splicing and some assembly work. Since the electrical conductivity of glue is greater than that of wood, the glue line absorbs most of the radio-frequency energy available, making this method somewhat faster than through heating for the curing of equivalent glue-line area of wood products.

Stray field heating makes use of fringing fields between adjacent electrodes to cure glue lines accessible from only one end of the object. It is used to attach structural members to the inner and under sides of cabinet panels.

Veener Production

One of the more recent unique applications is continuous edge-gluing of veneer stock ranging in thickness from 1/28 inch to 1/4 inch.[1] By dielectric heating, narrow selected clear stock, sliced or rotary cut, may be glued edge to edge, the stock flowing at right angles to the run of the grain and at a continuous speed up to 45 feet per minute. These veneers may vary from four feet to eight feet in length measured parallel to the grain. As the continuous glued sheet emerges from the off-bearing end, a clipper automatically cuts the stock into any desired widths, usually producing sheets of stock for plywood faces 4 feet by 8 feet in size. This device replaces methods of holding the veneers edge to edge with gummed tape or much slower methods of joining the wood edge to edge with glue set by contact with heated platens.

One of the earliest and outstanding uses of dielectric heating is the setting of glue in laminated sheets or plywood.[2] After the gluing and lay-up operation, several plywood sheets are stacked within a hydraulic press and heated electrically, as shown in Fig. 2, to 250F for complete glue setting, in less than 10 minutes for 24-inch stacks, after which finishing operations on the plywood can be immediately carried out. This method contributes to in-line production and eliminates storage space and drying-room needs (10-15 hours for complete glue-setting) associated with the older oven-heating process.

Lumber Edge-Bonding

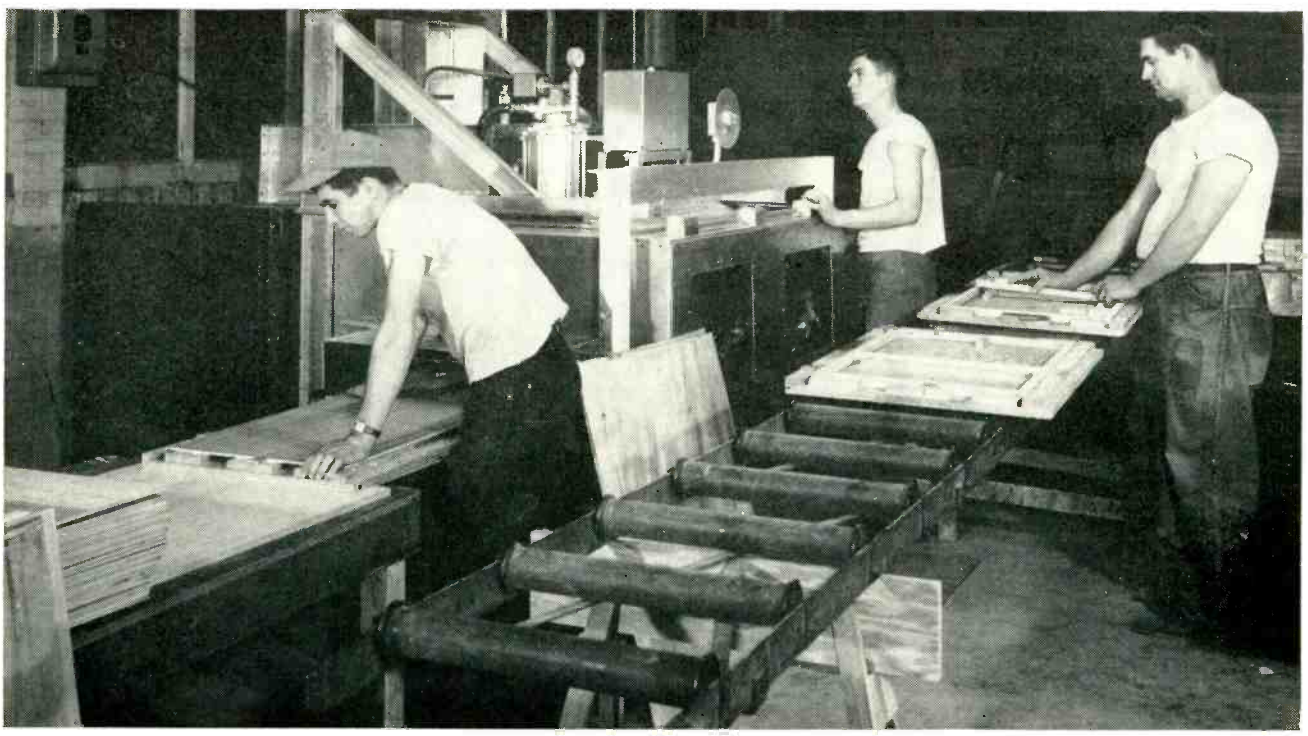
The principles involved in the continuous electronic edge-gluing of veneers have also been applied with excellent success to lumber in continuous forward movement.[1] Units are being built for the continuous edge-gluing of lumber in stock lengths or submultiples thereof up to 75 inches in length, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches thick in softwoods, and random widths moving through the electronic press at 15 lineal feet per minute. Submultiples of 75 inches, such as three rows of panel stock 24 inches long or four rows of 18-inch long stock, may be run simultaneously. As the continuously glued strip or strips emerge from the off-bearing end of the press, a flying-saw mechanism traveling with the moving stock cuts it off into given panel widths.

Electronic edge-bonding of narrow boards to form large panels and core stock is applied in the manufacture of desks, tables and other types of furniture.[3] One 5-kilowatt one-man edge-gluing panel-making unit operates at a frequency of approximately 5 mc and will glue panels up to 37 inches by 50 inches, with thickness from $\frac{1}{2}$ inch to 2 inches. The heating time is usually 30 to 50 seconds. The entire operation, handled by one man, is automatic; one pushbutton starts the sequence of applying top and edge pressure, heating, opening press, and ejecting panels. Production is continuous at the rate of a panel in less than a minute, with finishing operations following immediately.

Rway Furniture Co. makes use of electronic edge bonding equipment to glue and cure 10,000 square feet of panels in a two-shift, 18-hour day. The operation is fully automatic, with the operator's only duty being to load boards on the feed belt and remove completed panels. Time cycles vary with the type of wood stock being glued—such as poplar, birch, ash or elm, but are always below 40 seconds.

For core stock or edge-gluing applications, where narrow relatively inexpensive boards are glued edge to edge to form large panels, the basic installation consists of the r-f generator, an air or hydraulic-operated press for application of edge pressure to the core panel, and a layup-infeed table with glue spreader.[4] A typical installation of a Westinghouse 10-kw r-f generator and Earle Hart Co. core press turns out one-inch-thick panels approximately 36 inches by 84 inches with heat cycles of 35 seconds. Based on increased production and labor savings, press-generator combinations costing about $15,000 pay for themselves in less than a year.

Production from these edge-glu-



CABINET WALL GLUING—Glue used to join mounting blocks and other wood members to panels of television cabinet subassemblies are cured in about 15 seconds in this Westinghouse 10-kw installation. Man at right places blocks and strips in pallet-type positioning jig; outer panel is set over this after glue is applied

ing presses runs up to 10,000 board feet per eight-hour day; the production figure depends on the type of wood being glued and the average number of glue lines in the panels, and assumes that room-temperature-setting urea glues are used. For estimating purposes, hardwood core panels can be cured at a rate of 150 square inches of glue line per kilowatt-minute of heater output; for soft woods, the production rate is about 250 square inches of glue-line per kilowatt-minute.

Production rate by edge-gluing has been a controversial subject. In edge-gluing a tennis racket, for example, it is possible to get production rates ranging up to 750 square inches of glue line per kilowatt-minute: in this application the volume of wood is very small relative to the volume of glue line and little power is lost to the wood. The rates of 100 to 250 square inches of glue-line per kilowatt-minute apply in general to core stock and panel production.

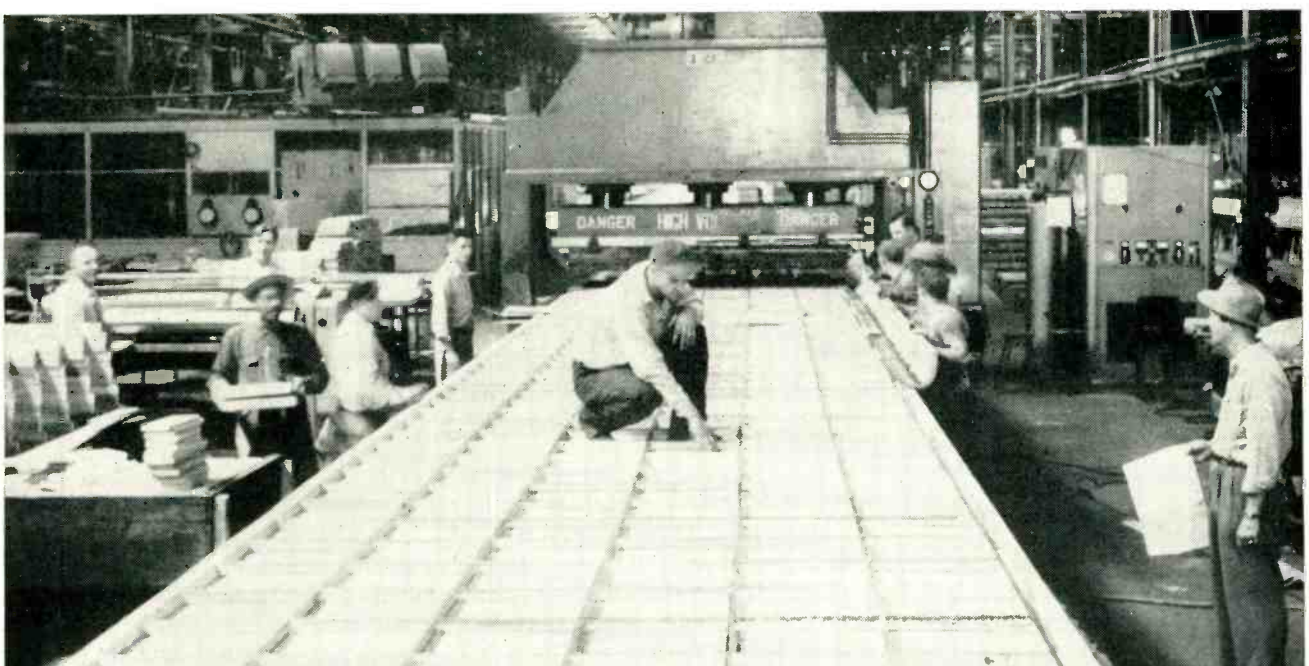
Subassembly of Wood Products

Butter tubs from wood scraps is another achievement of dielectric heating. Wisconsin Butter Tub Company's plant in Marshfield, Wisconsin uses a Bell Machine electronic edge-gluing press and special machines designed by the user to do this job.[5] Scrap pieces, too short to be used in the sash and door industry, are electronically glued in a press. A conveyor-type glue spreader applies urea resin glue to one edge of the boards and delivers them to the operator who assembles a press load of eight 16 by 16 by 1¼ inch panels on a press layup table. The gluing operation is fully automatic, with the charge being pushed at the touch of a foot pedal into the press, which in turn applies pressure to the panels; a complete set is obtained in a glue-curing cycle of less than a minute.

From the glued panel, four slightly tapered pieces with beveled edges are cut on a circular saw. These pieces then go to a bandsaw where they are clamped in a special rotating fixture and are split in two pieces, each having one curved surface. From the bandsaw they go to special planers where the one flat surface is planed to a curve paralleling that of the sawed face, giving the final shape of the tub or bucket staves. Bottoms and covers are also turned from electronically glued panels. Electronic gluing, in use here for over two years, has stepped up production to 2,000 per day, these being used as containers for butter, shortening, oleomargarine, jams, jellies, mincemeat, sauerkraut and fish, and as hand-painted wastebaskets for the novelty trade.

TV Cabinet Assembly

Probably one of the most competitive markets in the woodworking industry is that encountered in the manufacture of tv cabinets. Here the elimination of a few screws on each cabinet can represent thousands of dollars in annual savings, and r-f heating has been able to do just that. An air-operated press for gluing the several sides of a console tv cabinet together in one operation has eliminated driving screws or clamping for a prolonged glue cure period.[4] This air-operated installation turns out 500 cabinets per 16-hour day. Based only on labor saved in not having to drill and drive screws as was previously done in assembling cabinets, it has been possible to cut production time by 20 percent,



BOXCAR WALL GLUING—Entire wall subassembly for plywood freightcar is here being prepared for moving into electronically heated press to cure glue joints between reinforcing strips and plywood faces. Equipment was developed by Thermex Division of The Girdler Corp. Resulting cars are stronger than conventional steel cars with a corresponding reduction in labor cost. In addition, elimination of the screws saves 3.9 cents per cabinet, or about $4,300 in a 222 work-day year. This manufacturer has about 30 r-f generators performing practically all types of gluing jobs.

Stromberg-Carlson has gained increased output of television cabinets per assembly fixture, reduced production costs, and improved cabinet quality through the use of dielectric heating. Further, rejects for repairs dropped from as high as 15 percent in humid weather with older gluing methods to ½ percent under the same conditions but with electronic glue-curing. Production loss due to high humidity and slow-drying is no longer a factor. Production savings due to the installation of r-f heating for assembly gluing paid for the electronic equipment in nine months.

In the manufacture of television and other types of cabinets, stray-field heating has proved particularly useful for the quick curing of glues joining mounting blocks and other wood members to the inside of panels. The electrodes consist of straps at alternating positive and ground potential. The wood pieces are jigged on the wood members on the conveyor; glue is next applied, and cabinet panels are placed on top of the pieces just before the subassemblies are pushed through the press for setting of the glue. This setup is suited to in-line production and an endless conveyor belt system. The heat cycle of one installation with a 10-kilowatt output electronic heater is about 15 seconds, the actual total 8-hour production being in excess of 1,000 panel sides. Labor costs at a plant having six electronic installations of this type average 9 cents per panel less than with older methods involving clamps, for an annual saving of about $20,000 a year.

Progressive Hoosier Cabinet Co. is another woodworking manufacturer who has experienced manpower, floor area and material cost savings in the gluing and curing of panel-to-frame television cabinet assemblies with electronic bonding equipment. One girl simply applies glue to frame members, loads the machine with two panels at a time and pushes a button. After the 50-second heating cycle another girl removes bonded cabinet subassemblies completely cured, ready for machining. Output averages 80 panels per hour.

Boxcar Walls

Massive subassembly work is also being done with dielectric heating as a production tool. A plywood freight car, stronger and lighter than conventional cars, has been made possible by electronic curing of glued joints. Pressed Steel Car Company preassembles the boxcar sides, and top and floor panels, as complete units. Each assembly is then moved into an r-f heating press which cures the glued joints. This new technique permits fast production of freight cars built sturdily for rough railroad service.

Forming Curved Surfaces

Glue-curing and forming operations for laminated clock cases, chair seats and backs, piano sections, sporting goods and other wood products are being done by through heating with 13.6-mc r-f energy. Units with outputs of 2 kw and 10 kw are in operation at The Seth Thomas Clock Co. and The American Furniture Co., respectively. Generally a pair of dies existing from previously used methods is faced with sheet brass electrodes, these dies and installed electronic equipment being capable of handling production requirements. Considerable cost savings over previous slow glue-curing methods requiring a large number of dies are achieved by these more advanced production systems.

Improvement in Quality

With electronic glue-curing, radical changes in moisture content of the lumber and pockets of resin must be watched, because arcing and open glue lines will result. An electronic edge-gluing machine is considered not only an instrument for more efficient production but also an electromechanical inspector for controlling quality.[6] With an electronic edge gluer, lumber that has more than 4 or 5 percent moisture differential to the panel itself will be rejected, because the generator will refuse to glue it, the machine having been set for a certain cycle for properly dried stock. Lumber of mixed species, mixed densities, low temperature, excessive thickness variations and poor jointing will be revealed by unglued joints.

High-frequency heating provides increased production and lower labor costs, particularly where production volume justifies the setting up of special jigs to glue specific joints or formed plywood. The production cost of fabricating waterfall bends on beds (shown in Fig. 2) was cut 40 percent by using r-f to set the glue in a routed joint after the bend was formed with pressure. A table-model television cabinet is being assembled in a jig and completely bonded in 2½ minutes, where the old method required 4 hours drying in clamps while piled in a heated room.

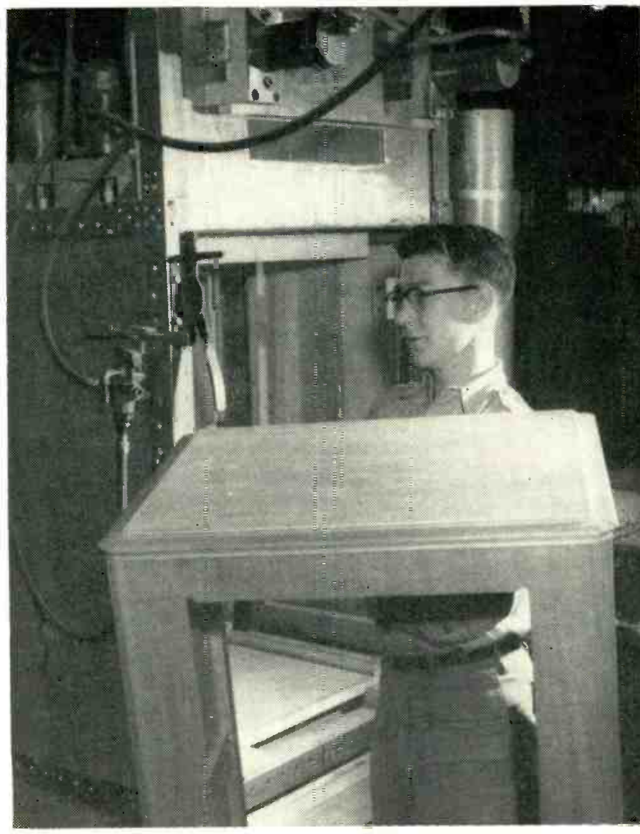
With r-f, the production of plywood drum-type gasoline tanks for the armed services jumped 25 percent, the labor cost dropped 20 percent, the quality was improved and the tooling cost was only 50 percent of the cost estimated for the old method. Mass production of bent plywood furniture has been made possible with the use of high-frequency heating. In one quick operation the veneers are formed into simple or compound curves and the adhesive set to hold the form required.

In the mounting of plywood onto frames for the manufacture of case tops and furniture, r-f stray-field heating of glued joints has eliminated nailing and filling the nail holes, with 50 percent reduction in the labor costs involved. These few examples indicate the contribution of r-f heating toward quality and reduced costs of many wood products.

R-F Drying of Lumber

Another advance by the woodworking industry has been its application of dielectric heating to the drying of hardwood lumber to a desired moisture content.[7] The 65-year-old plant of G. F. Mooney and Son, Inc. cures green-state white birch to be used in the handles of household and industrial tools in 12 to 15 hours by dielec-

CURVES—Forming and glue-curing laminated cases for clocks with Westinghouse equipment. Glue is automatically applied to individual laminations by roller of machine in foreground



JOINTS—Air-operated press and Westinghouse high-frequency generator equipment for setting glue in joints of entire television receiver console cabinet in one two-minute operation

tric heating, compared to 12 to 36 days in conventional dry kilns or four to six months by the open-air drying process. This new system has made possible year-round cutting and drying of lumber and has enabled the company to reduce its lumber inventory by 60 to 70 percent and still meet customer requirements. Further, quality is maintained, the dried wood being completely free of warping and checking.

Modernization of Factories

Dielectric heating equipments are not necessarily used only by those industrials whose equipments are all 100-percent up-to-date. There are plants in which the only modern production unit is an electronic heater. In one such plant, nearly all work is done by hand; piles of lumber, cabinets and materials are carried from one department to another on the heads of laborers.[8] Skilled craftsmen hand-fit all joints. Hand-carvings, hand-sanding and hand-rubbed finishes are the rule. Child labor is employed on jobs where much elbow-grease and little else is required. The apprentice system is in effect, and the foreman is not known as the foreman but is called the teacher. This factory is known as Industria Mueblera, S. A., in Mexico City.

Every gluing operation in this factory—from attaching the finest carved overlays to laminating large sheets of curved plywood—is done with industrial high-frequency dielectric heating equipment. Small subassemblies are glued together in a matter of seconds with a small portable unit containing a set of electrodes in a hand gun. Complete cabinet assemblies are placed in hydraulically operated box clamps where electrodes are arranged to assemble the whole cabinet in a one-shot operation.

This case may be somewhat extreme, but is an example of the acceptance of electronic equipment for heating dielectric materials, even where associated production techniques are obsolete by present standards.

These successful applications of dielectric heating are made possible by the cooperation among users, glue manufacturers, woodworking equipment makers, electronic equipment companies and industrial electron tube manufacturers. All deserve credit for analyzing the potential applications of dielectric heating as an industrial tool and developing materials, components and units to meet specific requirements. Particularly is this so in the electron-tube industry. Only with high-frequency tubes in the needed power levels, developed to give long life for economical service, could this advanced heating method have been made reliable and cost-saving for the woodworking industry.

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Reducing Distortion

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FREQUENCY-DIVISION multiplex is widely used in point-to-point communications to provide several independent voice channels on a single vhf or uhf carrier.

The simplest kind of frequency-division multiplex starts with a single voice channel that modulates an r-f oscillator called a subcarrier. The subcarrier in turn modulates the vhf or uhf transmitter. If another voice channel is desired, it is added by modulating a second subcarrier frequency. The subcarrier outputs are then combined to modulate the transmitter. More voice channels may be added as long as each modulates a different subcarrier frequency.

Intermodulation

If either the mixing network or the transmitter's f-m characteristic is nonlinear, certain intermodulation products are generated. The products generally produce beats and signal distortion. The beats may fall anywhere within the r-f spectrum including the receiver passband. If the beats falling within the passband are of sufficient amplitude, they may override or distort the desired signal information and render the entire subcarrier communications system unusable.

In one present-day system, all subcarriers fall within the 160 to 960-kc spectrum. If 12 channels are used, it is possible to space the channels so that no harmonics of any one carrier fall on top of another carrier. This arrangement does not, however, eliminate all possible beats that occur within the spectrum. The system also requires a wide spectrum for its 12 channels.

This paper discusses a method for analyzing beats or distortion terms in a frequency-division multiplex system with a view toward decreasing distortion while using the smallest possible spectrum. Expressions are derived for the second, third and fourth-order distortion terms and for the distortion due to these terms.

It is found that by limiting the applied peak-to-peak voltage regardless of the number of channels used, keeping individual channel voltages equal in magnitude and restricting the frequency spectrum to one octave, significant reductions occur in percentile distortion.

An operational 24-channel system appears in the photograph. Each of the cabinets contains six complete channels. At the top of each cabinet are stacked six terminal equipments with the six subcarrier receivers and transmitters below. Each cabinet's power supply is located at the bottom.

Experimental Results

Actual measurements made on this system indicate close agreement with theoretical calculations based upon the equations to be derived. The chart in Fig. 1 was plotted from actual measurements. The solid line represents the signal-to-noise output of a single channel operating alone. The dashed line represents the signal-to-noise output of the same channel when the 23 other subcarriers are turned on. The signal-to-noise ratio is reduced because of increased noise arising from intermodulation products or beats that fall within the passband of the receiver under observation.

The r-f input is merely the combined output of the subcarrier transmitters. It is applied to a video amplifier that modulates the uhf carrier.

The difference between the two curves in Fig. 1 measures the increase in noise due to beats. Taking this difference, the signal-to-intermodulation ratio may be obtained. This is plotted as the dashed line in Fig. 2. Close agreement between theory and practice may be seen by comparing this dashed line showing actual results with the solid line indicating the theoretical signal-to-intermodulation ratio derived using the equations to be discussed.

There will be no increase in intermodulation if all the subcarrier transmitters are now modulated by the voice-channel outputs. This is because a modulated f-m signal is a single vector that merely changes

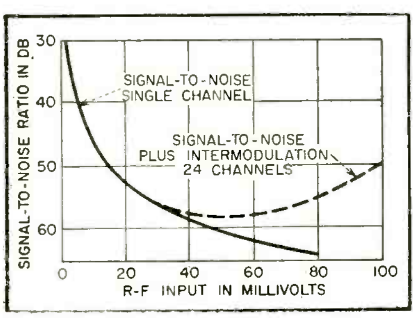


FIG. 1—Signal-to-noise ratio vs r-f voltage input. Dashed line shows noise increase with all channels operating

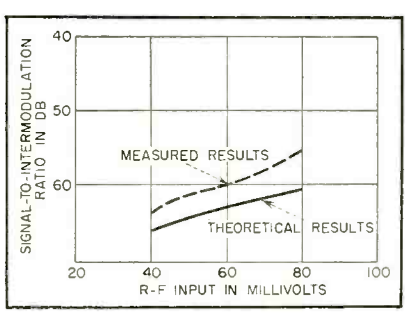


FIG. 2—Signal-to-intermodulation ratio versus r-f voltage input illustrates agreement of calculated and measured results

In Microwave Systems

Limiting applied peak-to-peak voltage, regardless of number of channels, and restricting frequency spectrum to one octave reduces percentile distortion in frequency-division multiplex systems. Expressions are derived for second, third and fourth-order terms and resulting distortion

phase with modulation. There is no variation in amplitude and no new carriers are introduced. However, it is possible for sideband splatter to occur if the subcarrier receivers are not selective enough to reject adjacent-channel signals.

Theoretical Analysis

The analysis is based upon computations of spurious frequencies and their magnitudes when multiple sinusoidal voltages are applied to the input of a nonlinear network. The nonlinear response may be expressed as a power series

$$i = a_1 e + a_2 e^2 + a_2 e^3 + \ldots \quad (1)$$

where i is the instantaneous network response, and e is the instantaneous value of the applied voltage. The coefficients a_1, a_2, a_3, etc are determined by the nature of the nonlinear network. We may define the percent distortion

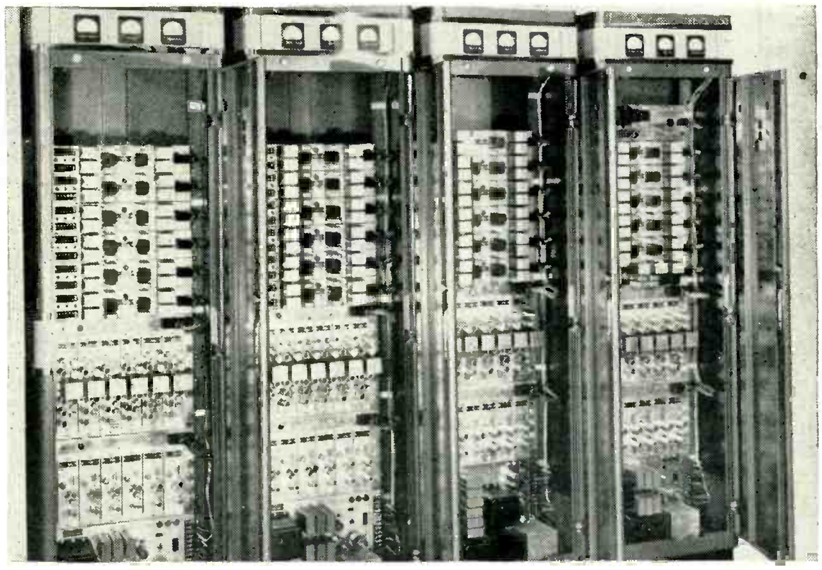
$$\% D = \frac{\text{sum of the squares of all spurious responses}}{\text{sum of the squares of all desired responses}} \times 100 \quad (2)$$

To simplify the computation, the desired responses will be assumed to be represented in the linear power-series term only, although it is appreciated that the odd-order terms of Eq. 1 will also yield an on-frequency response.

Since we are dealing with multiple sinusoidal voltages, the applied voltage may be represented as a summation of sine waves

$$e = \sum_{j=1}^{n} E_j \sin(\omega_j t) = E_1 \sin(\omega_1 t) + E_2 \sin(\omega_2 t) + E_3 \sin(\omega_3 t) + \ldots \quad (3)$$

Furthermore, it is considered desirable from the point of view of distortion to keep the maximum possible peak-to-peak applied voltage constant and independent of the number of channels n, as well as keeping the peak amplitudes of all the individual sine waves equal. These conditions are easily achieved in practice and are represented mathematically by



Complete 24-channel system. From top to bottom, each cabinet contains: six voice-channel terminal equipments, six subcarrier receivers and transmitters, and power supply

$$\sum_{j=1}^{n} E_j = E_1 + E_2 + E_3 + \ldots + E_n = E \text{ (a constant)} \quad (4A)$$

$$E_j = E/n \quad (4B)$$

All terms other than the linear term in Eq. 1 yield distortion products that may fall in our band of interest. Hence, we may break our problem into parts by investigating the effects of the second-, third- and fourth-order terms separately. For each order term it is necessary to determine if it falls within our receiver band and if it does we must find out how much distortion it will cause.

We may start the analysis by evaluating the second-order distortion. The evaluation of the effects of the second-, third- and fourth-order distorting network will be made in terms of the a coefficients of Eq. 1. How to evaluate these coefficients for any system will be shown later.

Second-Order Distortion

By limiting this analysis to the first two terms on the right-hand side of Eq. 1, we may write

$$i = a_1 \left(\sum_{j=1}^{n} \frac{E}{n} \sin(\omega_j t) \right) + a_2 \left(\sum_{j=1}^{n} \frac{E}{n} \sin(\omega_j t) \right)^2 \quad (5)$$

If the indicated operations are performed and all d-c terms are neglected, we obtain

$$i = a_1 \left(\frac{E}{n} \right) \sum_{j=1}^{n} S_j + a_2 \left(\frac{E}{n} \right)^2 \left(-\frac{1}{2} \sum_{j=1}^{n} S_{2j} + \sum_{j,k=1}^{n} S_{j-k} + \sum_{j,k=1}^{n} S_{j+k} \right) \quad (6)$$

where j does not equal k and the sin $(\omega_j t)$ terms have been replaced by the symbol S_j. Therefore, S_j represents sinusoidal waves of unit amplitude having a frequency $\omega_j/2\pi$. Furthermore, the sin $(\omega_j \pm \omega_k)t$ terms here have been replaced by $S_{j \pm k}$ respectively.

In the determination of the percent power distortion we only need to substitute the proper terms of Eq. 6 into Eq. 2. This operation will yield the following expression for the percent distortion D_2 due to a second-order distorting network

$$\% D_2 = \frac{a_2^2\left(\frac{E}{n}\right)^4\left(\frac{1}{4}\sum S^2_{2j} + \sum S^2_{j-k} + \sum S^2_{j+k}\right)}{a_1^2\left(\frac{E}{n}\right)^2 \sum S^2_j} \times 100 \qquad (7)$$

The limits on the summation signs have been dropped for convenience.

Table I—Number of Terms In Each Summation as a function of Number of Channels

Type of Term	Number of Such Terms as a Function of n
S_j, S_{2j}, S_{3j} etc	n
S_{j-k}, S_{j+k}	$\frac{n(n-1)}{2}$
S_{2j-k}, S_{2j+k}	$n(n-1)$
S_{j+k+l}, S_{j-k-l}	$\frac{n(n-1)(n-2)}{6}$
S_{j-k+l}	$\frac{(n-1)(n-2)}{3}$
S_{3j-k}	$n(n-1)$
$S_{2(j-k)}$	$\frac{n(n-1)}{2}$
S_{2j-k-l}	$\frac{n(n-1)(n-2)}{2}$
S_{2j+k-l}	$n(n-1)(n-2)$
$S_{j+k+l-m}$ $S_{j+k-l-m}$	$\frac{n(n-1)(n-2)(n-3)}{8}$
$S_{j-k-l-m}$	$\frac{n(n-1)(n-2)(n-3)}{24}$

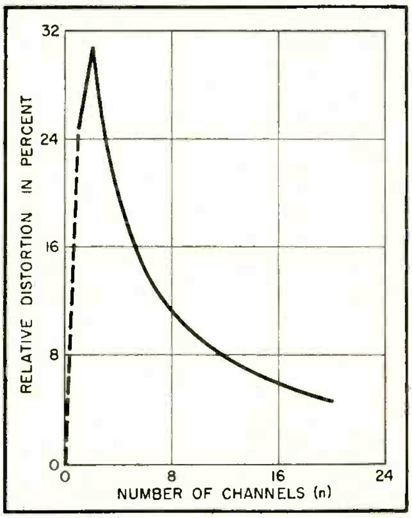


FIG. 3—Relative distortion versus number of channels for second-order terms

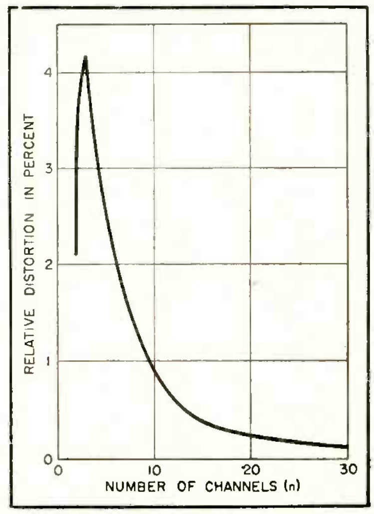


FIG. 4—Relative distortion versus number of channels for third-order terms

Because we are concerned with a steady-state analysis we will consider the time average over many cycles of the S_j^2 terms. The time average of all such terms is the numerical value $\frac{1}{2}$ and this factor occurs in all terms of the numerator and denominator in the same manner. It is, therefore, possible to factor this $\frac{1}{2}$ term and cancel it out of the equation. The problem, therefore, reduces to finding the number of terms in each summation as a function of the number of channels n.

It is readily found from Table I that the number of S_j and S_{2j} terms is n while the number of S_{j-k} and S_{j+k} terms are equal in number and equal to $n(n-1)/2$.

Using these relationships we may write the following equation for the percent of second-order distortion

$$\% D_2 = \left(\frac{a_2 E}{a_1}\right)^2 \left(\frac{1}{n^2}\right) \left[\frac{1}{4} + (n-1)\right] \times 100 \qquad (8)$$

A plot of $\% D_2/\left(\frac{a_2 E}{a_1}\right)^2$ is shown in Fig. 3. We see that when the peak-to-peak voltage is held constant, the total distortion decreases steadily as n increases beyond 3, and in fact, for large n the distortion is inversely proportional to n. This distortion results in d-c terms not computed, in double-frequency terms, and in sum-and-difference terms. If the multiplex system is contained within an octave, none of these terms is contained within the frequency range of interest.

Now that we have evaluated the effect of the second-order term, we may proceed by determining the effectiveness of the third-order term in causing distortion products within our receiver band.

Third-Order Distortion

Even though the multiplex system is contained within an octave, spurious components will lie within the band of interest if third-order distortion is present.

By use of Eq. 1, 3 and 4 we see that the current due to the cube term alone may be expressed as

$$i_3 = \frac{a_3 E^3}{n^3}\left(\sum S_j\right)^3 \qquad (9)$$

By trigonometric relationships i_3 may be expanded into

$$i_3 = \frac{a_3 E^3}{n^3}\left\{\frac{9}{4}\sum S_j + \frac{1}{4}\sum S_{3j} + \frac{3}{4}\sum S_{2j+k} + \frac{3}{4}\sum S_{2j-k} + \frac{3}{2}\left[\sum S_{j+k+l} + \sum S_{j-k-l} + \sum S_{j+k-l}\right]\right\} \qquad (10)$$

If as before we divide the sum of the squares of the distortion terms of Eq. 10 by the sum of the squares of all the desired responses, take the time average of all of these terms and determine the number of the various terms, we obtain for the percent power distortion

$$\% D_3 = \left(\frac{a_3}{a_1}\right)^2 \left(\frac{E}{n}\right)^4 \left[\frac{9}{16}(n-1)(2n-3)\right] \times 100 \qquad (10)$$

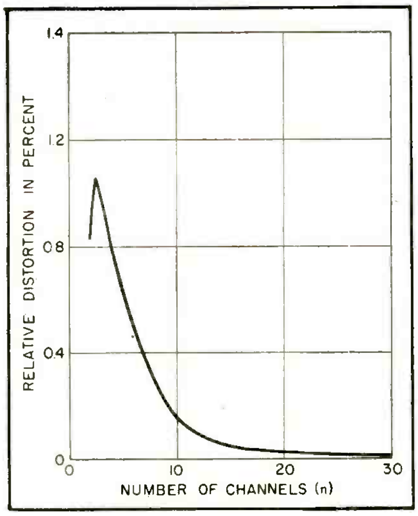


FIG. 5—Relative distortion versus number of channels for fourth-order terms

Evaluation of this distortion term was facilitated by the use of Table I which shows the number of individual terms that may be expected from a given type of sine-wave signal as a function of the total number of channels n.

A plot of $\%D_3 \left(\frac{a_3}{a_1}\right)^2 E^4$ as a function of n is given in Fig. 4.

In the foregoing analysis for $\%D_3$, all terms such as S_{2j-k}, S_{j-k-l} and S_{j-k+l} were included as causing distortion since they might fall within the receiver band. Considering an octave band we see that if the channels are all spaced equal distances apart and if the distance between channels is twice the distance from the extreme channels to the edge of the octave, then some of these terms will fall outside of the band of interest. In order to determine the relative number of such frequency components that do fall within an octave it is necessary to make a probability evaluation. This evaluation will be discussed in a later section.

To help understand why the relative $\%D_3$ drops off as fast as is evidenced in Fig. 4, the following table has been prepared for large n

	Voltage	Power Per Channel	Total Power
Fundamental Signal	$1/n$	$1/n^2$	$1/n$
$\%D_3$	$1/n^2$	$1/n^4$	$1/n^3$

If a completely analogous procedure is followed for the fourth-order distorting term, the expression for $\%D_4$ is

$$\% D_4 = \left(\frac{a_4}{a_1}\right)^2 \left(\frac{E}{n}\right)\left(\frac{n-1}{8}\right)$$
$$(21\, n^2 - 78\, n + 76.25) \times 100 \qquad (12)$$

Evaluation of this term involves the relations indicated in Table I.

A plot of $\%D_4 / \left(\frac{a_4}{a_1}\right)^2 E^6$ versus n is given in Fig. 5.

From a practical viewpoint we can readily see why distortion decreases with increasing n. From Eq. 4A we see that the total peak-to-peak voltage is constant. If one frequency is used, this maximum will be reached on every cycle, yielding distortion terms. If two frequencies are used, the probability that their maximum values will add in phase to yield this same maximum is much reduced. If n frequencies are used, the probability that they will ever add in phase to the maximum allowable value is very small. This means that the center portion, which is more linear, will be utilized more and more. The result is to decrease the distortion substantially because the nonlinear portion of the network is reached less and less.

The price of this decreasing distortion as channels are added is that each channel puts out less voltage or power; there will be some lower limit for the minimum usable carrier power per channel, based on a signal-to-noise analysis.

Furthermore, by containing the frequency range within one octave, we see that many frequency terms fall outside the band of interest, reducing the distortion. Figures 3, 4 and 5 show that the greatest reduction of distortion is realized when a large number of channels is utilized.

The table above shows that for large n the total distortion power decreases more rapidly than the total fundamental power by a factor of $1/n^2$, which explains in a qualitative way the reason for the reduction in the percentile distortion.

The above results would therefore indicate that for any nonlinear network, it is desirable to limit the maximum possible peak-to-peak applied voltage, to keep all the individual voltages equal in magnitude, and to limit the frequency spectrum to one octave if possible. Although Eq. 8, 11 and 12 yield the expected percent distortion due to the second-, third- and fourth-order terms respectively, they are of little value unless their various coefficients can be evaluated. The following section is therefore devoted to determining these coefficients. Due to the obvious importance of the third-order term, its coefficient will be evaluated first.

Evaluation of the Coefficients

The coefficients of any of our distorting networks may be evaluated

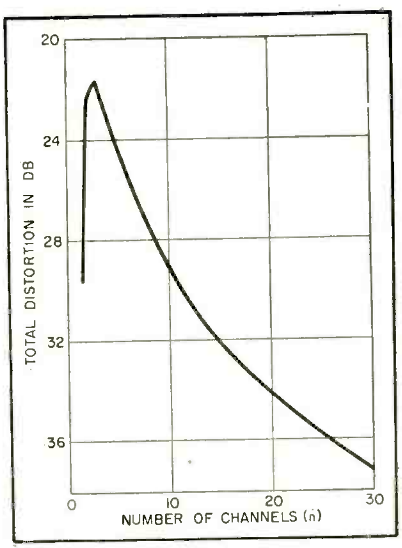


FIG. 6—Total distortion due to third-order terms

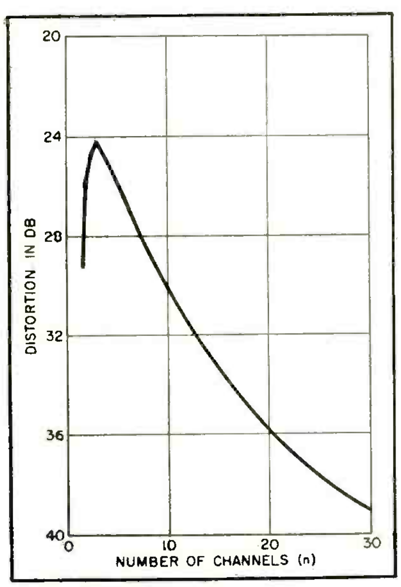


FIG. 7—Distortion falling within an octave and due to third-order terms

in a practical situation by putting a single sine-wave signal into the system and then analyzing the resultant output waveform. If we have a third-order distorting network and limit our band of interest to an octave it follows that an input of the form E (sin ωt) will yield

$$\text{Output} = a_1 E \sin \omega t + a_3 E^3 \sin^3 \omega t \quad (13)$$

If this term is expanded and the distortion terms selected, we may write

$$\text{Percent Third-Order Voltage Distortion} = \frac{a_3 E^3 (1/4) \sin (3\, \omega t)\, (100)}{a_1 E \sin (\omega\, t)} \quad (14)$$

If this distortion is measured as 10 percent, it follows that

$$\left(\frac{a_3}{a_1} E^2 \right)^2 = 0.16 \quad (15)$$

Equation 11 may therefore be written

$$\%\, D_3 = \frac{0.16}{n^4} \left[\frac{9}{16} (n-1)(2\,n-3) \right] \times 100 \quad (16)$$

This evaluation permits the existing curve shown on Fig. 4 to be evaluated directly in decibels. Figure 6 shows a plot of Eq. 16. We have, therefore, reduced the mathematics to a practical situation. The coefficients could have been evaluated for any percentage of system distortion.

Comparison of Networks

It has been shown that a single second-order distorting network has no distortion products that fall into an octave. However, if all of the output products of one second-order distorting network are fed into another second-order distorting network, the output of this second network will have distortion products that do fall into an octave. Insofar as one third-order distorting network produces products that do fall within the octave, the question arises, which produces more distortion components within the band of interest: two second-order distorting networks in cascade or one third-order distorting network, assuming that each network has the same percentage distortion.

The expression for the percent

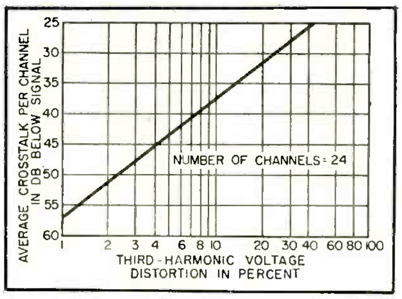


FIG. 8—Average crosstalk per channel versus third-harmonic voltage distortion

power distortion due to 10-percent third- order voltage distorting network that may lie within one octave has already been given by Eq. 16.

A similar derivation for two 10-percent second-harmonic voltage distorting networks in cascade yields

$$\%\, D_{22} = \frac{0.0064}{n^4} \left[\frac{9}{16} (n-1)(2n-3) \right] + \frac{0.000064}{n^6} \left[\frac{(n-1)(21n^2 - 78n + 76.25)}{8} \right] \quad (17)$$

The first term of Eq. 17 is seen to be identical to the right hand side of Eq. 16 except that it has a smaller coefficient. These coefficients are found to differ by 14 decibels.

The last term of Eq. 17 has a coefficient that is 40 db smaller than the right-hand term of Eq. 16. Also by inspection it can be seen that the last term of Eq. 17 decreases faster, with increasing n, than does Eq. 16. Hence this last term of Eq. 17 may be disregarded completely. For the conditions chosen, then, Eq. 17 is always substantially smaller than Eq. 16. This may be represented mathematically as $D_{22} << D_3$.

The conclusion therefore is that two second-order distorting networks in cascade, each having 10-percent voltage distortion, produce less on-frequency power distortion in one octave than one third-order distorting network having 10-percent voltage distortion. It can be shown that this is generally the case.

If only second-order distortion is known to exist in a system, then if one-octave filters are inserted after each second-order distorting network it should become impossible for any on-frequency distortion components to appear at the output of the system.

Probability

Equations 11 and 16 include all the terms having frequency terms of the kind S_{2j-k}, S_{j+k-l}, and S_{j-k-l}. The probability that all of the terms of the kind S_{2j-k} fall within an octave is $\frac{1}{2}$, while the probability that all the terms of the kind S_{j+k-l} and S_{j-k-l} fall within an octave is $\frac{3}{4}$. Using this information Eq. 16 becomes

$$D_3 = \frac{0.16}{n^4} \left\{ (n-1) \left[0.281 + 0.75\,(n-2) \right] \right\} \quad (18)$$

Equation 18 therefore represents a more accurate evaluation of the total power distortion that would be expected to fall within an octave if one were given a third-order distorting network with a 10-percent voltage distortion characteristic.

If Eq. 18 is written for any amount of third-order harmonic distortion it becomes

$$D_3 = \left(\frac{a_3}{a_1} \frac{E^2}{n^2} \right)^2 \left\{ (n-1) \left[0.281 + 0.75\,(n-2) \right] \right\} \quad (18\text{A})$$

A plot of Eq. 18 expressed in decibels is shown in Fig. 7. A plot of Eq. 18A versus percent third-harmonic voltage distortion is given in Fig. 8.

The theoretical signal-to-intermodulation ratio is obtained using Eq. 16 or Fig. 8. Taking the subcarrier bandwidth into account, these yield directly the theoretical signal-to-intermodulation ratio at the subcarrier receiver input. For comparison with experimental findings, this information is then converted to signal-to-intermodulation ratio at the subcarrier receiver output by use of standard formulas and is plotted in Fig. 2.

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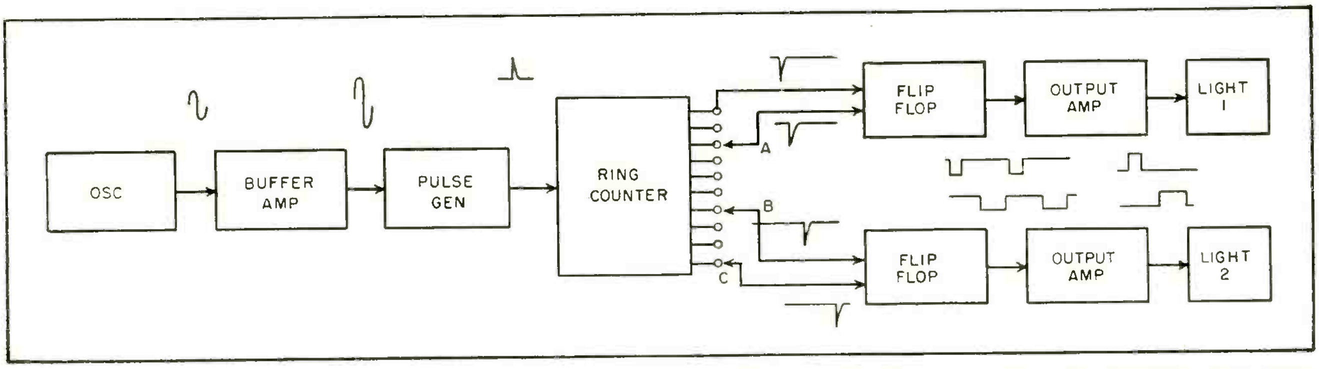

FIG. 1—Block diagram of binocular stimulator showing pulse lengths and phase relationships of signals in two separate output channels. Ring counter gives single negative pulses on successive output taps

Pulsed Light Measures Flicker Perception

Medical apparatus for diagnosis flashes light at rate of 4 to 60 pps and has variable on-off period ratio. Ring counter used to control frequency division, phase shift and pulse length is adaptable to other pulsing circuits

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An intermittent light stimulus with a repetition rate of 10 or 15 pulses per second is generally perceived as flickering. If the repetition rate is gradually increased beyond the critical flicker frequency (cff), the flicker will suddenly vanish and the light will appear completely steady.

Critical flicker frequencies may range from about 5 to 60 cycles depending in part on light characteristics such as color, brightness and on-off ratio. However, for given stimulus conditions the cff will vary from one individual to the next. Physicians, physiologists and psychologists are interested in discovering the reasons for these individual differences in the perception of intermittent light.

Electronic Modulation

In earlier studies intermittent light was produced by mechanically chopping light rays with sector disks or perforated cylinders. Flicker rate was changed by means of variable speed driving motors. Mechanical devices are generally cumbersome with relatively poor frequency stability. For this reason completely electronic instruments for producing the modulated light are becoming more popular.

The electronic device described here incorporates various improvements over previous instruments[1, 2, 3] of this type. A larger frequency range, a linearized calibration curve and the possibility of varying the on-off ratios and phase relationship of two separate high-intensity light sources make this a versatile and useful laboratory instrument. Although the apparatus was designed for a specialized application certain circuit features, especially the use of a ring-counter for phase shift and pulse-length control as well as frequency division, are of general interest.

The instrument has a precision dial covering a frequency range from 4 to 60 pps with vernier frequency adjustment. During calibration a tuning eye indicates synchronism of the internal oscillator with 60-cycle current.

For binocular stimulation two high-intensity glow-modulator tubes supply rectangular light pulses. A milliammeter is used for balancing the tube currents.

A control for varying the phase relationship between the two trains of light pulses makes it possible to change the phasing in 36-deg steps over a range of 360 deg. Two other switches control the relative lengths of the light pulses. On-off ratios such as 1-to-9, 2-to-8, 3-to-7 may be selected as desired. Both the phase relationships and the on-off ratios are maintained with a high degree of accuracy and are completely independent of frequency.

Basic Design

A block diagram of the apparatus is shown in Fig. 1. A master oscillator, with a frequency range of 40 to 600 cps, keys a thyratron pulse generator giving short positive pulses for triggering the decade ring counter. At the counter, the frequency of the master oscillator is divided by a factor of ten yielding a flicker frequency range of 4 to 60 pps.

Negative output pulses from any of the ten counter tubes may be chosen by means of three ten-position switches connected in parallel. The selected impulses trigger two separate flip-flop circuits used as rectangular wave generators. One triggering input of flip-flop 1 is permanently connected to the output terminal of the first counter tube. A negative pulse appearing on that terminal will flip the circuit on and a second impulse selected with switch *A* will turn it off. The block diagram shows switch *A* set to the third counter output position. In this case the on period of flip-flop 1 will be two counts (2/10 cycle) and the off period eight counts (8/10 cycle).

Flip-flop 2 is turned on with a negative impulse from switch *B*. The switch thus controls the phase relationship between the outputs of the two flip-flop circuits in 36-degree steps. With the switch set as shown in the block diagram, flip-flop 2 will be turned on five counts after flip-flop 1, and the two circuits will operate exactly 180 deg out of phase. The on-off ratio of flip-flop 2 is controlled by switch *C*. The same ring counter thus determines the relative pulse lengths and phase relationships of two separate wave trains.

The flip-flop circuits drive the power amplifiers that supply the necessary currents for the glow modulator tubes.

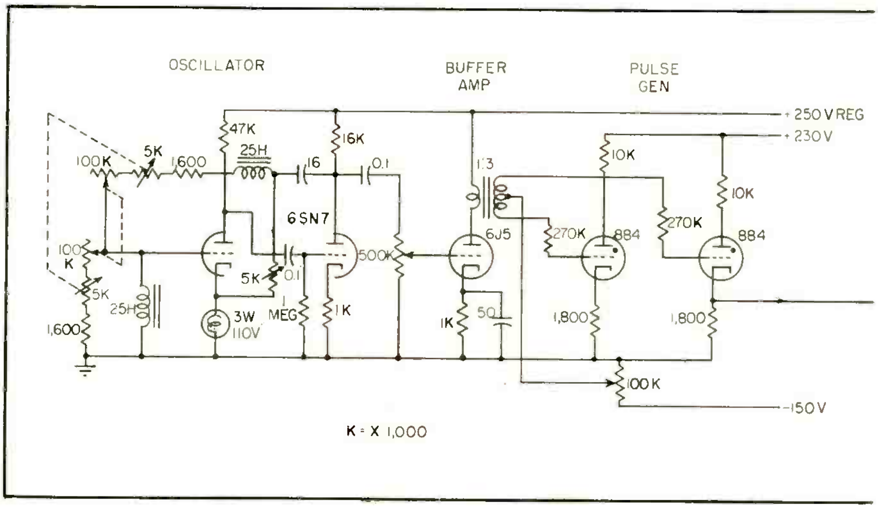
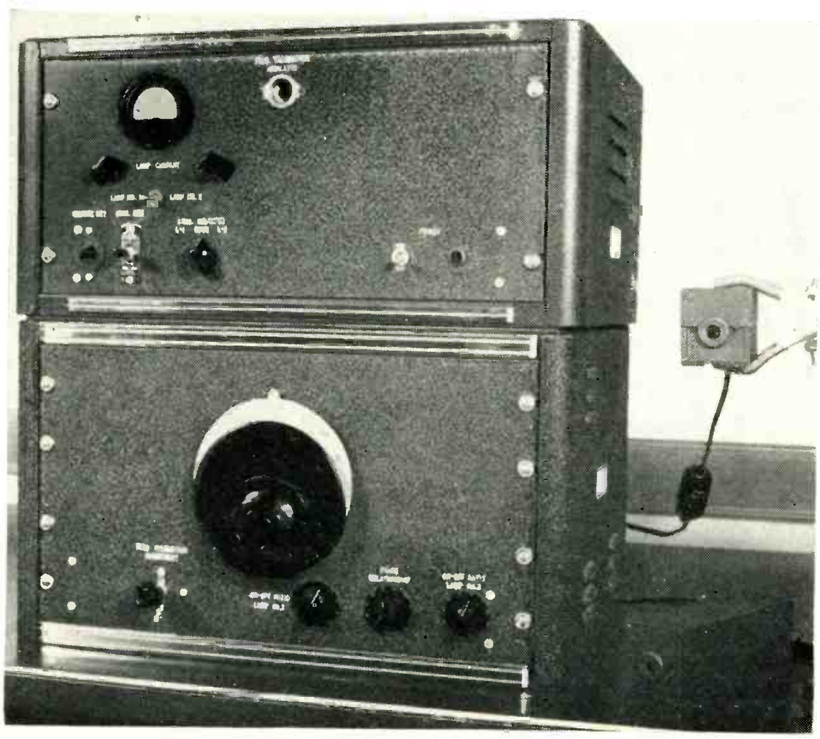


FIG. 2—Circuit diagram of visual testing apparatus. Only one output channel is shown

The circuit of the oscillator, buffer, and pulse generator is shown in Fig. 2. The oscillator consists of a Wien bridge type R-L coupled circuit. The R-L coupling is used in place of the usual R-C combination to achieve a linear relationship between frequency and shaft rotation of a linear potentiometer.

Greatly increased feedback at higher frequencies was not completely compensated for by the variable resistance characteristic of the Mazda lamp in the cathode circuit and higher frequencies are slightly compressed on the dial.



Binocular stimulator with light source shown at right

Special high-Q, low-frequency inductors are used in the tuned circuit. Even then, 40 cps represents about the lowest practical frequency for sustained oscillation. This is reduced by the decade ring counter to a lower limit of 4 cps.

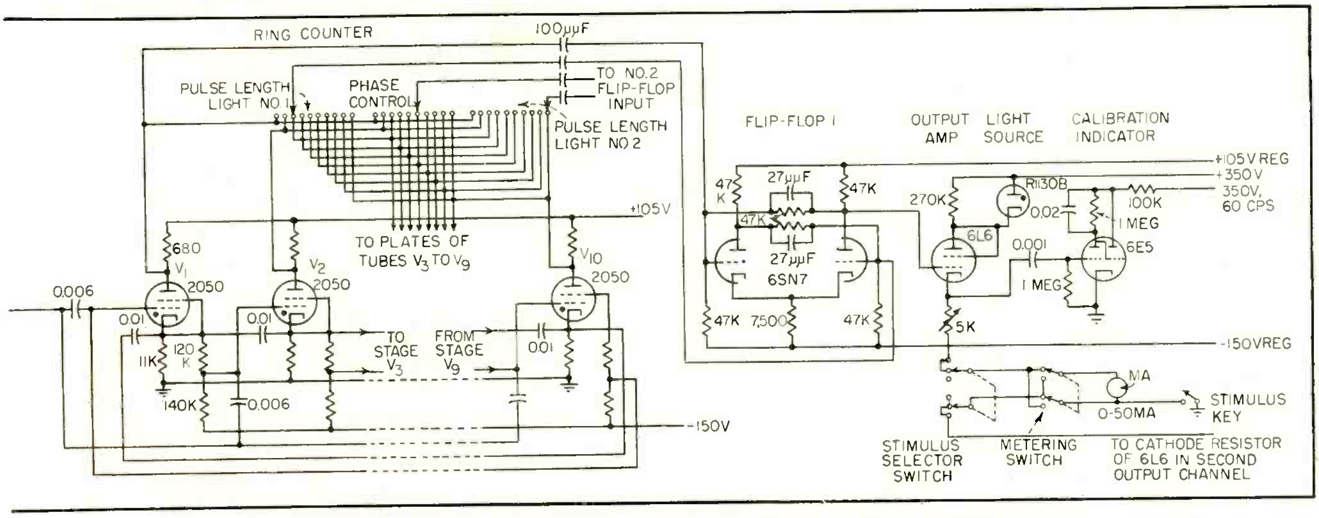
The frequency control consists of two 5-inch, 100,000-ohm potentiometers mounted on a common shaft. A smaller potentiometer is placed in series with each of the larger units for vernier calibration.

A buffer amplifier boosts and isolates the oscillator output and supplies the push-pull voltages for driving the thyratron pulse generator.

The pulse generator consists of two 844 thyratrons in a plate-coupled parallel switching circuit. This circuit provides a simple method of obtaining steep triggering pulses for the ring counter. Positive pulses appear across the cathode load of one thyratron and are differentiated by the grid circuits of the counter. The repetition rate of the pulse generator is determined by the frequency of the master oscillator.

Ring Counter

The ring counter is used for frequency division as well as for pulse length and phase control. Thyratrons can handle the relatively low pulse repetition rates of this instrument but a vacuum tube ring counter would be necessary for high frequencies. The thyra-



Second channel is similar to first except that calibration indicator is left out

tron circuit[5] has the advantage of requiring somewhat fewer parts than a comparable v-t circuit.

Positive triggering pulses are applied simultaneously to the grids of all counter tubes. With none of the thyratrons conducting, the trigger pulses are of insufficient amplitude to override the high negative bias on all grids and the circuit remains at rest.

A motor-driven timer is used momentarily to ground the grid of tube V_1 about 20 seconds after the set is turned on. The positive voltage now on the cathode of V_1 will reduce the negative bias of the second tube V_2 to a point just slightly below firing level. The next positive trigger on the grids will fire V_2. Through the coupling capacitor the cathode voltage of V_2 is momentarily added to the cathode voltage of the first tube driving it positive with respect to the plate and extinguishing the tube. The cathode voltage of V_2, now in a conducting state, also reduces the negative bias on V_3. The third tube is cocked and is ready to be fired by a subsequent triggering pulse.

Negative output pulses are obtained across the plate loads of successive counter tubes. Impulses to trigger the flip-flops at any count from 1 to 10 may be selected with the ten-position switches.

Flip-Flop Circuit

The negative triggering pulses selected by the ten-position switches on the ring counter are supplied to two separate output channels. Each channel consists of a flip-flop circuit, an output amplifier and a glow-modulator light source. One channel also incorporates a tuning eye calibration indicator.

To preserve the rectangular wave shape at frequencies as low as 4 cps the output of the flip-flop is direct-coupled to the 6L6 amplifier. Use of the ring counter made direct coupling in previous stages unnecessary, since the lowest frequency for the master oscillator, pulse generator and ring counter is 40 cps.

The 6L6 output tube has a variable cathode resistor for adjusting the current through the glow modulator. The unbypassed cathode resistor also provides negative feedback to the tube improving its response.

With the exception of the tuning eye circuit, the second output channel is identical with the first. It is supplied with negative triggers from two separate ten-position switches in the ring counter for phase shift and pulse-length control. A selector switch is provided in the cathode circuits of the 6L6's to energize either or both stimulus lights. Another switch in the common ground lead of the two 6L6 cathode circuits serves as stimulus key. To prevent interaction, the two output tubes have separate high voltage supplies.

The glow modulator tubes are mounted in two separate 2 by 2-inch slide files. The subject looks at the light through a hole drilled in the front. Wires for the tube pass through a second hole in the rear of the box. A lengthwise slot in the bottom of the container permits adjustment of the light. The grooved sidewalls hold a metal iris, ground-glass diffusing plates and neutral tint filters for intensity control. The containers are painted a flat black both inside and out. For binocular stimulation both light sources are inserted in a larger viewing box, while for monocular experiments a single light source is clamped to a laboratory stand.

Preliminary calibration tests indicate that frequency stability of the instrument is on the order of ± 0.1 cps. The output waveforms viewed on an oscilloscope appear perfectly rectangular for all frequencies, current values, on-off ratios and phase relationships.

The instrument described was designed for a study directed by Henry Misiak of Fordham University, and supported by a research grant (G-3704) from the National Institute of Neurological Disease and Blindness, of the National Institutes of Health, Public Health Service.

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Graphical Design of Tuning Elements

Procedure for preparing simple design chart from which combinations of coil turns and capacitance range can be found for tuning a given frequency range. Applies also to tuned lines. Simple measurements give required data for a family of curves, eliminating cut-and-try or calculation methods

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For parallel resonant circuits, the resonant frequencies of coils plotted against tuning capacitance on log-log paper are, within limits, parallel straight lines. A scale perpendicular to a family of such curves is proportional to the logarithm of the number of turns for any given winding length and diameter of coil. These simple relations form the basis for the graphical tuned-circuit design procedure presented here.

Transmission lines used as tuning elements may be plotted in the same manner as coils. The scale perpendicular to a family of coaxial or open-line curves is proportional to the logarithm of the line length for lines of the same impedance and proportional to the logarithm of the impedance for lines of the same length. As the slopes of both the coil and transmission line families of curves are the same, it is possible to determine accurately the transmission line or coil parameters for use together or separately as tuning elements when solving superheterodyne tracking and similar tuning problems.

An infinite number of special or general charts may be prepared from a relatively few measurements with simple equipment. A Q meter, a calibrated grid-dip meter or any other device capable of determining the resonant frequency of a tuned circuit may be used.

Coil Examples

Figure 1 illustrates a typical family of curves for coils 1 inch in diameter and 1½ inches long. Graphs for each individual coil of a given number of turns are constructed by drawing a straight line through two or more corresponding points on the graph. These points are located by determining the resonant frequencies of parallel circuits using the desired coils with known values of capacitance, as shown on the graph. The spacing between the graphs for individual coils is approximately proportional to the logarithm of the number of coil turns.

The information recorded in Fig. 1 is sufficient to determine the coil or capacitor requirements for any application requiring a coil with the dimensions given. For example, a 20-turn coil will tune from 4.7 to 11.5 mc with a total capacitance variation of 200 to 30 μμf. To tune an oscillator above this frequency in a superheterodyne receiver having 0.5-mc i-f (requiring oscillator tuning from 5.2 to 12 mc), the same coil could be used with a total capacitance variation of 165 to 27.5 μμf. The exact oscillator tuning

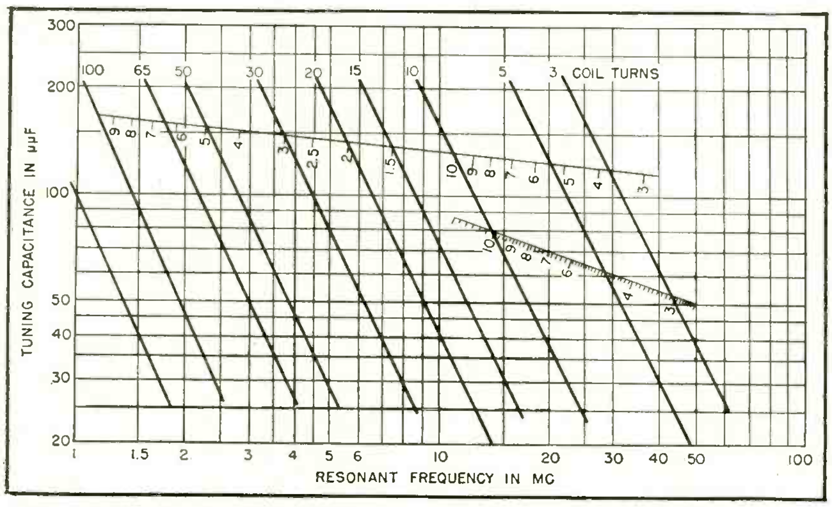
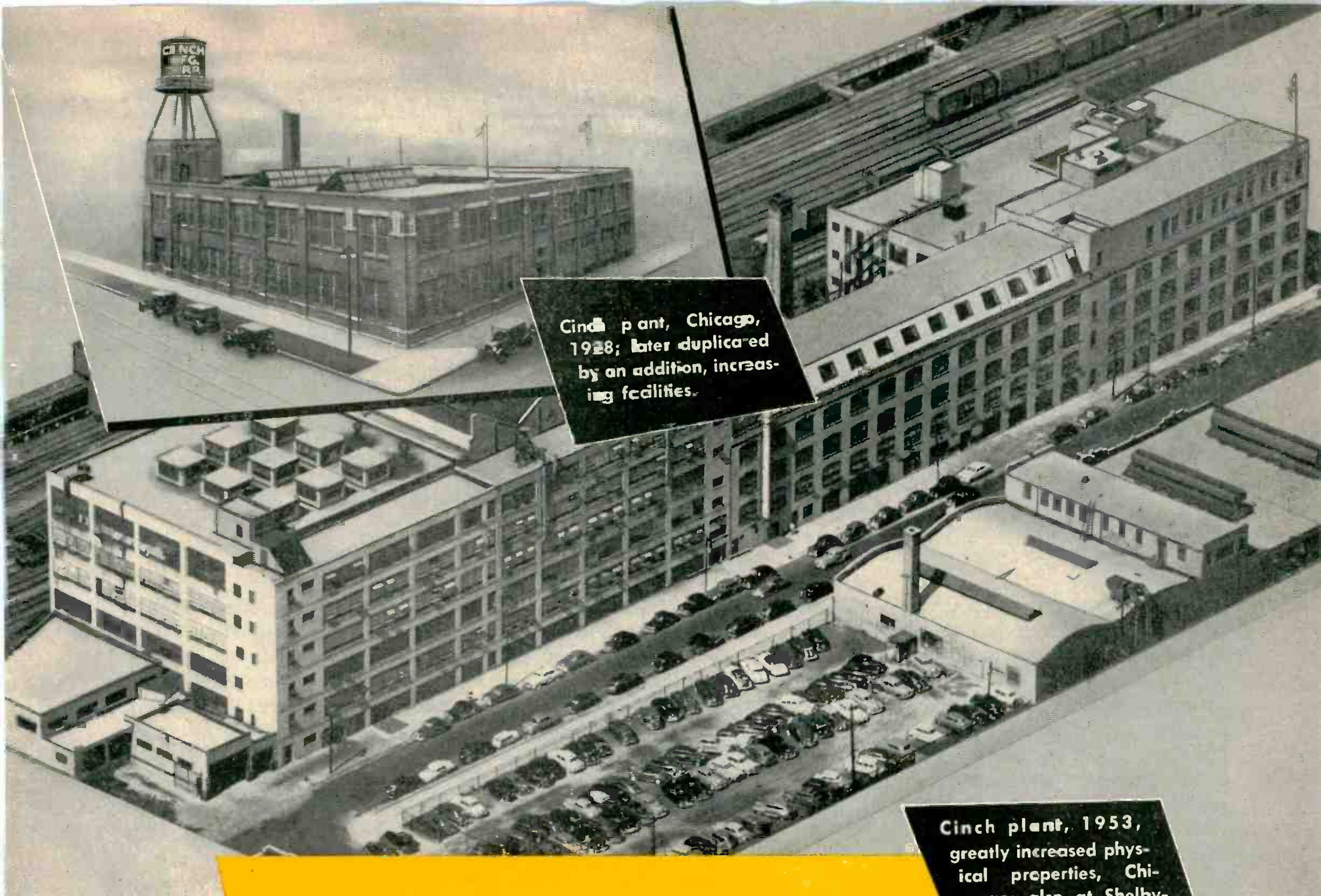


FIG. 1—Example of graphical design procedure for a coil 1 inch in diameter and 1½ inches long, with various numbers of turns spaced to fill entire length. Accuracy is excellent up to approximately 200 mc as method takes into account distributed capacitance and other sources of error usually neglected because of calculation difficulty. Charts for other coils can be prepared after a few simple measurements



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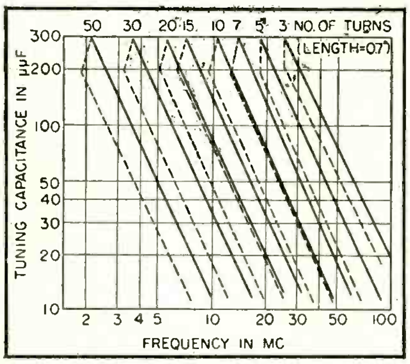

FIG. 2—Chart for National XR-50 coil form. Dotted lines indicate change obtained when using XR-50 iron slug. Copper slug gives shift in opposite direction from the solid lines

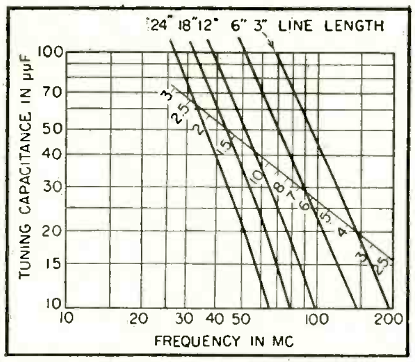

FIG. 3—Chart for shorted quarter-wave tuned parallel line having a characteristic impedance of 157 ohms. Diagonal overlay scale shows logarithmic spacing of curves

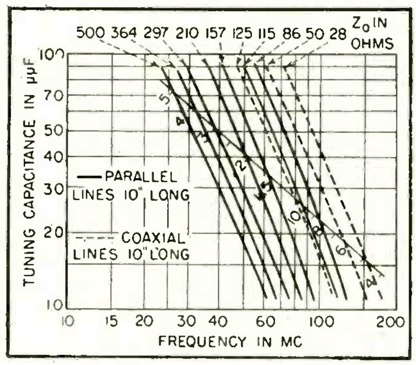

FIG. 4—Chart for 10-inch length of transmission line used as tuning element. Solid curves are for parallel lines; dotted curves are for coaxial lines of same length

capacitance required at each frequency may be determined from the chart, and the capacitor plate shapes to provide tracking may be accurately calculated.

Figure 1 shows that this same 20-turn coil will cover the 7-mc and 14-mc amateur bands with a 100-μμf variable tuning capacitor if the total distributed, tube and minimum capacitances are not greater than 17 μμf. A 50-μμf fixed capacitor and a paralleled 50-μμf variable capacitor used with this coil would prevent inadvertent tuning to the 14-mc band instead of the 7-mc band. Further, an 80-μμf capacitance (consisting of fixed, distributed and the minimum capacitance of the tuning capacitor) and an 8-μμf spread variable capacitor will permit bandspread of 7 to 7.3 mc over the full capacitor shaft rotation. Many other tuning problems may be solved similarly.

The slight slope change and bending of the individual coil plots as the frequency approaches the natural resonant frequency of the tuning element are due to the increased proportional effect of the distributed capacitance, coil leads and terminals, and other factors impossible to eliminate and difficult to calculate in practical coil problems. These factors are usually neglected on impedance charts, making the charts useless for practical applications requiring accurate construction of small inductances. Precise determination of coil parameters is obtained by limiting the use of a given chart to a 10-to-1 turns ratio when determining coil parameters from data taken with coils of a few turns. This effect is illustrated in Fig. 1 by the compression of the scale for coils of less than 10 turns where the above-mentioned factors are of appreciable comparative magnitude. The log scale from the graph paper is a convenient scale for use as an overlay on the chart.

Figure 2 shows a similar family of curves for a commonly used commercial coil form. The inductance variation made possible by positioning the slug is illustrated by the dashed lines.

Transmission-Line Examples

Figure 3 illustrates a typical family of curves for different lengths of a shorted quarter-wave tuned parallel line of 157 ohms characteristic impedance. This chart was prepared in the same manner as Fig. 1 and 2. The spacing between individual graphs is proportional to the logarithm of the line length. The stray and lead effects are more pronounced on this graph as they are a proportionally greater amount of the total inductance and capacitance for a practical tuner of this type, particularly as the frequency approaches the natural resonant frequency of the tuning element and the distributed capacitance approaches the tuning capacitance.

Figure 4 illustrates a typical family of curves for transmission lines 10 inches long with various impedances. The spacing between individual graphs is proportional to the logarithm of the characteristic impedance of the line. Connections and normally neglected factors become appreciable for extremely low-impedance lines, as evidenced by the apparent shrinking of the log scale for graphs of low impedances.

Coaxial lines (dotted lines on Fig. 4) may be plotted together with open lines (solid lines on Fig. 4). With a given capacitance variation available for tuning a line of given physical length, the tuning range (but not tuning ratio) varies considerably with impedance. With the selection of a low-impedance line the highest maximum frequency for a given minimum capacitance can be obtained.

Applications

Other similar charts may be rapidly prepared. From two or more experimentally plotted graphs of individual elements approximately within the desired range, a family of curves may be drawn to permit accurate selection of the desired tuning elements. Frequency doublers or power amplifiers may be accurately ganged by this system. As charts for progressively larger power coils or doubler coils all have the same slope, the choice of capacitors and inductors to gang and track becomes relatively elementary. This technique also applies to open or coaxial lines and permits the same techniques to be used on higher frequencies. Figure 3, for example, illustrates the tuning ranges of several lengths of 157-ohm line. From Fig. 4 the line impedance and loading capacitance may be determined for tuning a desired frequency with a 10-inch long line.

Why the Mallory UHF Tuner Should be Part of Your New TV Plans

The Mallory UHF Tuner can be the complete answer to your UHF tuning problems . . . whether you build converters, all-channel receivers, or both. It consists of three sections of variable inductance. It covers the range between 470 and 890 megacycles with approximately 2 mmf of shunt capacity. Selectivity is excellent over the entire band.

No matter how you decide to handle the problem of UHF reception, it will pay you to investigate the various possibilities offered by the Mallory UHF Tuner. One of the following combinations is the answer to your requirements . . .

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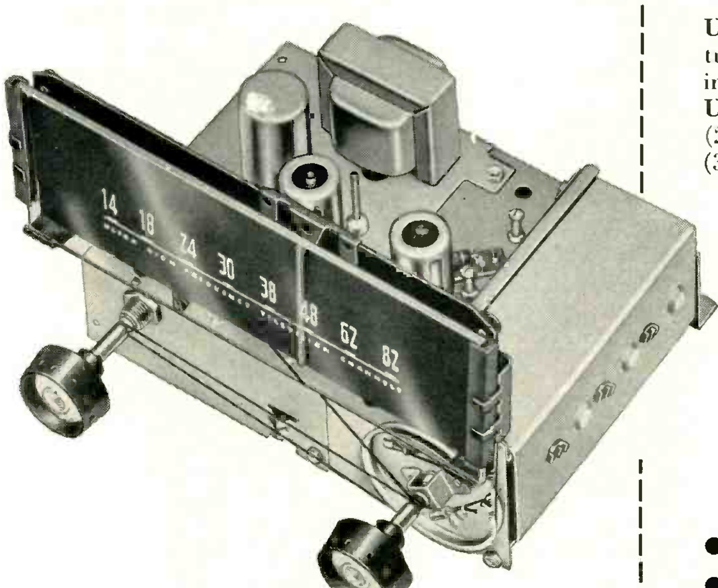

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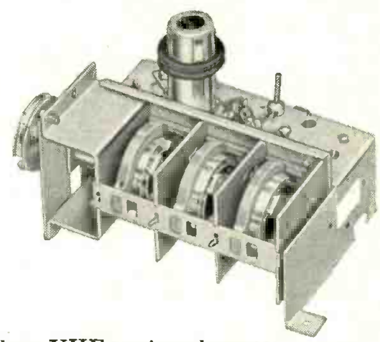
- Mallory UHF Converter chassis . . . ready to mount in your cabinet.
- Complete Mallory UHF Converter with your brand label.

FOR RECEIVERS . . .

UHF Tuners, for use in combination with VHF tuners, are available in 3 different designs . . . each in 3 different stages of assembly: (1) To convert UHF signals to 82 megacycles on channels 5 or 6. (2) To convert UHF signals to 130 megacycles. (3) For operation into a 41 megacycle IF amplifier.



- Mallory UHF tuning element.
- Mallory RF assemblies. This includes the tuner, oscillator, tube, crystal and associated circuitry.
- Mallory RF assemblies with an IF amplifier operating at conversion frequency.

Get in touch with us regarding the Mallory UHF Tuner. We will be glad to work with you . . . see how these various possibilities can be fitted into your plans for UHF television. Write today.

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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS featured in this issue:

Transistor Oscillator Circuit

By L. Fleming
Falls Church, Va.

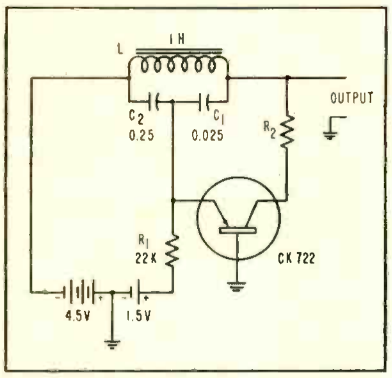


FIG. 1—Transistor oscillator suitable for fixed-frequency audio source, using two-terminal inductance

TRANSISTOR OSCILLATORS engineered for special applications have appeared in the literature,[1] but as yet few have been reported that require no specially-constructed components and give stability comparable to that of conventional tube circuits. In this early stage of the art, specific transistor circuits are of value in clarifying the concepts learned in higher-level texts and papers. The circuit of Fig. 1 is presented with this in mind. In addition, it provides a fixed-frequency audio source of value in laboratory and testing instruments having waveform, stability, and tolerance to component and voltage changes as good as is found in similar simple tube circuits.

Figure 1 shows constants for a frequency of 1,000 cycles. Output is 3 volts with a high-Q inductor, internal impedance around 20,000 ohms. Battery drain is less than 50 microamperes. The transistor is the readily available CK722. Inductor L need have only two terminals—no taps or multiple windings. The oscillator is class C. In-phase feedback from collector to emitter is effected by two capacitors C_1, C_2, connected in a kind of Colpitts circuit. Optimum feedback ratio C_2/C_1 varies from 10 to 50, depending on the impedance and Q of the tuned circuit.

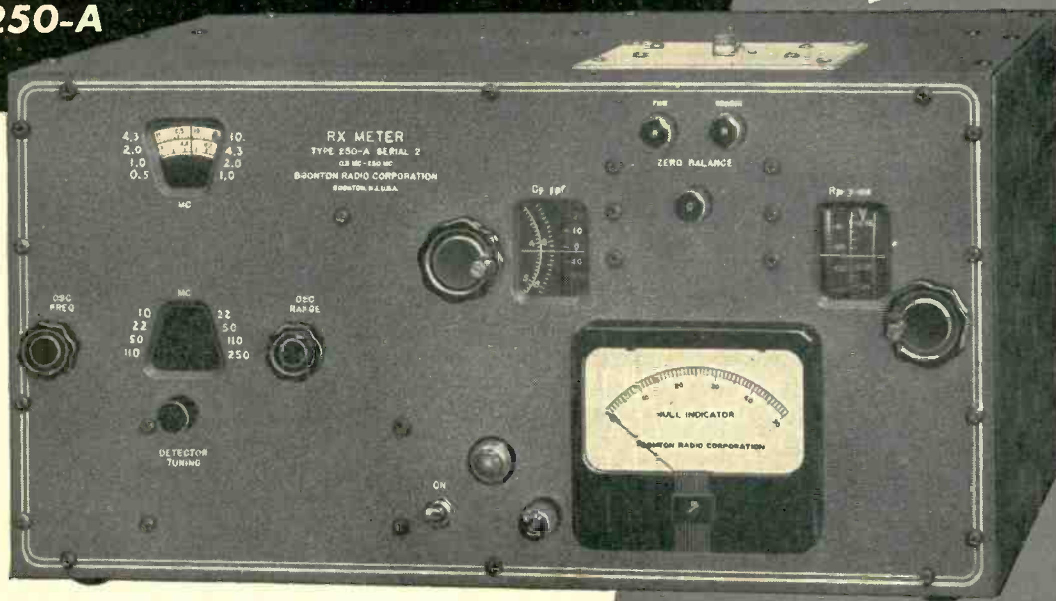
The effect of changing the ratio is evidenced principally in the waveform. Emitter resistor R_1 determines mainly the angle of conduction, hence the battery drain and the internal impedance; any value from 5,000 to 100,000 ohms will work. The purpose of resistor R_2 is to limit reverse collector-current flow during that part of the half-cycle when the collector is positive. Its value depends on the Q of the tuned circuit. With zero resistance at R_2, the positive peaks of the voltage wave have flat tops. Waveform improves rapidly as R_2 is increased

MOBILE PICKUP SPEEDS TELEFAX

Facsimile equipment connected to two-way radio circuit produces a telegram while the driver proceeds to point of delivery. Six cars being tested in Baltimore, Md. use special radio and conversion equipment shown at left. Facsimile machine to right of driver reproduces telegram transmitted from office

NEW RX METER......

TYPE 250-A



FREQUENCY RANGE: 0.5 mc to 250 mc

The 250-A RX Meter is a completely self-contained instrument for use in measuring the equivalent parallel resistance and capacitance or inductance of two terminal networks over a wide frequency range. It includes an accurate continuously tuned oscillator, high frequency bridge, "unbalance" detector and null indicator.

All variable components of the bridge are high quality capacitors, which are driven by carefully designed anti-backlash gear trains. The Capacitance indicating dial can be read to 0.05 mmf, and the Resistance indicating scale is expanded to cover 28 inches in length. No corrections are required over the frequency range for the Resistance readings.

USES

The 250-A RX Meter can be used to measure the equivalent parallel resistance and capacitance of resistors at high frequency. If the reactance is inductive the value can be determined. By very simple formulas the equivalent series parameters can be deduced. The instrument will also measure components which are primarily inductive or capacitive. The characteristic impedance, attenuation and velocity of propagation of transmission lines can be determined.

Specifications

FREQUENCY: 0.5 mc to 250 mc in eight ranges.
Rp RESISTANCE RANGE: 15 to 100,000 ohms.
Cp CAPACITANCE RANGE: +20 μμf to—100 μμf.*

*Capacitance range may be increased to ±120 μμf by use of external coils or condensers.

Price: $1250.00 F.O.B. Boonton, N. J.

FEATURES

- Measures equivalent parallel resistance and capacitance or inductance of two terminal networks.
- Operates over a Wide Frequency Range.
- Includes self-contained oscillator, bridge, detector and null indicator.
- Null Indicating Meter has automatic gain control which maintains on scale readings under all conditions to avoid meter damage and permit indication of proper direction of adjustment for reaching bridge balance.
- Wide spread resistance dial scale covering total of 28 inches.
- Power Supply internally regulated.

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to a thousand ohms or so, then more slowly. Oscillation stops at around 40,000 ohms.

A germanium diode can be substituted for the resistor R_2, its cathode poled toward the tuned-circuit terminal, to remove this reverse collector current. It was found however that the output wave contained small discontinuities at the points where the diode stopped conducting, an effect absent with the resistor. Since the resistor value is not critical, it seems the preferable element to use.

With laminated silicon-steel-core inductances, such as ordinary chokes, which typically have a Q of 6 at 1 kc, R_2 may not be necessary.

The upper frequency limit for this transistor in the circuit of Fig. 1 is generally about 50 kc (although there are instances of oscillation at 2 mc) and in multivibrator and similar circuits 20 to 30 kc. In the class-C circuit, the collector current rises as the upper frequency limit is approached, indicating an increase in the angle of flow.

While the oscillator will operate with any supply voltages over 1.5 v within the ratings of the transistor (lower voltages than 1.5 were not tried), the only advantage in increasing them is to raise the voltage or power output. A collector-to-emitter supply voltage ratio in the order of 3 to 1 appears to give the best waveform. In general, higher collector voltages will increase the voltage level but the angle of current flow will decrease. To obtain greater power output the current must be increased by raising the emitter source voltage or decreasing R_1.

REFERENCE

(1) D. E. Thomas, Low-Drain Transistor Audio Oscillator, *Proc IRE*, 40, p 1,385, Nov. 1952.

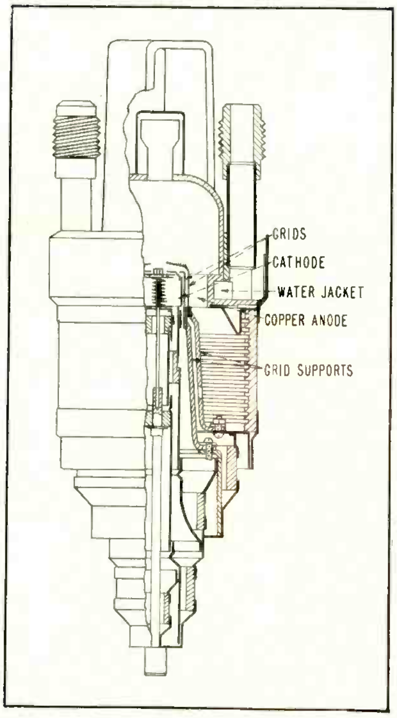

FIG. 2—Five-kw power output tetrode GL-6182

New UHF Transmitting Tubes

A 250-WATT POWER tetrode driver and a 5-kw power output tube for uhf transmitting applications have been announced by GE. Both tubes are designed for use as broadband amplifiers in class-B television service and as class-C amplifiers or oscillators in grounded-grid circuits with both grids at r-f ground potential.

The GL-6283 has a continuous rating of 150 watts at frequencies up to 900 mc, with a synchronized peak power gain of seven. Up to 900 mc the GL-6283 may be operated in a quarter-wave-output cavity. Above 900 mc, operation is in a three-quarter-wave mode.

As an r-f amplifier in class-B tv service, typical operating conditions with a six-mc bandwidth are: plate 1,500 v; screen, 300 v; plate current, 0.325 amp; driving power at tube, 35 watts; power output, 250 watts.

For typical operation as a class-C r-f power amplifier and oscillator in a grounded-grid circuit the plate voltage would be 1,400 v; screen voltage, 250 v; and plate current 0.230 amp. Driving power of 15 watts gives a power output of 150 watts.

The GL-6182 power tetrode is a water-cooled tube rated at 5 kw up to 900 mc, using quarter-wave cavity. Three-quarter-wave mode operation is possible at frequencies above 900 mc with reduced power output.

As a class-B r-f amplifier with a plate voltage of 8,000 v and screen voltage of 600 v, plate current is 1.3 amp, grid current 0.30 amp. Driven by 300 watts, power output is 5,000 watts with a six-mc bandwidth at 900 mc.

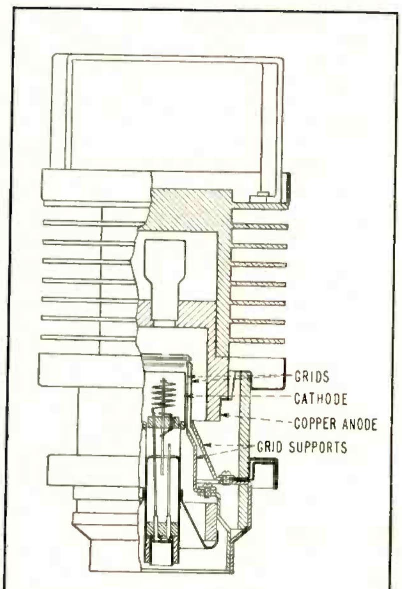

FIG. 1—Cut-away view of GL-6283, 250-watt uhf driver

New Magnet Materials

BISMANOL is the name applied to a manganese-bismuth alloy devised by U. S. Naval Ordnance Laboratories. The material is not new, having been described by F. Heusler in 1904 and again described in 1939 in British patent 596,966. It is again described in U. S. patent 2,576,679.

The material is manufactured by a reaction between molten bismuth and manganese produced in a slowly rotating stainless steel vessel covered by an inert atmosphere and maintained at a temperature of 1,300 F. When the reaction has been completed, the material is cooled and the excess bismuth squeezed out of the melt at approximately 25 tons per sq in.

The resulting mass of crystals of MnBi are then pulverized to under 325 mesh and compacted under a pressure of 6,000 to 10,000 pounds per sq in. together with a very strong magnetic field in the order of 10,000 oersteds or more.

In its present state of development, Bismanol has a residual flux

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The versatility of these three series of single turn, continuous rotation Helipots makes them ideal for such uses as servo systems . . . analog computers . . . pH indication and control . . . level indication and control . . . telemetering circuits . . . color analysis and control . . . navigation aids . . . radar indicators . . . laboratory instruments, and many more. Your particular requirements will determine the model . . . the number of ganged sections . . . the number and placement of tap connections . . . the style of mounting . . . and other characteristics best suited to your needs.

Every Helipot series is available in variations to meet your exact specifications. Our engineering department will gladly give you every assistance . . . in adapting standard Helipots to your particular requirements . . . in building entirely new Helipots to meet your needs.

Below is a Quick-Reference-Guide to the J, L, and Y Series Helipots. For complete information, write for Data File 602.

	Model Y Series	Model J Series	Model L Series
Diam.	(a) 1¾″	2″	3″
Resist. Range	50—50,000 ohms (b)	50—50,000 ohms (b)	50—100,000 ohms (b)
Power Rating	2.5 watts	4 watts	5 watts
Active Elec. Rotation	356° ±1°	357° ±1°	358° ±1°
Coil Length	4.6″	5″	8″
Mounting	Y—Threaded Bushing. YS—Servo Flange, Sleeve Bearing. YSP—Servo Flange, Ball Bearing. YF—Two-hole Servo, Sleeve Bearing. YFP—Two-hole Servo, Ball Bearing.	Threaded Bushing (Spec.). Servo Flange, Ball Bearing (Std.).	L—Threaded Bushing. LS—Servo Flange, Sleeve Bearing. LSP—Servo Flange, Ball Bearing.
Max. No. Ganged Sections (c)	14	8	8
Max. No. Tap Connections per Section (c)	17	21	33

(a) Model Y Series Helipots are available in both linear and non-linear versions.
(b) Higher or lower resistance values can be furnished on special order.
(c) Sections can be ganged and tap connections added, during manufacture.

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density of about 4,800 gauss, a coercive force of some 3,650 oersteds and a maximum energy product of 5.30 × 10^6 gauss-oersteds. This latter figure compares favorably with Alnico V, but the coercive force is much higher and the residual flux density is much lower than that of Alnico V. A shorter and fatter Bismanol magnet is therefore required to supplant an Alnico V magnet in any given design. The amount of magnet material utilized in both cases is about the same.

Pure crystals of MnBi contain 20.8 percent manganese and 79.2 percent bismuth. Besides a current market price of $2.25 a pound, in ton lots, the greatest obstacle to mass development of Bismanol is the fact that the entire world's annual production of bismuth is insufficient to supply even the total requirements of loudspeaker manufacturers in this alloy.

Another permanent magnet material with promise of immediate adoption is Ferroxdure. This ferrite, in the form $BaO \cdot 6\ Fe_2O_3$ may find immediate use for focusing television cathode-ray tubes.

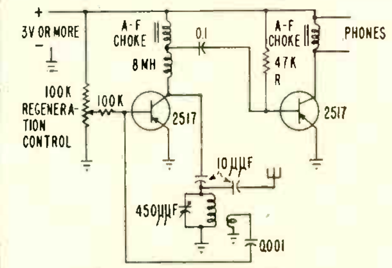
Although it has a residual flux density of only 2,000 gauss, a coercive force of 1,500 oersteds and a maximum energy product of 0.80 gauss-oersteds, the availability and low cost of its constituents combined with the high coercive force of the material makes it almost ideally suited to this television application.

The material is manufactured by intimately mixing fine powders of ferrous and barium oxide, presintering at a temperature about 1,800 F, pulverization and mixing with a binder and finally sintering at about 2,300 F. The material is developed by North American Philips Co., patent holders.

This information is contained in a private communication from Earl M. Underhill, Crucible Steel Co. of America, Harrison, N. J.

Transistor Broadcast Regenerator

By Peter G. Sulzer
Kensington, Md.



BROADCAST COIL - 15:1 TURNS RATIO

THE CIRCUIT of the receiver shown above is self-explanatory. It should be noted, however, that not all of the available type 2517 transistors will oscillate up to the top of the broadcast band.

Bias resistor *R* is subject to considerable variation and should be adjusted to produce about 0.5 ma collector current.

With a 7.5 v supply and the proper coil, the receiver will work up to 4 mc.

In the broadcast band, the sensitivity is such that about 0.5 microvolt 30-percent modulated will produce a readable output.

Broadcast Remote Control

UNATTENDED OPERATION of a-m and f-m broadcast transmitters of ten kilowatts and less power into nondirective antennas became legally possible by change of FCC rules effective April 15, 1953. System details of two manufacturers' equipment are shown below. Circuit details of another telemetering system are given on page 138 of this issue of ELECTRONICS.

Equipment available from the Rust Industrial Co., Inc. comprises two units, one at the broadcast studio and one at the transmitter. Two pairs of telephone wires are required for control and metering. These facilities are additional to audio lines.

Shawinigan Falls, P. Q. radio station CKSM is remotely controlled by this CGE equipment. Dial is located at studio. Transmitter engineer tests selector with pushbutton

Figure 1 indicates the system interconnections. Switch *S* initiates operation by supplying 12 v d-c to the control line. The LOWER switch in unit *B* increases the voltage to 25 v and the RAISE switch increases it to 50 v. Telephone dial *C* interrupts the control-line voltage by the number of impulses dialed and steps *D* to show the number by means of indicating lights.

Relays *F*, *G* and *H* bridged across the control line are voltage-selective. Relay *F* follows dial pulses on 12 volts and in turn operates *N*, which does not release during dial impulses. However, if control voltage fails for two seconds, relay *N*

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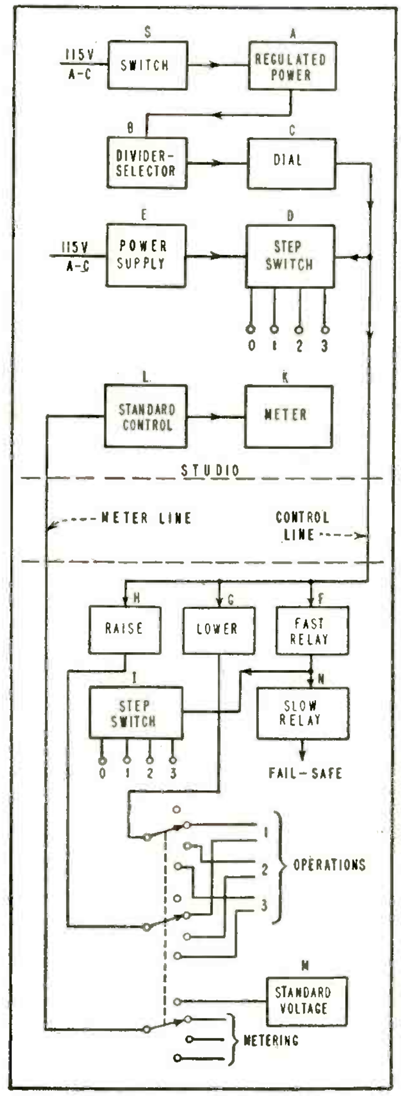


FIG. 1—Remote control provides for raising and lowering functions, as in tuning final stage

takes the transmitter off the air. Relay *G* operates on 25 volts but falls out above 12 v. Similarly *H* picks up at 50 v and falls out above 25 v.

Relay *F* operates stepping system *I*, which gives visual indication of the particular function chosen. Reversible motors and contactors connected into the individual channels are operated according to the studio engineer's instructions by means of the LOWER and RAISE switches. The stepping switch also connects to the metering line any one of nine different metering elements (of which three are indicated). All potentials or currents are converted to a low direct voltage proportional to the parameter being measured.

In stepping position 0 a standard voltage source *M* at the transmitter is connected to the metering line. Standardizing control *L* at the studio is then adjusted for a standard deflection in order to correct all readings for variation in line resistance owing to temperature changes.

Tone-Dial System

In a remote control system designed by Gates Radio Co., audible tones are used for switching and a dial-impulse stepping switch for selection of the function to be monitored.

This system shown in Fig. 2 requires two telephone pairs between studio and transmitter. One pair carries a voltage proportional to

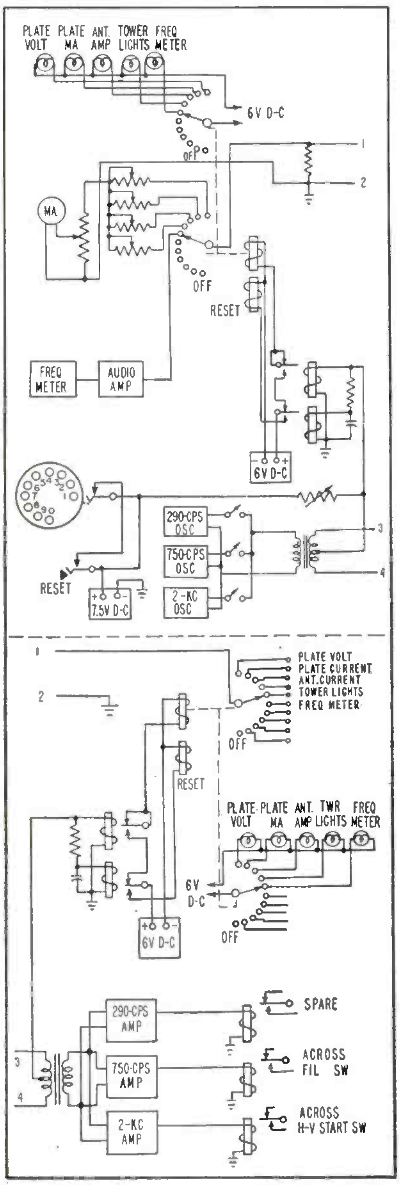


FIG. 2—Step control uses tones with stepping switch for monitoring

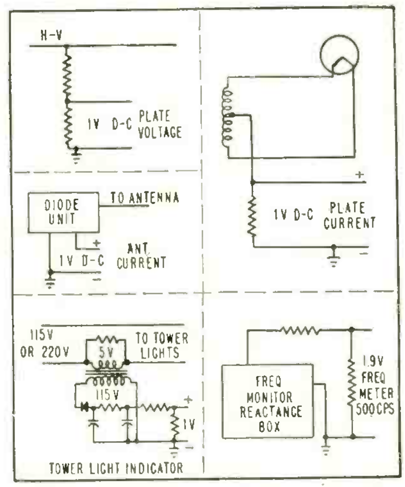


FIG. 3—Monitoring voltages are obtained in several ways

the voltage or current being monitored and this is shown on a meter at the studio. The other pair is bridged with a center-tapped hybrid coil. Audio tones are sent over the pair but dial impulses use, in effect, two sides of this line against ground.

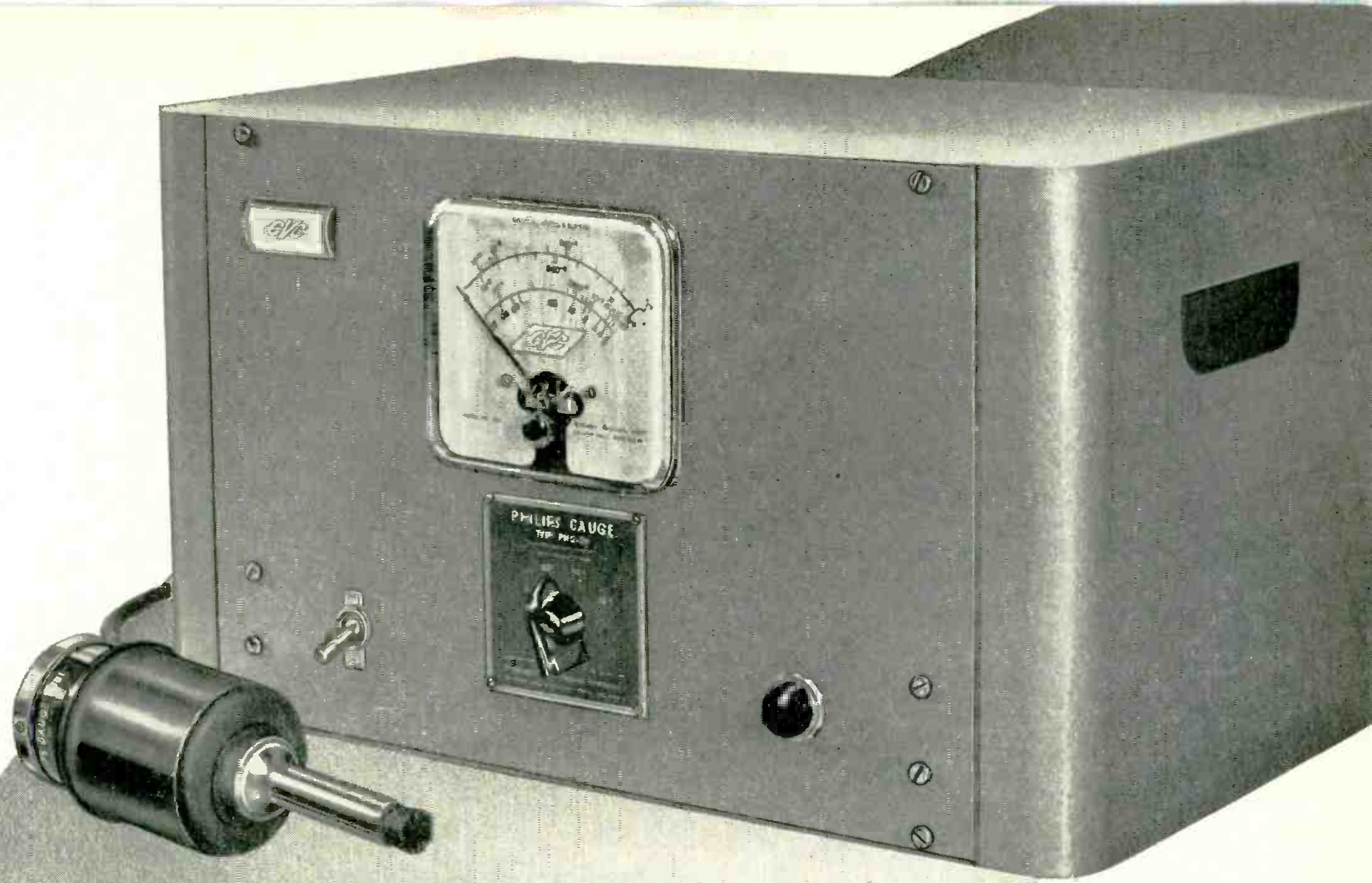
Various suggested means of obtaining monitoring voltages are shown in Fig. 3.—A. A. McK.

Power Requirements for Transistor Circuits

By J. Dalfonso

Chief Engineer
Battery Division
P. R. Mallory & Co., Inc.
North Tarrytown, N. Y.

Two basic questions relative to transistor power-sources concern present-day and future power requirements. The fact that transistor characteristics are essentially ideal implies that in class-A and class-B operation the theoretical limit of 50 percent in power efficiency may be realized in practice, and perhaps 100 percent efficiency can be approached in class-C amplification. Hence, in power applications these rule-of-thumb efficiency figures can be used to calculated the magnitude of the power required from the primary-power source. Further, because of the ideal shape of the characteristics, the rule may be applied in any power range from the micropower levels of present-day transistors to the probable large power-level operation of power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ELECTRONS AT WORK (continued)

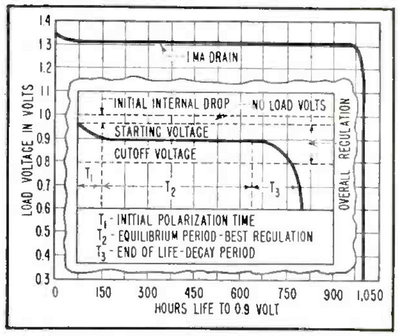


FIG. 1—RM cell load voltage vs time at constant load at 70 F. Inset, typical voltage regulation

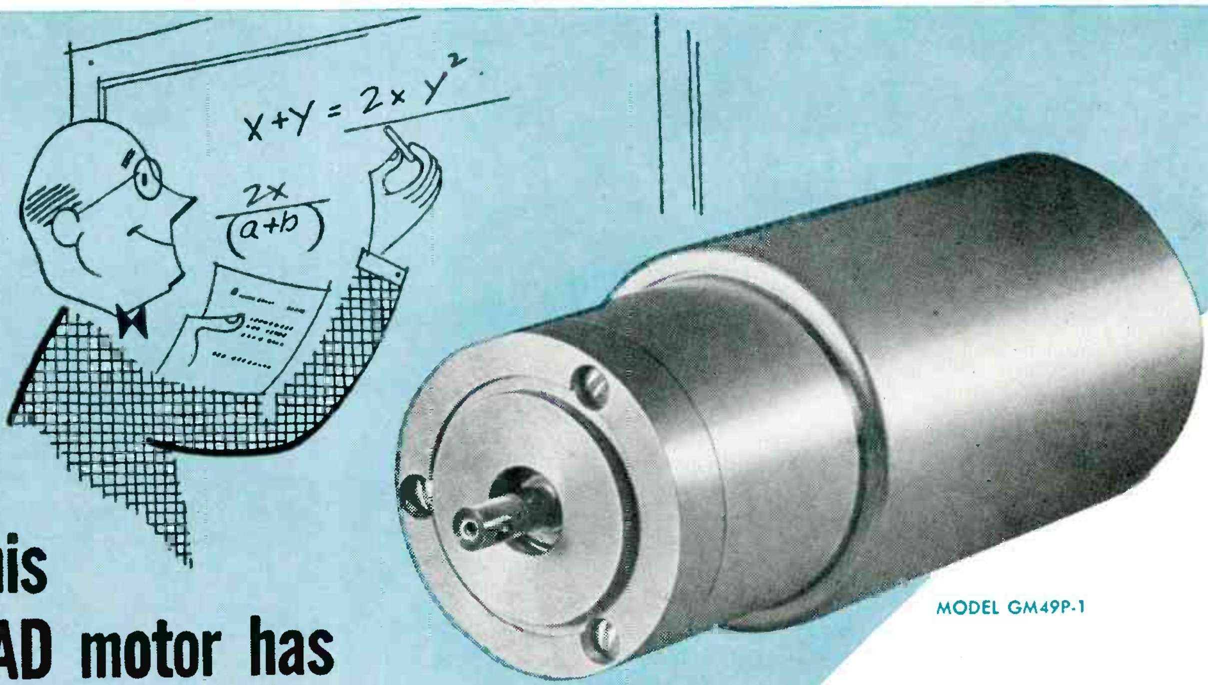
transistors to be produced in the future.

In addition to the actual quantity of primary power to be supplied by the power-supply source, there are three other important characteristics. Of primary interest is a requirement for uniformity of electrical characteristics: that is, constancy of voltage, or constancy of current, with respect to time. In a transistor, the collector sensitivity in respect to changes in emitter voltage is quite high, as has been mentioned by Wallace and Pietenpol and others. For this reason it is necessary frequently to provide the emitter-bias from a constant-current source, such as a high resistance in series with a constant-potential source.

Second and third items of importance in the power-supply are long life and small size, to match corresponding characteristics of transistors themselves.

If battery-powered, portable equipment is to become popular, it is necessary that the batteries have long operating life. It is necessary also that they be compact, lightweight, and of uniform electrical characteristics during their life, and that the dependence of voltage upon temperature be a practicable minimum. The shelf life should be lengthy, because there will be days and even months during which such equipment is not in use. The RM mercury-oxide cell fulfills these requirements.

The characteristics of transistors are such that in order to increase the power output (within the maximum rating) it is necessary only to increase the collector potential by providing additional source-



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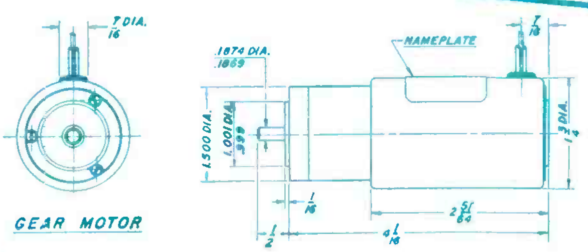

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400 Cycle Capacitor Run Induction Gear Motor

115 Volts • 400 Cycles • 1 Phase • 0.5 Amps.
Full Load Torque: 100 Oz.-In.
Starting Torque: Over 100 Oz.-In.
Gear Head Lubricated per Mil-G-3278
22 R.P.M. • 314 to 1 Gear Ratio • Reversible Rotation
Intermittent Duty: 15 Minutes on, 15 Minutes off

Ambient Temperature: −55° to +74° C

Altitude: to 50,000 Ft.

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- Automatic Controls
- Automatic Pilot
- Radar Equipment
- Electronic Control
- Actuators
- Timers

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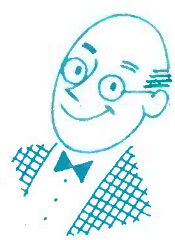

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voltage; and to increase the collector current, by adjustment of the emitter bias. Thus, normally, the transistor is biased and powered for the output desired, within its rating, using low values of collector current and collector voltage for low-power applications. The mercury-oxide cell has a constancy of voltage such that it may be used as a secondary standard for voltage. Thus many cells can be added in parallel and/or series to increase the power output for equipment to any desired level.

Transistor applications usually

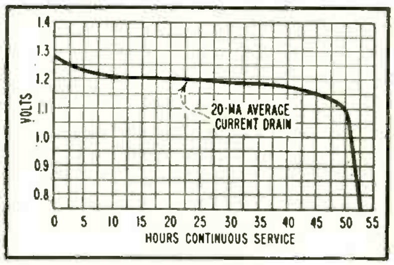

FIG. 2—Variation of potential with 20-ma drain of RM-1 cell

require a different arrangement of potentials on transistor control elements than those required by vacuum-tube elements. The base-emitter circuit of a transistor, which corresponds to the grid-cathode circuit of a vacuum tube, is usually low in impedance. Power is consumed in this circuit. The supply must be capable of supplying a bias current rather than a bias potential, as is usually supplied for a vacuum tube. This bias current may be opposite to, or in the same direction as, the collector current, depending on the type of transistor and the circuit connections.

Junction transistors belong to two major classes: the npn, in which conduction is primarily by diffusion of negative charges through the junction; and the pnp, in which conduction is primarily by diffusion of positive charges. This situation is similar to a hypothetical one that might exist in the vacuum-tube industry if we should discover a thermionic emitter of positrons. The obvious requirement in this situation is to establish the collector potential for the npn as positive

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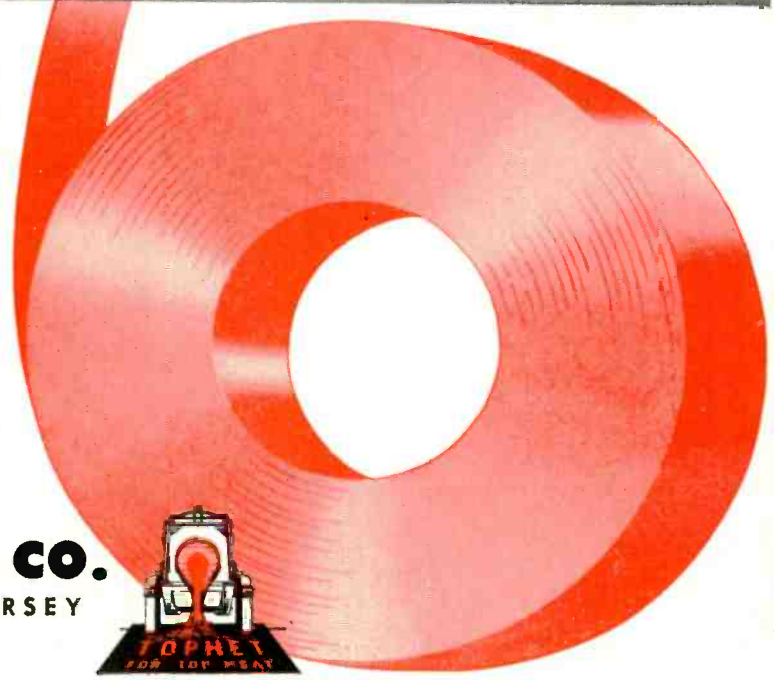

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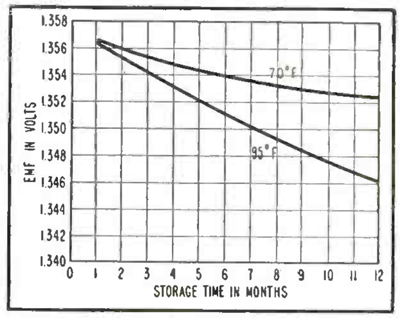

FIG. 3—EMF vs storage time at two temperatures

(normal in relation to vacuum tube practice), but that for the pnp as negative.

Figure 1 (inset) shows the general characteristics of the RM-cell system. The equilibrium period T_2 represents practically 97 percent of the cell life when the current drain is relatively low, as shown for a type RM-1 cell in Fig. 1. In the equilibrium period, the potential is constant (at 98 percent of no-load potential) within less than $\pm \frac{1}{2}$ percent at low levels of drain. At high levels of drain, the potential will vary by $\pm$ 2 percent from 90 percent of the no-load level, as shown in Fig. 2. The equilibrium period at this increased drain would be approximately 67 percent of the cell life.

Larger cells or groups of smaller cells in parallel, of course, show better equilibrium-period characteristics for equivalent rates of drain. Since current-drain per unit of electrode area determines the equilibrium period, potential may be kept as constant as desired for any predetermined equilibrium period by proper design.

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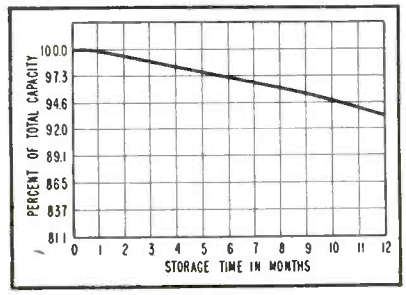

FIG. 4—Percent total capacity vs storage time at 70 F

0.07 cubic inch and weighing only 0.14 ounce, will provide approximately 250 hours of service life in a 1-ma transistor application.

The average transistor collector-voltage, in the majority of applications, will be below 10 volts and may be as low as 0.1 volt. Collector currents will be in the range of a few milliamperes down to several microamperes.

Type RM mercury batteries do not deteriorate or lose their energy appreciably during long

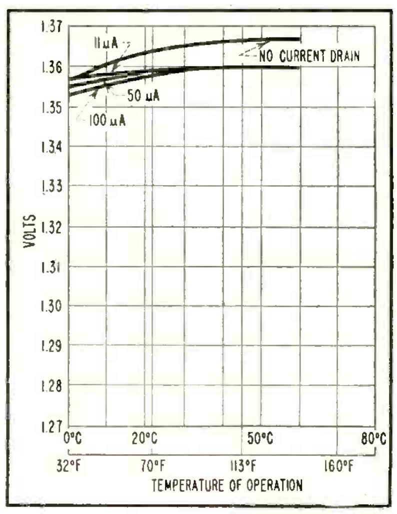

FIG. 5—EMF vs temperature at light loads

storage periods, as shown in Fig. 3 and 4. Field reports indicate such batteries perform satisfactorily even after two or more years of shelf life.

Mercury batteries maintain their dependable characteristics over a wide temperature range. Some subsurface survey instruments are operated at temperatures above 250 deg F. At the other extreme, dependable performance can be expected as low as 32 deg F in low current-drain applications as shown in Fig. 5.

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Noise Reduction in Intercom Systems

BY ROBERT J. STAHL
Color Television Inc.
San Carlos, Calif.
and
GLENN A. WALTERS
Dalmo Victor Co.
San Carlos, Calif.

OF FIRST IMPORTANCE in the elimination of noise in intercommunication systems is the design of the amplifiers. Circuit arrangements that allow audio signals to the speaker only when the system is in actual use will overcome many noise objections. Power supply and other circuits that are inherent sources of noise must be constructed in accordance with good engineering practices. However, from an economic standpoint, it is necessary that a minimum number of components be used.

Fortunately, the voice frequencies that must be transmitted over the intercom system are higher than the line frequency, so filter requirements of the supply are quite nominal. Amplifier components should be so chosen that a relatively large attenuation is presented at frequencies below 200 cps.

Assuming that the aforementioned principles are followed, there are still several considerations necessary to obtain satisfactory noise rejection. Transmission level will directly control the signal-to-noise ratio. All other factors being equal, a system that transmits the signal at a relatively high level is desirable as this keeps amplification required at the receiving end to a minimum, and amplification of line noises is kept to a minimum.

One means of obtaining a high transmission level is the use of a split-amplifier circuit, one section of which is shown in Fig. 1. Two identical circuits are used, one located at the control position and the other at the remote position of the system. In use, the function of each of these circuits is switched from preamplifier to power ampli-

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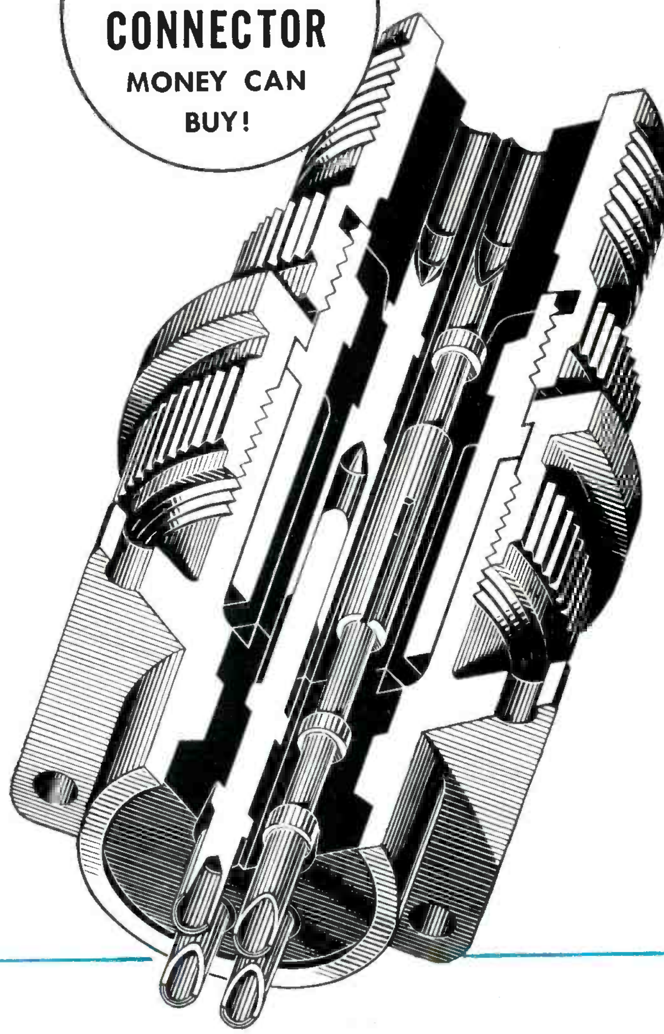

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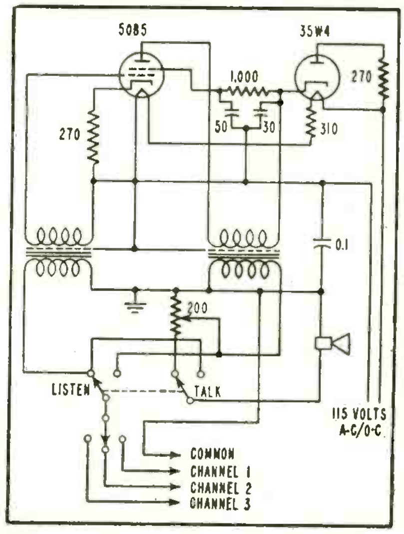


FIG. 1—Circuit of split-amplifier unit of a low-noise intercommunication system

fier depending upon the operator's requirements.

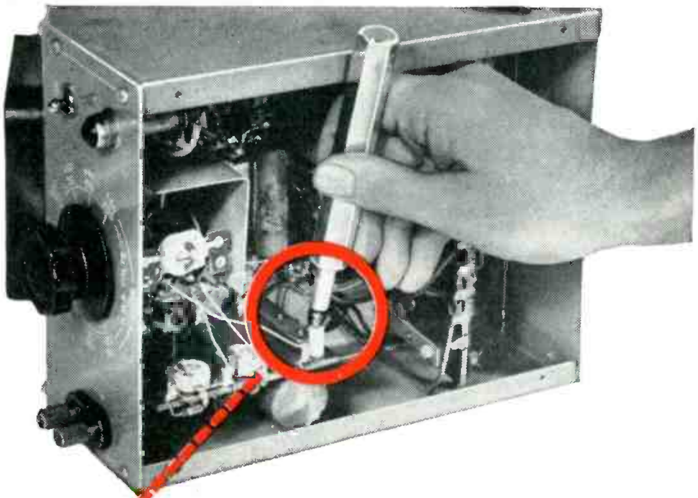
A single class-A stage is used with a type 50B5 pentode. Transformer coupling is used in both the input and output circuits. When the unit is in receive condition the stage is used as a power amplifier. The secondary of the output transformer is connected to the speaker while the input primary is connected to the audio line. In the transmit condition the speaker is switched to the input transformer of the 50B5, the secondary of the output transformer is connected to the audio line. The loudspeaker is then used as a microphone.

In this circuit the number of components is kept to minimum. All portions of the circuit are used in both transmit and receive condition, and the intelligence signal receives one stage of additional gain over that given to the external noise signal.

The system uses a 45-ohm interconnecting line and has a total gain of about 55 db. Hum output at full gain with signal terminals open circuited is less than 40 microwatts. Properly installed the units have average noise output that does not exceed 100 microwatts.

Interunit Circuits

The choice of line impedance will affect noise performance. High impedance favors capacitive pickup while low-impedance systems will be more susceptible to inductive



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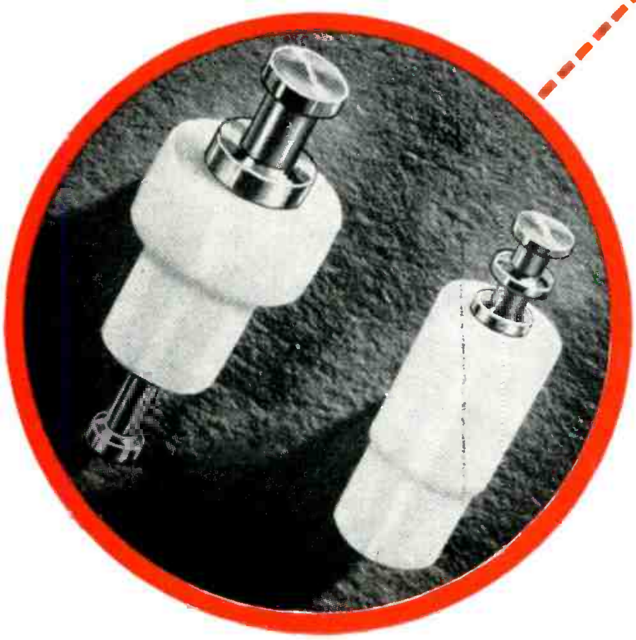

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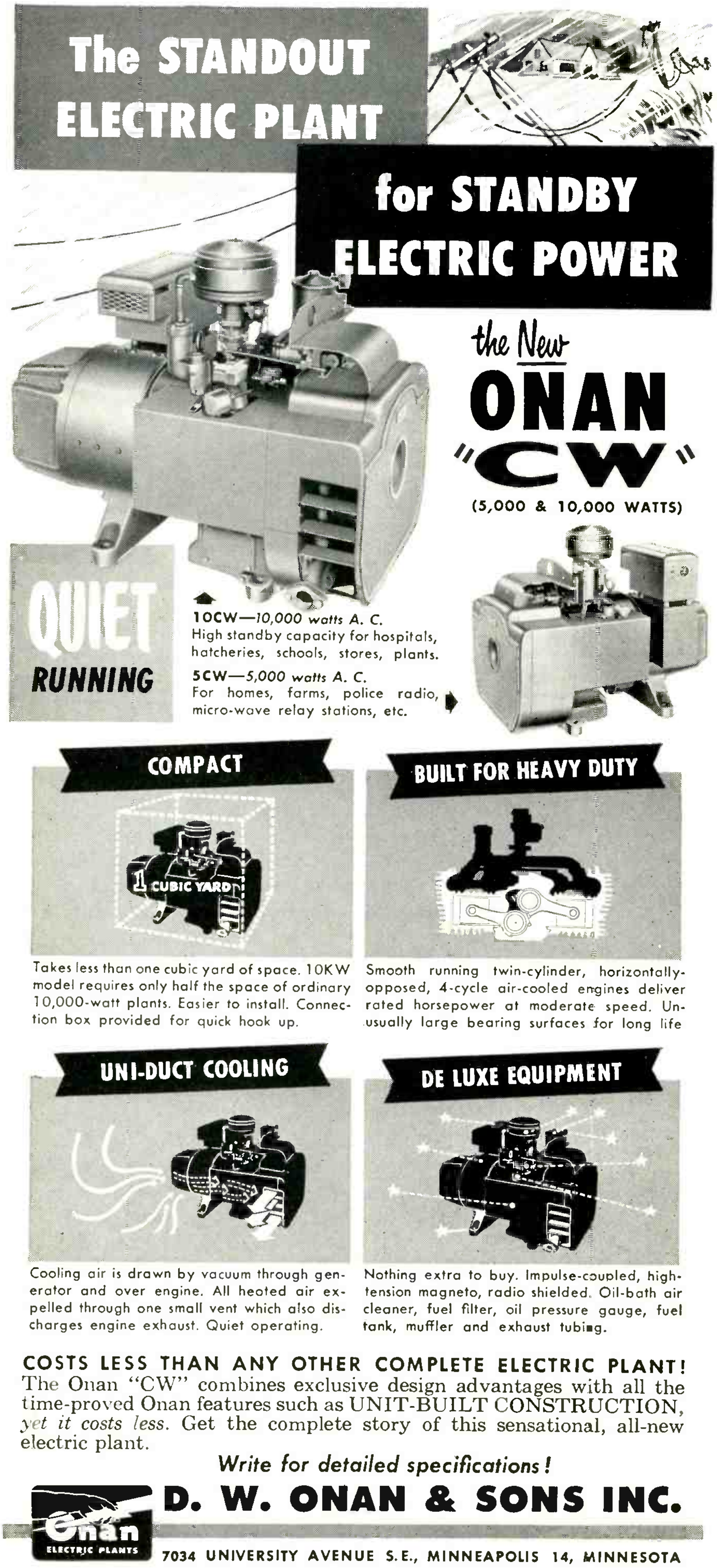


noise. From a practical standpoint, however, it will be found that ohmic losses fix the low-impedance limit. A good compromise appears to be about 45 ohms.

Noises introduced through ground routes will be less severe if a transformer type power supply is used but the increased cost is not justified in the average installation.

Ground Coupling Noises

The type of wiring used for the audio link between stations has a profound effect upon noise pick-up. The most common, and perhaps the most frequently misunderstood, noise source is introduced into the intercom system by means of ground coupling. The most prevalent cause for such noise is the voltage drop in building wiring caused by varying load currents.

Depending upon the character of the load devices and wiring adequacy, the voltage between ground and the low side of the line may contain high harmonics of the line frequency and miscellaneous noise potentials amounting to 10 volts or more peak amplitude. This voltage is applied directly to the B— lead of intercom a-c/d-c plate supplies. Since the earth ground connection does not have zero impedance, it is possible to have ground coupling to noise sources located in nearby buildings using a separate service and ground connection.

Referring to the input circuits shown in Fig. 2, it can be seen that the negative return of the plate supply is coupled to the audio line

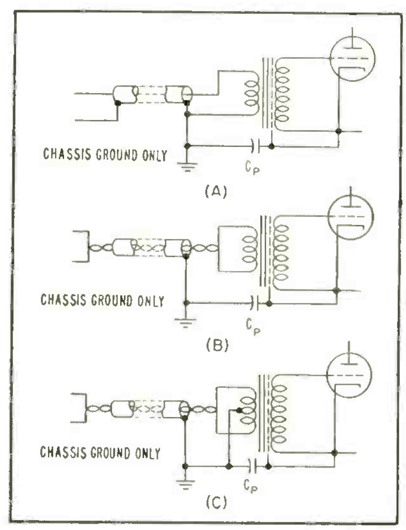
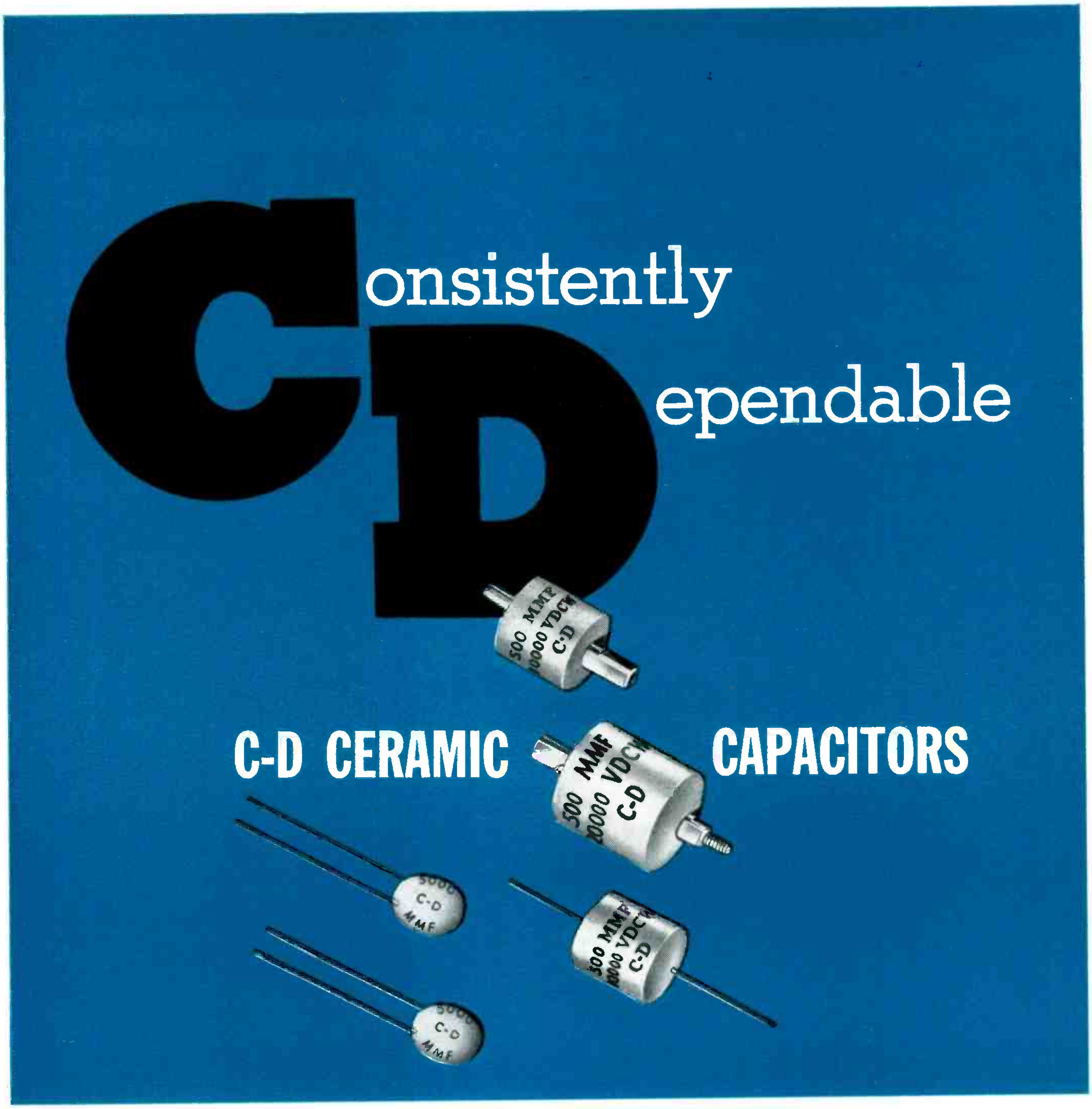
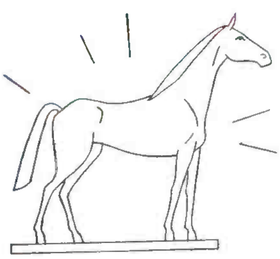


FIG. 2—Three input circuits for intercom systems





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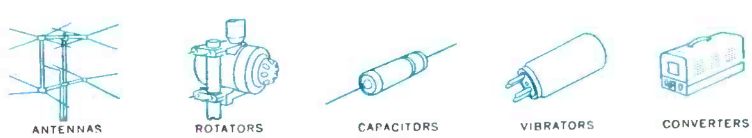

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through the bypass capacitor and/or the interwinding capacitance of the input transformer. Voltage is developed across these capacitances by virtue of the current flowing through stray line-to-ground capacitance C_G. This cable-to-ground capacitance is in the vicinity of 5 to 10 $\mu\mu$f per foot.

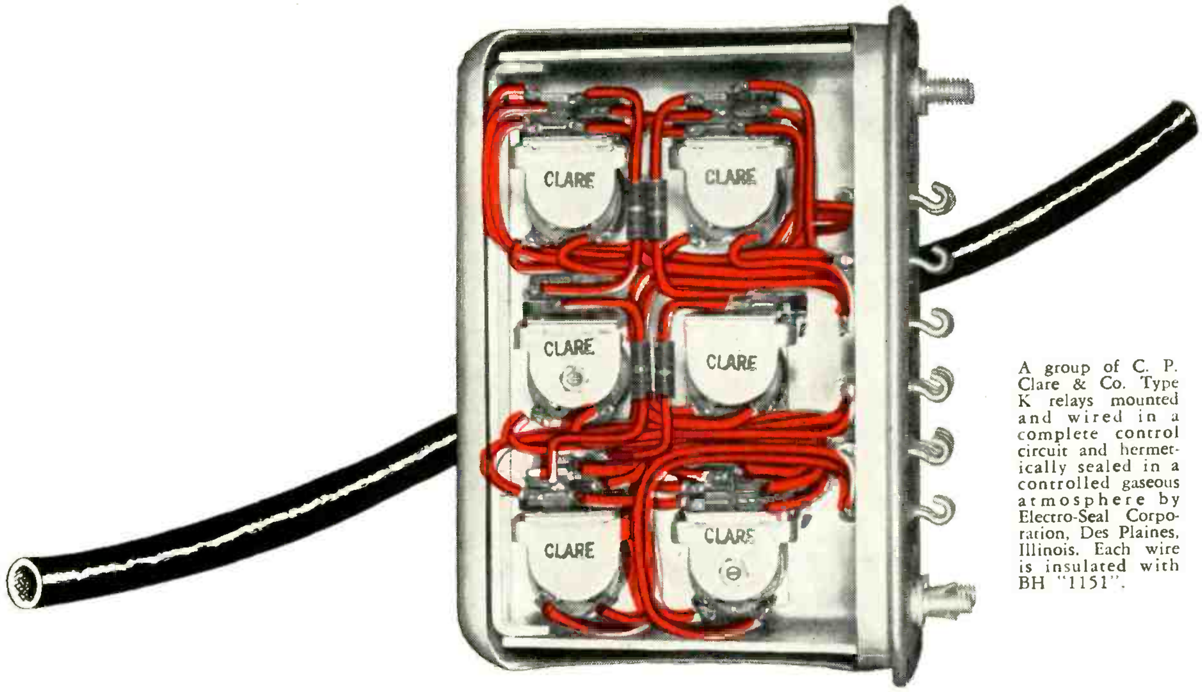
Electrostatic coupling between the audio line and the various master stations in the system contributes stray voltage, depending upon the design of the stations and individual ground couplings. Assigning the symbol C_N to the capacitance between the audio line and B—

$$E_N = E_M \frac{C_G}{C_G + C_N}$$

The noise actually reaching the grid of the first amplifier stage depends upon details of the input circuit. For the three circuits of Fig. 2, assume the following typical values: $E_M = 10$ volts between ground and low side of line, $C_G = 1{,}000$ $\mu\mu$f line to ground capacitance, $C_P = 0.1$ μf bypass, $C_T = 100$ $\mu\mu$f input transformer total primary capacitance and $\alpha_T = 10^4$ input transformer attenuation of electrostatic signal.

Calculations are based on the use of unshielded audio line. In Fig. 2A; $C_n \cong C_P$, therefore $E_N \cong 0.1$ and the electrostatically coupled input to the grid is $\alpha_T E_N = 10^{-5}$ volts, a negligible amount. However, due to the unbalanced configuration, currents from C_G will flow through the primary and induce an additional noise potential.

With primary and secondary impedances of 50 and 50,000 ohms respectively, about 10 millivolts on the grid can be expected at 200 cps under the assumed conditions. If the primary is allowed to float, as in Fig. 2B, this unbalanced current can be largely eliminated at the expense of raising E_N to 9 volts because of the reduction in C_N. The grid input due to electrostatic coupling then becomes $\alpha_T E_N = 0.9$ millivolts. When added to the induced signal originating from stray unbalances, this still represents a worthwhile total improvement over circuit 2A. Connecting the grid to the winding end most distant from the primary is important in this



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arrangement of the circuit.

The balanced and bypassed arrangement of Fig. 2C similarly reduces induced noise while maintaining electrostatically coupled noise at 10^{-5} volts. The disadvantage of this circuit lies in complication of the talk-listen and channel selector switches since neither line terminal can be made common.

Aside from the choice of input circuit and plate supply, ground noise susceptibility can be controlled by proper installation. Shielding the audio line is effective in troublesome situations. The shield should not be grounded but returned to the station common, otherwise the noise is aggravated. Twisting of leads does not help prevent this type of noise unless the primary is balanced.

In all cases, locating signal leads away from ground or grounded objects (such as pipe or steel beams) reduces ground-coupled noises. Isolating transformers assist in eliminating coupled noise if the undesired signal is not connected to the secondary, the secondary is effectively earth grounded, and magnetic coupling to the isolating transformer is avoided.

Acknowledgment is made for the assistance of Gordon Babcock and other members of the engineering staffs of Dalmo Victor Company and Color Television, Incorporated.

Transistor-Controlled Garage Door

BY A. H. FORBES and ROBERT L. RIDDLE
Staff Members
Department of Electrical Engineering
Pennsylvania State College
State College, Pa.

THE REMOTELY CONTROLLED garage-door opener employs a point-contact transistor-amplifier circuit that requires low standby power. The block diagram, shown in Fig 1, outlines the operation of the circuit in functional form. Block *A* is located in

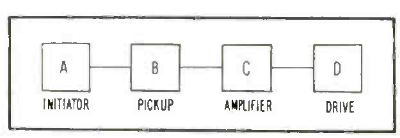
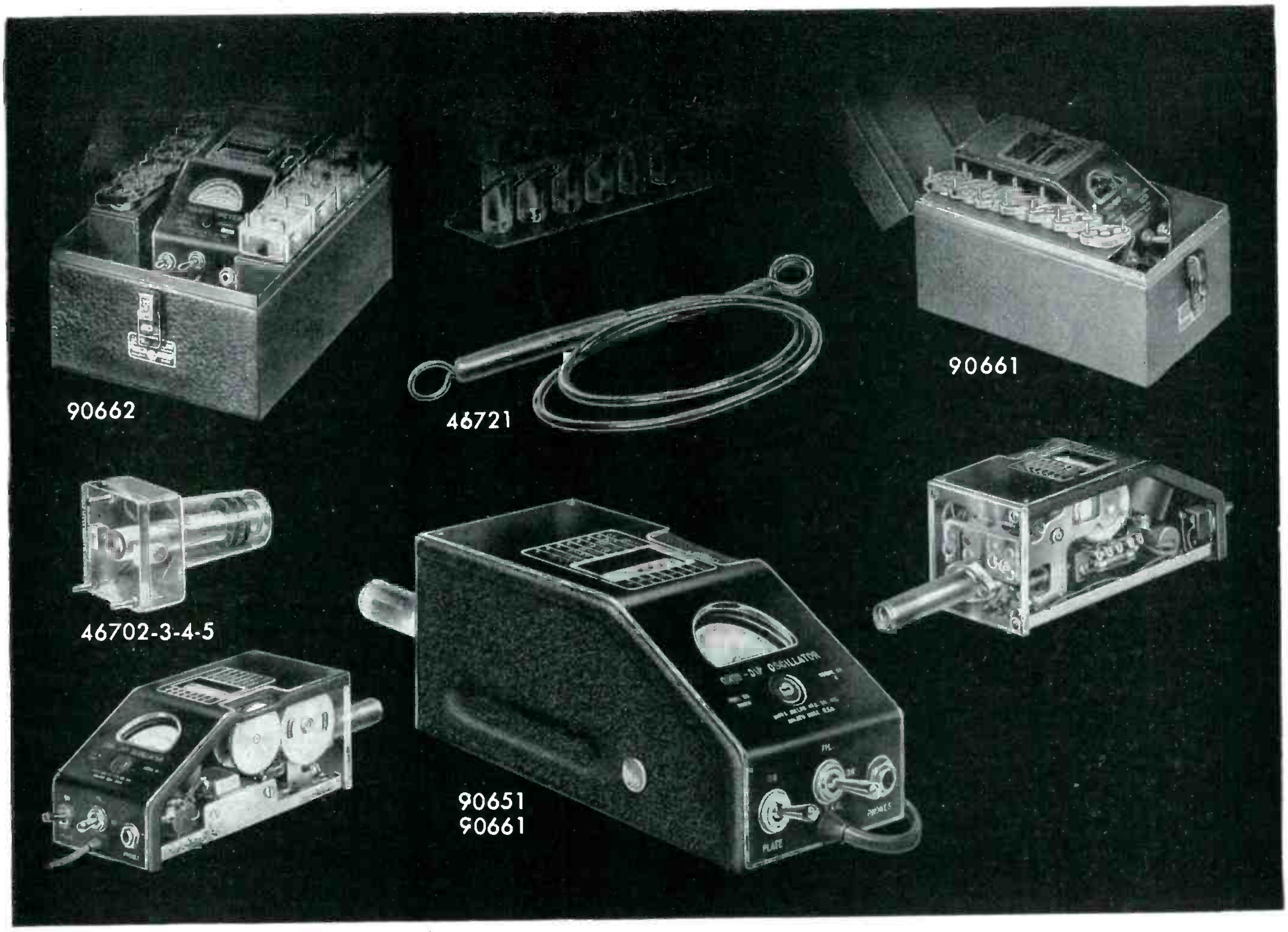


FIG. 1—Block diagram of remote-control door opener



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The 90661 Industrial Grid Dip Meter is similar to the 90662 except for a reduced range of 1.7 to 300 mc. It likewise incorporates the three wire grounding type cord and metal carrying case.

The 90651 Standard Grid Dip Meter is a somewhat less expensive version of the grid dip meter. The calibration while adequate for general usage is not as complete as in the case of the industrial model. It is supplied without grounding lead and without carrying case. The range is 1.7 to 300 mc. Extra inductors available extends range to 220 kc.

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the automobile and serves to initiate the circuit operation. This portion of the circuit contains a vibrator connected to the six-volt car battery. The output of the vibrator is connected to a coil mounted under the car radiator. This coil is wound center-tapped with 200 turns around a core of transformer laminations $1 \times 1 \times 18$ in.

Block *B* contains the coil L_2 located flush with the surface of the driveway to serve as pick-up. This element is a 5,000-turn coil manufactured by the Horni Signal Company. The coil is provided with a laminated core to insure low loss and good coupling with the movable primary coil mounted on the car.

The transistor amplifier circuit, block *C*, is controlled by the pick-up coil and in turn controls the intermediate relay K_2 circuit that activates the garage motor drive mechanism.

Block *D* contains the motor-drive mechanism and motor relay K_3.

Circuit Operation

The circuits included in the various blocks of the functional block diagram are shown in Fig. 2.

The function of the initiator and pick-up is to provide a means of coupling between the car and the transistor amplifier circuit. When switch S_1 is closed, the resulting current flowing in coil L_1 sets up an alternating magnetic field that induces a voltage in coil L_2. This voltage is then used to drive the transistor amplifier.

The amplifier circuit is biased with approximately thirty volts collector voltage and zero emitter current. The thirty volts for the collector is obtained from a 115-to-30 v transformer. The collector circuit is connected in series with a germanium diode and relay K_1 to the output of the transformer. The germanium diode prevents current flow in the forward direction through the transistor collector circuit, thus biasing it in the reverse direction. Capacitor C_2, in parallel with the relay coil K_1, filters the current flow through this element.

Capacitor C_1 in the emitter side of the transistor resonates with the pick-up coil L_2, which improves the

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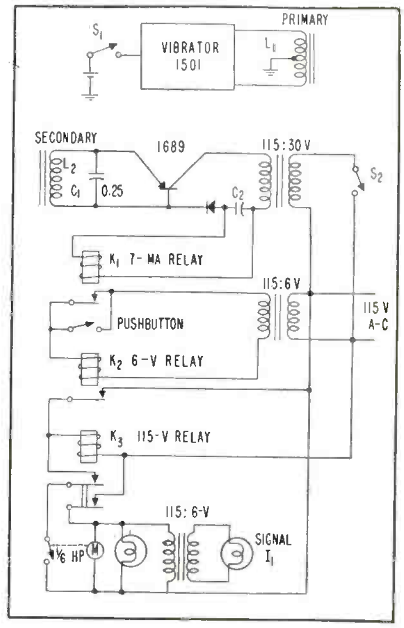

FIG. 2—Transistor-controlled automatic garage door mechanism

sensitivity of the circuit.

Quiescent collector current is approximately 1 milliampere. When L_2 is energized with a minimum input power of 0.5 milliwatt a current of 7 milliamperes will flow in the collector lead. This is sufficient to operate relay K_1. This circuit could be made much more sensitive by using a relay that requires less driving current.

Motor Driving Mechanism

Many different drive mechanisms could be used to complete the operation of this door opener. The particular installation illustrated in this article is one that has been in operation for twenty years.

Prior to the installation of the present pick-up system, it had been activated by means of a weatherproof pressure switch operated by driving over the switch.

The momentary contact intermediate relay is used in order to facilitate the installation of manual pushbuttons at convenient points, and interconnection between *C* and *D*. These circuits operate at 6 volts and are run with bell wire.

Relay K_3 is provided with a holding circuit to operate the drive motor during the cycle. A light is installed in parallel with the operating motor to provide illumination in the garage while the doors are in operation. The signal light I_1 is also in

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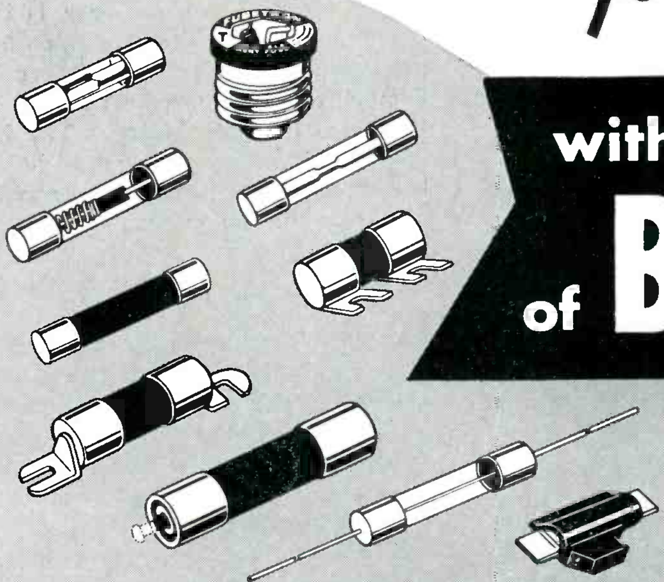

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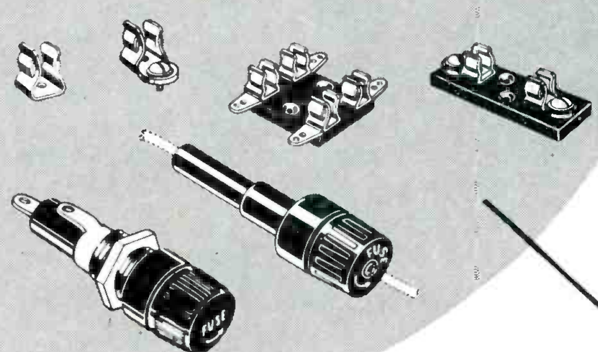

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parallel with the motor. This indicates definite operation of the circuit to the driver as the car passes the coil in the driveway.

The door mechanism consists of a reducing gear and a reversing gear. The reversing gear, upon reaching the end of a cycle, either opening or closing the door, is interlocked with a stop button as shown in Fig. 2. As the gear is moving to the reverse position it presses the stop button. The inertia of the motor is sufficient to complete the movement, thereby setting up the mechanism for its next activation.

Operating Characteristics

The power necessary for standby operation in this circuit is very small; the transistor itself requires one kilowatt-hour every four years. This is less than the exciting energy required by the various transformers in the circuit.

The coil coupling, between L_1 and L_2 required in this application is low enough with a 12-watt input to coil L_1 to permit operation with a coil spacing of twenty inches. This permits the automobile a 17-in. leeway to the right or left of the center of the driveway. The speed of operation of the circuit is sufficient to give reliable operation when passing over the buried coil at 12 miles an hour.

Frequency Economy in Mobile Radio

BY K. BULLINGTON
Bell Telephone Laboratories

THE NUMBER of usable channels that can be obtained in the vhf and uhf mobile bands depends not only on the width of the individual channels, but also on how and where each channel is to be used. Cutting channel spacing in half doubles the number of potential assignments, but it does not automatically increase the number of usable channels.

When two channels are being operated on different frequencies in the same general area, the coverage area of each is limited by signal-to-noise considerations. In addition each channel may affect the other because of spurious radiation from

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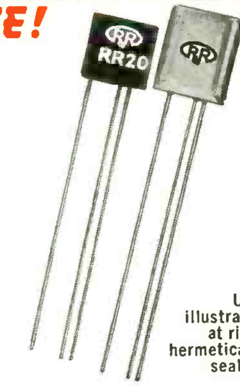
TYPE NO.	RR14‡	RR20‡	RR21‡
Collector Voltage—volts	−1.5	−1.5	−15.0
Collector Current—ma	−0.5	−0.5	−3.0
Ico—Microamp.*	10	10	30
Current Amplification	25	40	25
Power Gain—db	30	40	—
Noise Factor—db (1 Kc)	22	22	—
Power out—mw (10% Dist.)†	—	—	20.0

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

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



Unit illustrated at right hermetically sealed.

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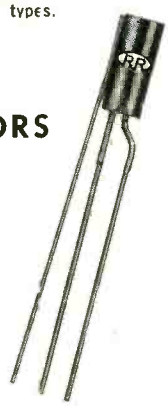

POINT CONTACT TRANSISTORS Typical Characteristics at 25° C		
SWITCHING TRANSISTORS		
TYPE NO.	R1698	R1734
Off Collector Current max. ma (I_e = 0)	−2.2 (@ V_c = 40V)	−0.7 (@ V_c = −7V)
On Collector Voltage max. volts (I_e = 3.0)	−4.0 (@ I_c = 5.5 ma)	−1.2 (@ I_c = −4.0 ma)
Collector Dissipation max. m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

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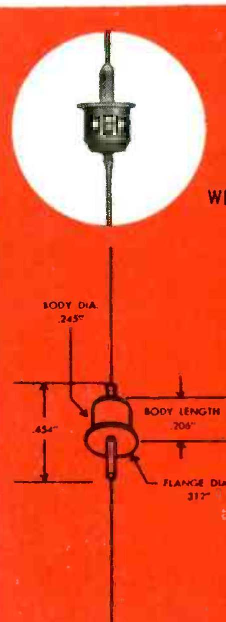

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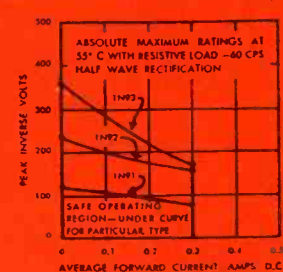

JUNCTION POWER DIODES Maximum Ratings at 55° C—Resistive Load			
TYPE NO.	1N91	1N92	1N93
Peak Inverse Voltage (volts)	100	200	300
Peak Forward Current (ma)	470	310	230
D.C. Output Current (ma)	150	100	75
Voltage Drop at Full Load (volts)	0.5	0.5	0.5
Surge Current (amps)	25	25	25
Reverse Working Voltage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

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transmitters, insufficient receiver selectivity, frequency drift and receiver oscillator radiation. Even infinite i-f selectivity cannot solve many present interference problems.

When three or more channels are operating in the same area, interference occurs because of intermodulation in transmitters and receivers. Sufficient radio-frequency selectivity to separate the working channels could remove this interference. In practice, this is not feasible, and it is necessary to consider possible modulation products from channels falling within a frequency band several percent wide. The number of possible interfer-

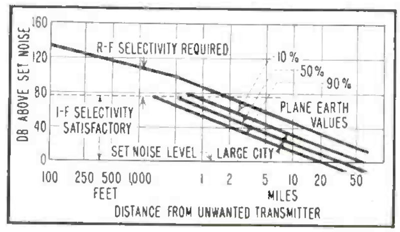

FIG. 1—Estimated intensity of unwanted signals at 150 mc for 100 watts radiated power

ence conditions that result from third-order intermodulation alone rises from 9 for 3 working channels to 50 for 5 channels, to 450 for 10 channels, and to 495,000 for 100 working channels. Some of these interference combinations overlap and fall on the same channel; but even considering all possible duplication, intermodulation interference rapidly becomes controlling as the number of closely spaced channels working in the same area is increased.

The interference levels to be expected at various distances from an unwanted 100-watt transmitter are estimated on Fig. 1. For example, at a distance of 5 miles the unwanted signal is likely to be 25 to 60 db above the set noise in a typical mobile receiver. If the receiver has at least this much i-f selectivity against the unwanted signal, no interference can occur. On the other hand at a distance of only 500 feet the total selectivity required is about 115 db. It is not sufficient to provide all of this selectivity in the i-f stage. The required suppression

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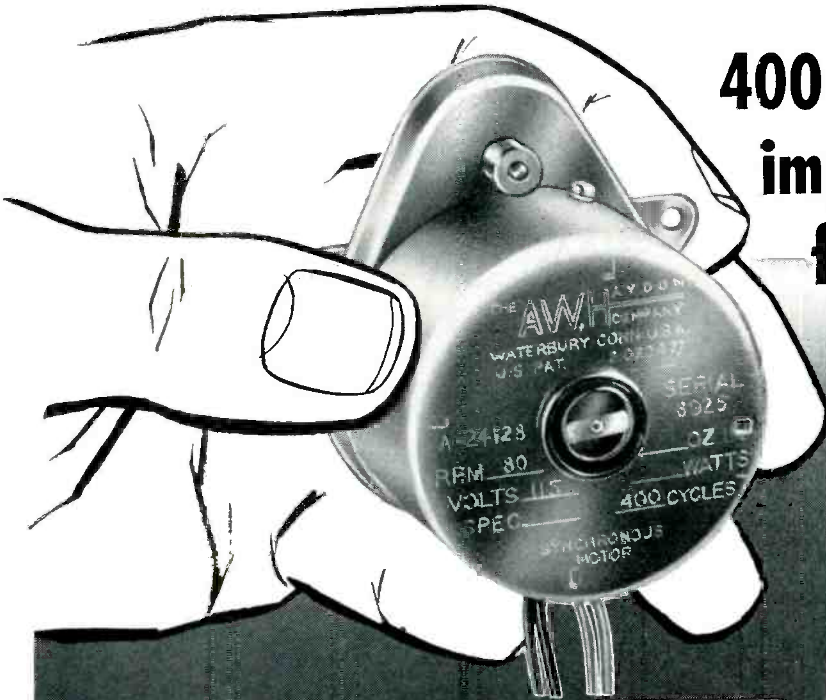

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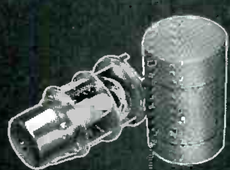

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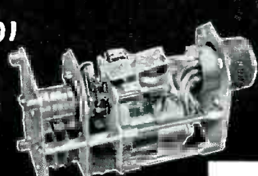

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shown above the dotted line (about 40 db at 500 feet) must be provided by r-f selectivity if desensitization and intermodulation effects are to be avoided.

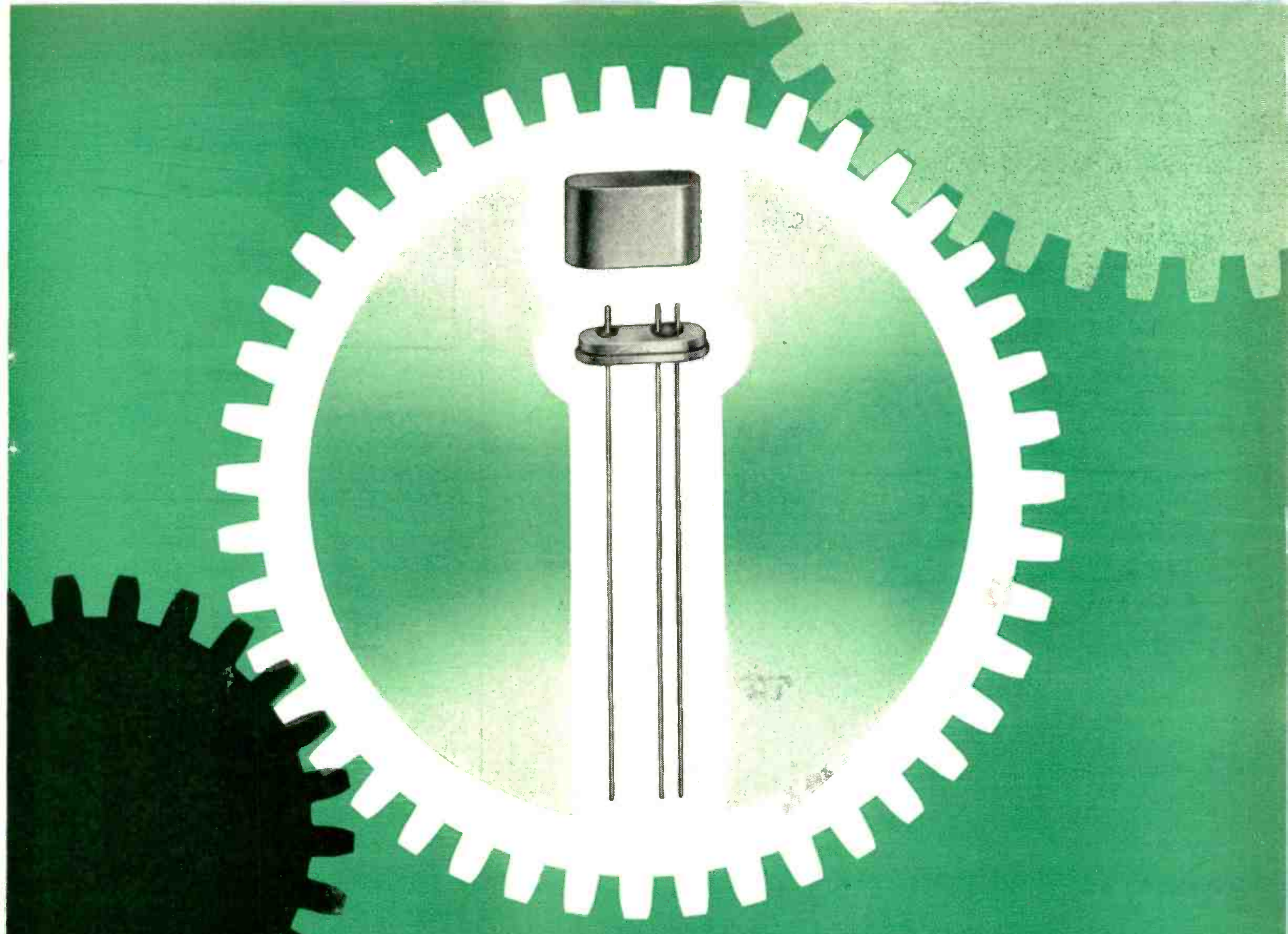
The importance of the division between i-f and r-f selectivity is shown in Fig. 2. Two strong unwanted signals intermodulate and produce in the receiver itself a third unwanted frequency whose approximate magnitude (in the absence of r-f selectivity) is shown on the ordinate. The abscissa is the distance from the receiver to one of two unwanted transmitters while the parameter on the curves is the distance from the receiver to the second unwanted transmitter. Since the magnitude of this intermodulation product can be 40 db or more above set noise, it is evident that serious interference results whenever it falls on the desired frequency of the receiver.

It is not technically feasible to achieve enough radio-frequency selectivity to permit unrestricted and unco-ordinated use of many channels in a given area, unless the channels are, on the average, separated by about ½ to 1 percent of the operating frequency. This means that in the 152-to-162 mc band only about a dozen interference-free channels can be obtained in the same area.

Lacking adequate r-f selectivity, operating frequencies might be chosen with sufficient care so that the more serious intermodulation products are avoided. However, the number of possible interference products increases by at least the cube of the number of channels and the usefulness of this method is also limited to about a dozen interference-free channels in a given area.

Still another way to reduce the intermodulation interference is to space the transmitters far apart, but Fig. 2 indicates that appreciable interference can occur near an unwanted transmitter even when the transmitters are separated by as much as 5 miles. If a separation of several miles were required between base stations the selection of transmitter sites would be difficult and the number of channels that could be assigned to a given city would be severely limited.

If more than 1 or 2 dozen



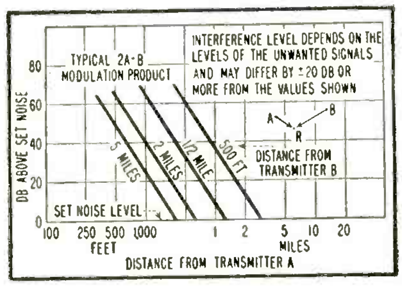


FIG. 2—Estimated intermodulation interference generated in mobile receiver at 150 mc for 100 watts radiated power

channels are needed in a given area, it does not seem possible to avoid intermodulation interference unless the level differences are reduced by geographical and operational co-ordination. This means that the level of the potential interference can be permitted to be many db above set noise as long as it is always at least 10 to 20 db below the desired signal at all possible locations.

The first step is to use the two-frequency method of operation with adequate separation between the frequencies used for the opposite directions of transmission.

Another important feature is to locate all base transmitters at or near a common point so the level differences between the desired and undesired signals will never be excessive.

Under these conditions r-f selectivity or intermodulation problem in the mobile receiver can be eliminated by the use of automatic gain control in the r-f stage of the mobile receiver. In regions where the desired and undesired signals are weak the receiver has full sensitivity, while at locations near the transmitters both the desired and undesired signals are reduced in level before reaching the first converter. In order that the agc circuit be fully effective it is necessary that the transmitters be grouped together and that the desired carrier be transmitted to control the gain of the receiver.

Grouping base transmitters at or near a common point and using agc greatly reduces the requirements on the mobile receiver, but these measures complicate the design of the base transmitter. Intermodulation products generated in closely associated transmitters result in

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Power Rating	SIZE *Length*	SIZE *Diameter*	RESISTANCE *Min. (ohms)*	RESISTANCE *Max. (ohms)*
½ Watt	19/32"	11/64"	10	10,000
1	15/16"	19/64"	10	40,000
2	2 1/16"	19/64"	20	100,000

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1 Watt	19/32"	11/64"	10	10,000
2	15/16"	19/64"	10	40,000
4	2 1/16"	19/64"	20	100,000

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potential interference both within and outside the desired transmitting band. The intermodulation that falls on the mobile receiver frequencies within the co-ordinated system can be neglected because the desired signal is always sufficiently stronger. The intermodulation that appears as extra-band radiation outside the frequency range of the co-ordinated system must be suppressed by r-f filters. The guard band needed to prevent mutual interference between the co-ordinated system and its neighbors is small compared with the frequency space that is saved in the co-ordinated system by the close spacing of interference-free channels.

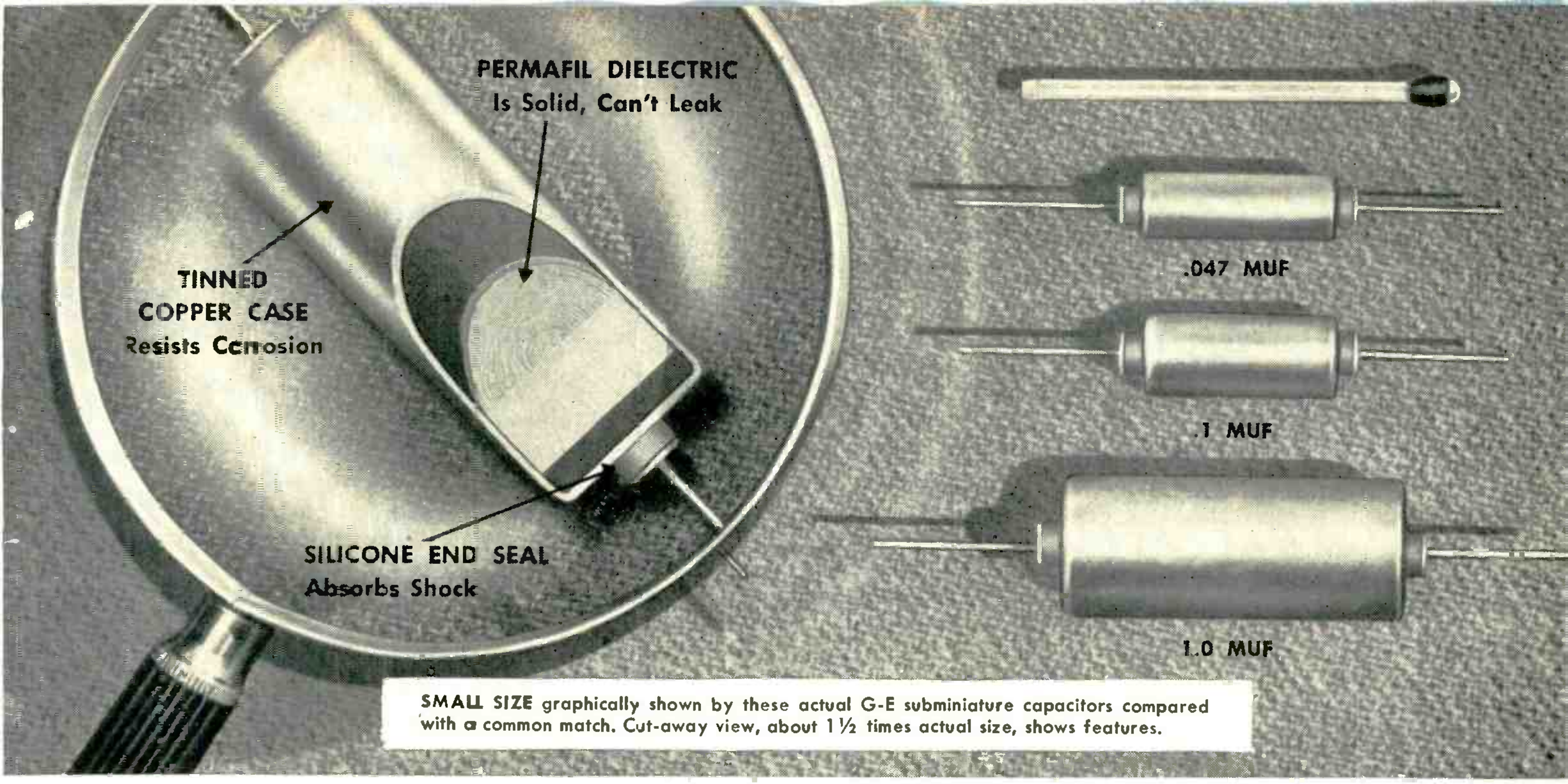
In the direction of transmission from the mobile transmitters to the base receivers, the above coordinating methods cannot be used, but equally effective ones are available. The r-f selectivity requirements can be reduced substantially by radiating only 1 or 2 watts from the mobile transmitters. In order to regain the full coverage area, multiple base receivers at different locations are needed and this use of space diversity techniques provides an opportunity to pick the receiver having the best signal-to-noise ratio. Moreover, the effects of the low power in the mobile transmitter and the better r-f filters that are possible in fixed locations together with the diversity provided by the multiple base receivers reduces the possibility of intermodulation interference to negligible degree.

Editor's note: The conclusions presented herein have been condensed from the author's paper, "Frequency Economy in Mobile Radio Bands", *BSTJ*, Jan. 1953.

Liquid Potting of Electronic Components

By Eugene J. Hebert
*National Bureau of Standards
Washington, D. C.*

Decreasing the size of components and increasing the compactness of electronic equipment without decreasing the power dissipation has made heat transfer a major problem of electronic design. In addition, present day specifications require certain electronic assemblies to function properly at ambient



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

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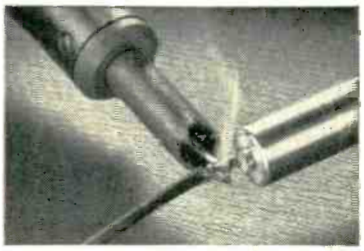
Solder right up to the bushing with G-E Silicone end seal—no danger of cracking glass.


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.

These G-E subminiature metal-clad capacitors meet all test requirements of JAN-C-25 and the proposed MIL-C-25A and can be supplied in both tab and exposed foil designs.

Excellent electrical characteristics are assured by the use of Permafil solid dielectric. Capacitance varies only 1 percent over the temperature range from 0 C to +125 C and only 7 percent over the entire range from −55 C to +125 C.

Exceptional shock resistance provided by exclusive G-E silicone end seals. This seal meets the moisture resistance tests of JAN-C-25 with d-c potential applied.

Muf ratings of these new G-E subminiature capacitors range from .001 to 1.0 muf in voltage ratings of 100, 200, 400 and 600 volts d-c working. They can be operated at full voltage up to altitudes of 50,000 feet.

Case sizes range from .235 inches in diameter and $\frac{11}{16}$ in length to 1 inch diameter and $2\frac{5}{8}$ inches in length.

Liquid-filled metal-clad line also available with G-E Pyranol* dielectric for operation from −55 C to +85 C **without derating.** These subminiature capacitors also incorporate the silicone end seal for maximum shock resistance and can be supplied in either tab or foil designs in ratings from .001 to 1.0 muf in voltages of 100, 200, 400, and 600 volts d-c working.

If your requirements demand the highest performance standards for subminiature capacitors, check with your nearest G-E Apparatus Sales Office for exact delivery information . . . or write to General Electric Company, Section 442-8, Schenectady 5, N. Y.

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temperatures up to 125 C.

In order to maintain equipment reliability under these conditions, the National Bureau of Standards Radar Miniaturization Laboratory has been engaged in a study of heat transfer in airborne electronic equipment.

The primary source of heat in electronic equipment is the electron tube. The power dissipated by the heater (or filaments) and the plate and screen produces the major portion of the heat in the typical receiving-type electron tube. The heater may produce up to 50 or 60 percent of this heat.

If the tube envelope becomes too hot, electrolysis will cause a decrease in the insulating properties of the glass, which may result in a complete insulation break-down. High envelope temperatures also increase the possibility of the tube becoming gassy either by releasing absorbed gases or by injuring the glass-to-metal lead seals. Detrimental shifts of tube characteristics, short-life cathode emission current and grid emission current are also caused by high temperature. To prevent these types of failures, there must be sufficient transfer of heat to maintain the temperature of the tube parts at a safe value.

When large electron tubes are replaced with electrically equivalent smaller types, there is a tremendous reduction in the conducting and radiating area without a corresponding reduction in dissipated power. Many small electron tubes are required to dissipate as much, and sometimes more,, heat than their larger prototypes. Hot spots may occur on the tube envelopes

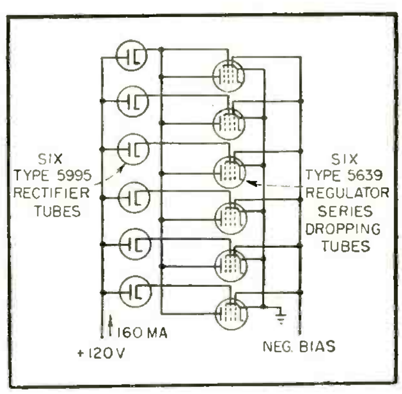

FIG. 1—Schematic diagram of subassembly used in potting tests

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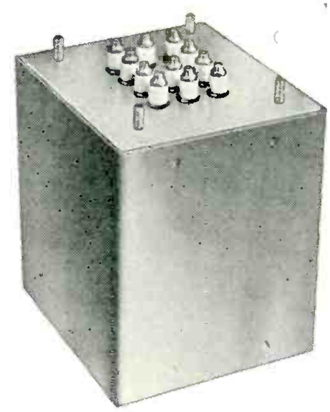

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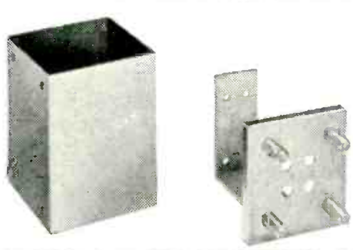

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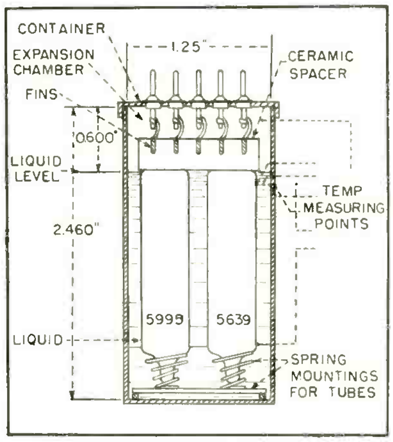


FIG. 2—Cross-section of potted unit with tubes in place

despite design efforts to prevent this. In compact miniature equipment, tubes are often placed close together, which causes the envelope temperature to rise still higher, because of reradiation and radiation from other tubes.

Several methods of maintaining the envelope temperatures of miniaturized electron tubes within rated values and distributing the heat such that hot spots are no longer a problem, were investigated. These objectives were to be obtained while maintaining tubes and circuitry in as compact an arrangement as possible.

For experimental purposes, the rectifier-regulator circuit shown in Fig. 1 was built to supply 160 ma at 120 volts. This unit approximates a subassembly of a developmental radar set and temperature requirements were set accordingly. The maximum allowable tube envelope temperature was 250 C, when the minimum-sized unit assembly was placed in still air at 125 C ambient temperature.

The tubes, all subminiatures, were placed in two parallel rows and spaced about 0.15 in. apart. The temperatures were measured with chromel-alumel thermocouples of the ring type (as recommended by several tube manufacturers), while the liquid temperature was measured with simple welded thermocouples. Thermocouple wire only 0.003 in. in diameter was used to minimize conduction through the thermocouple leads. Temperatures were measured at the base and at the top of the tubes, these being the hottest and coolest points, respec-

tively, for the tubes used.

When the unit was placed directly in still air at 125 C, the envelope temperatures at the bases of the type 5639 and 5995 tubes were over 250 C with only heater power applied. When the plate voltage was also applied, the temperature of the bases of these tubes rose slightly over 320 C. The 5995 and 5639 have maximum bulb temperature ratings of 250 C.

Metallic fin structures about the tubes were tried, but had little effect in still air at 125 C ambient. Poor contact between the bulb surface and the metal as well as reradiation between the fins probably account for there being no significant cooling by this method.

The unit was next enclosed in a container to evaluate the effect of liquid potting. Figure 2 is a cross section of the container showing the tube arrangement. The temperature of the liquid, when the unit was potted, was measured half way down the container near one end, and about half way between the end tube and the container. The fins shown are insulated from the case and are used to provide electrical connections to the tubes and to transfer heat from the tube leads to the potting fluid. The tubes are held in position by small, thin ceramic spacers held tightly in place by the tube lead connections to the fins

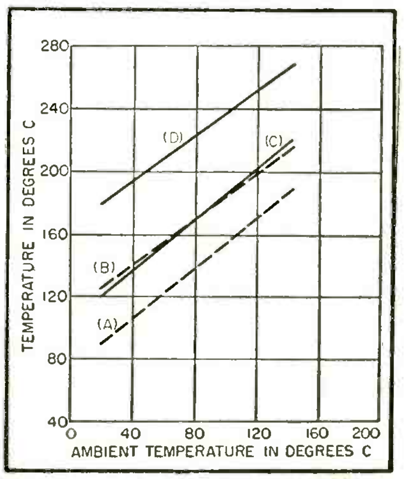
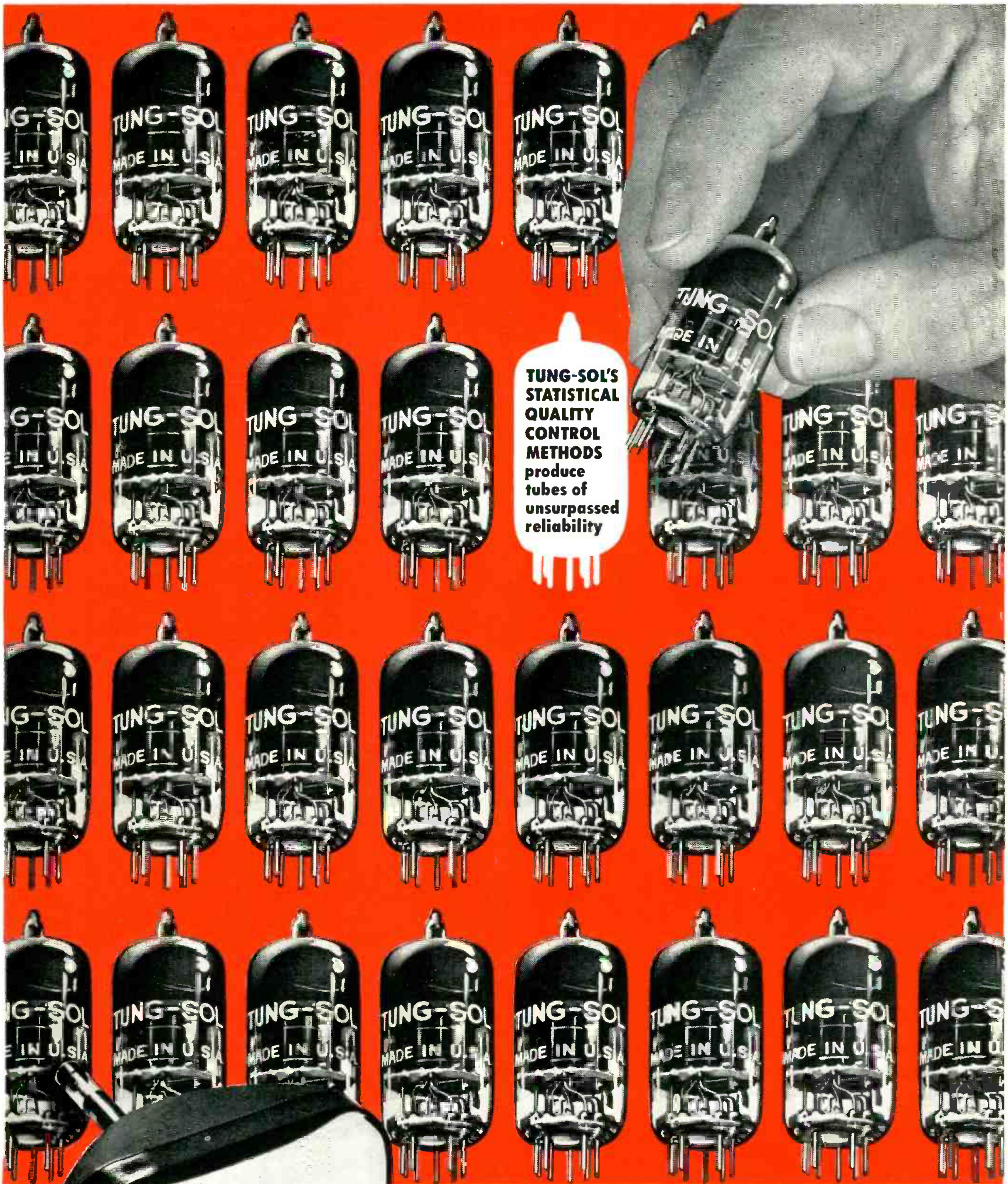


FIG. 3—Temperature chart for type 5639 tube in potted unit. Liquid temperature with heaters on (A), liquid temperature with heaters and plate power on (B), temperatures of tube base with heater on (C) and with heater and plate on (D)



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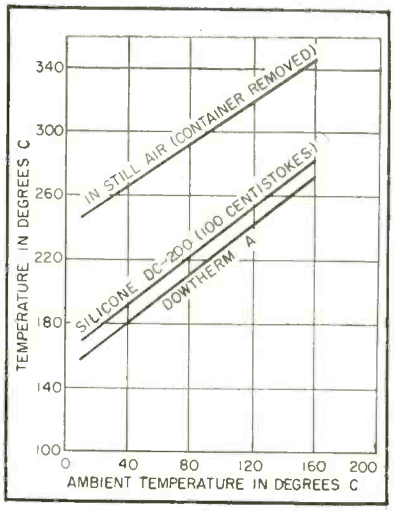


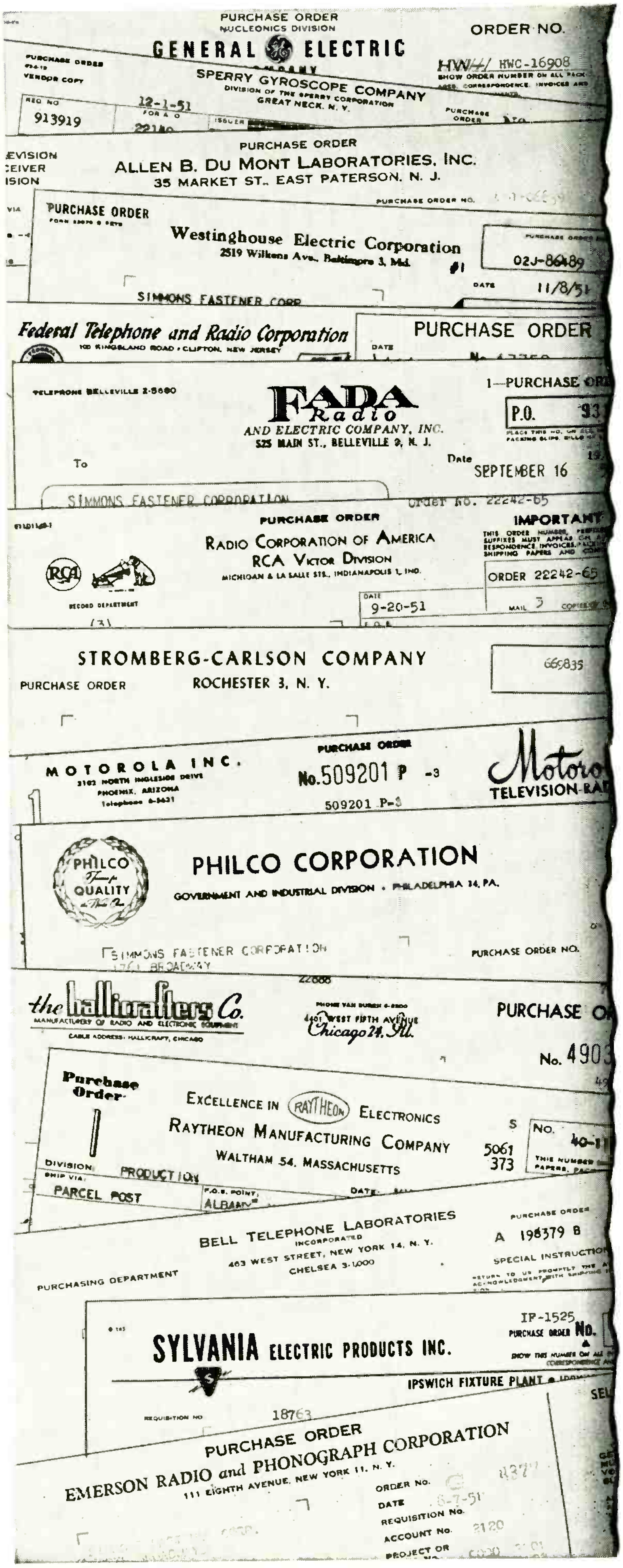
FIG. 4—Comparison of potting in two different fluids and in still air

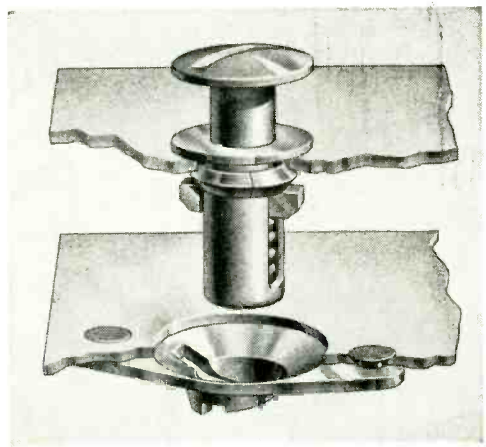
and by the spring mounting at the tube tops. This mounting does not interfere with the circulation of the potting fluid. Use of expansion devices, such as bellows, to limit pressure rise caused by expansion of the fluid was found unnecessary. The only requirement is the provision of sufficient space within the container for expansion of the liquid. The pressure developed in the unit described at 125 C ambient was 14.3 pounds per square inch gage.

Temperature measurements were taken with the unit oriented so that the tube bases were on top. Thermally, this is the worst possible position, since the hottest portion of the tubes used are at their bases in contact with the upper (and hence hottest) layers of the liquid. When the unit was oriented differently, the temperatures of the tube surfaces were slightly lower.

The potting liquid used was Dow-Corning Silicone DC-200 fluid of 100 centistokes viscosity. Lower viscosities of this fluid were not used because of the tendency to thicken at high temperatures over extended periods of time.

Results of operating tests made with the potted components are summarized graphically in Fig. 3 and 4. These tests indicate that liquid potting is useful where it is necessary to keep the temperatures of electrical components at safe operating values while maintaining





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the maximum unloaded Q for a given conductor size. For a cylindrical coaxial structure, R_o of approximately 77 ohms is indicated. The frequency limits F_{max}, F_{min} and the maximum angle of rotation are the remaining parameters.

From the knowledge of F_{max}, R_o and C_{min} the length of line and F_o the frequency at which the line is $\lambda/4$ in length can be determined.

$$F_o = \frac{\frac{\pi}{2} F_{max}}{\tan^{-1} \frac{1}{2\pi F_{max} C_{min} R_o}}$$

Having determined the parameter F_o, C can be expressed as

$$C = \frac{1}{2\pi F R_o \tan \frac{\pi}{2} \frac{F}{F_o}}$$

where C is the value of capacitance corresponding to a frequency F.

The Approximate Method

The approximate method is based on the assumption that the capacitor is divided into a large enough number of segments to permit the approximation

$$\Delta C = \frac{0.112 \times 10^{-12}}{D} \rho^2 \Delta\theta$$

ρ and θ are polar co-ordinates in inches and radians respectively and D is the spacing in inches.

Let the maximum angle of rotation be divided into a large number of equal parts and let ρ_n, C_n and F_n represent the radius, capacitance and frequency at the n^{th} segment respectively.

To a first degree of approximation then ρ_n in a small interval between C_{n-1} and C_n is

$$\rho_n = 3 \times 10^6 \sqrt{D \frac{C_{n-1} - C_n}{\Delta\theta}} = (1.2 \times 10^6) \times$$

$$\sqrt{\frac{D}{R_o \Delta\theta\, F_n F_{n-1} \tan\left(\frac{\pi}{2}\frac{F_n}{F_o}\right) \tan\left(\frac{\pi}{2}\frac{F_{n-1}}{F_o}\right)} \left(F_n \tan\frac{\pi}{2}\frac{F_n}{F_o} - F_{n-1} \tan\frac{\pi}{2}\frac{F_{n-1}}{F_o}\right)}$$

Analytical Solution

The requirement that frequency should vary linearly with angular

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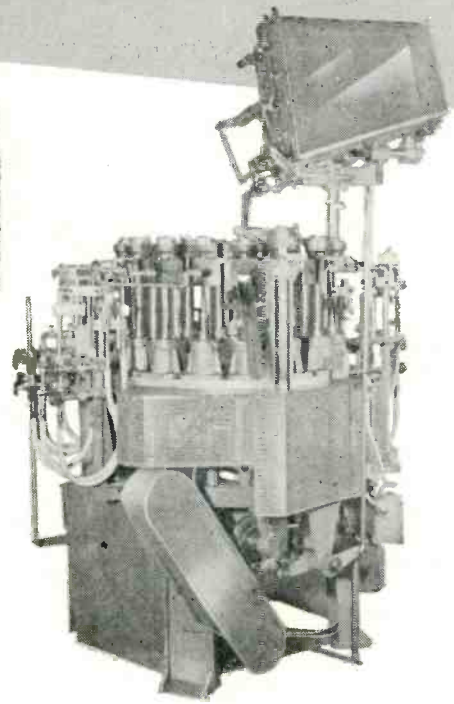

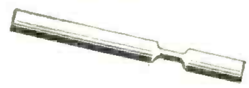

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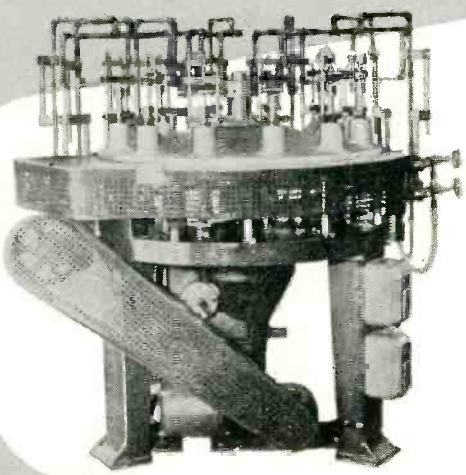

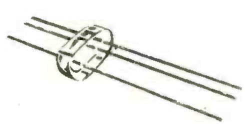

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rotation can be expressed by the simple equation

$$F = F_{\max} - k\theta \quad \text{where } k = \frac{F_{\max} - F_{\min}}{\theta_{\max}}$$

$$C = \frac{0.112 \times 10^{-12}}{D} \int_{0}^{\theta} \rho^2 d\theta + C_{\min}$$

$$\rho = 3 \times 10^6 \sqrt{\frac{dC}{d\theta} D}$$

$$C_{\min} = 0.5 \times 10^{-12}$$

$$\frac{dC}{d\theta} = \frac{1}{2\pi R_o} \times$$

$$\left[\frac{k}{(F_{\max} - k\theta)^2 \tan \frac{\pi}{2F_o} (F_{\max} - k\theta)} + \frac{\frac{\pi}{2} \frac{k}{F_o} \sec^2 \frac{\pi}{2F_o} (F_{\max} - k\theta)}{(F_{\max} - k\theta) \tan^2 \frac{\pi}{2F_o} (F_{\max} - k\theta)} \right]$$

$$\rho = \frac{1.2 \times 10^6 \sqrt{\frac{kd}{R_o}}}{(F_{\max} - k\theta) \tan \frac{\pi}{2F_o} (F_{\max} - k\theta)} \times$$

$$\sqrt{\frac{\tan \frac{\pi}{2F_o} (F_{\max} - k\theta) + \frac{\pi}{2F_o} \times}{(F_{\max} - k\theta) \sec^2 \frac{\pi}{2F_o} (F_{\max} - k\theta)}}$$

The expression of ρ versus θ thus derived applies to a set of two capacitor plates. Of course, as the number of plates is increased, the required geometry is not changed. It is only necessary to multiply ρ by an appropriate constant.

As a specific example let it be required to design a capacitor for the uhf band 480–890 mc using the following constants: $R_o = 77$ ohms, $D = 3 \times 10^{-2}$, $\theta_{\max} = \pi$, $C_{\min} = 0.5 \times 10^{-12}$ farads

$$F_o = \frac{\frac{\pi}{2} \times 8.9 \times 10^8}{\tan^{-1} \frac{10^4}{2\pi \times 8.9 \times 0.5 \times 77}}$$

$$= \frac{1.33 \times 10^9}{0.91} = 1.48 \times 10^9$$

The length of the line is approximately 2 inches

$$k = 1.3 \times 10^8$$

$$\rho = \frac{2.7 \times 10^8}{(9 - 1.3\theta)10^8 \tan 0.1 (9 - 1.3\theta)} \times$$

$$\sqrt{\tan 0.1(9-1.3\theta) + 0.1(9-1.3\theta) \sec^2 0.1(9-1.3\theta)}$$

The maximum radius for ρ_π

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$$\rho_\pi = 0.56 \frac{\sqrt{0.57 + (0.53 \times 1.34)}}{0.57}$$
$$= 1.1 \text{ inches}$$

Since the results obtained are inconsistent with the original assumption of small dimensions relative to λ, it becomes necessary to revise the design. It is impractical to reduce the spacing significantly. So the number of capacitor segments may be increased to obtain the desired dimensions. Increasing the number of segments by a factor n, ρ is reduced by a factor $\frac{1}{\sqrt{n}}$

It will be found in practice that after having arrived at a certain design it is frequently impossible to realize the postulated C_{min}. It is then necessary to base the new design on the value of C_{min} measured on the first model. A succession of such steps may be required before a final design is evolved.

The assistance of Samuel Hopfer and Samuel Rubin of the Polytechnic Research and Development Co. in proofreading the manuscript is gratefully acknowledged.

Oscillator for Comparison Measurement of Power Frequencies

By Attie L. Betts
*Associate Professor of Electrical Engineering
Oklahoma Institute of Technology
Stillwater, Okla.*

To eliminate some of the disadvantages found in other methods of measuring frequency variation, a typical audio-frequency oscillator circuit has been modified especially for the purpose of determining the frequency of the

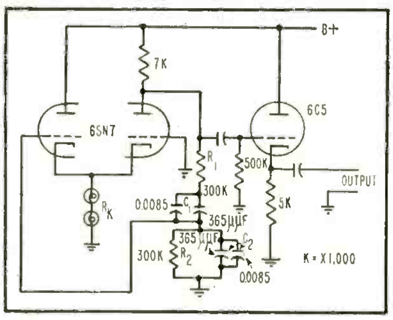

FIG. 1—Circuit of comparison oscillator

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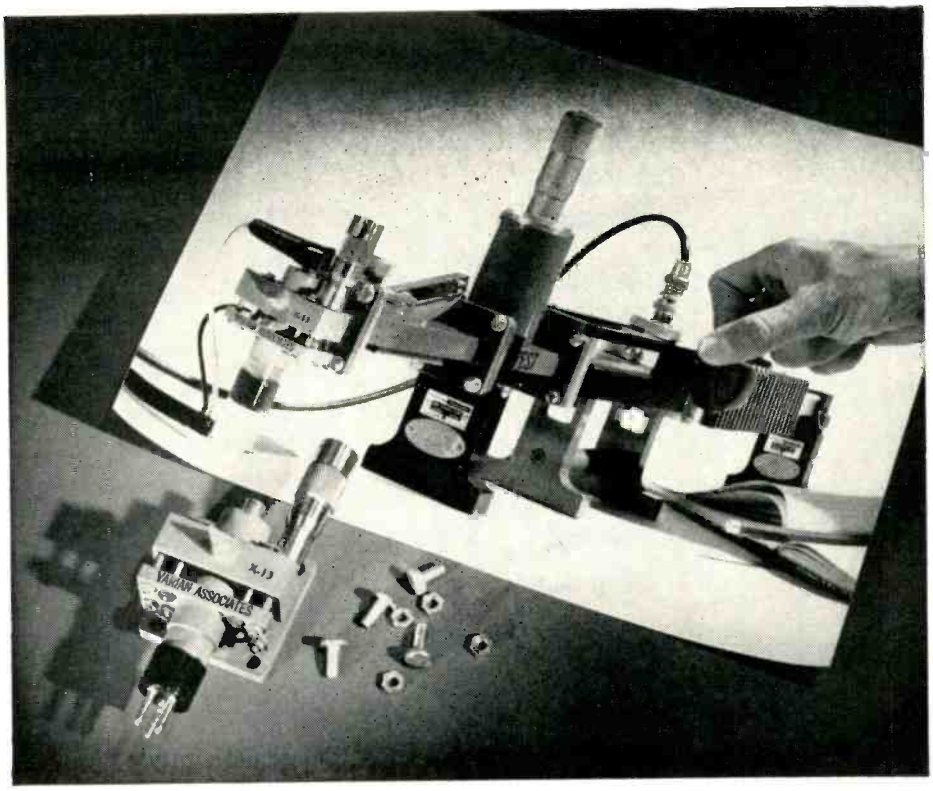

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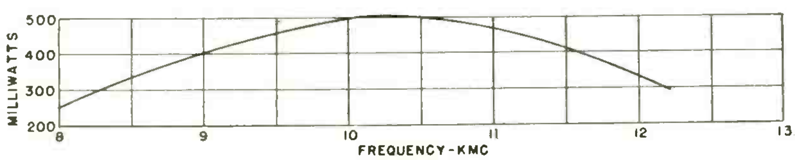

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power source by comparison techniques. The oscillator is of simple construction, easy to use, economical in cost and yet capable of measuring the frequency to 1/1,000 cycle per second. The schematic diagram of the oscillator circuit is shown in Fig. 1. This is a modification of the resistance-capacitance oscillator circuit.[1] The frequency controlling elements are R_1, C_1, R_2, and C_2 and the operating frequency is

$$f = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

The theory of operation of the conventional resistance-capacitance oscillator is given by many texts in the electronic field,[2, 3, 4, 5] and Sulzer[6] has listed several variations of the oscillator. However, the circuit shown in Fig. 1 deviates from the conventional sufficiently to warrant an explanation. The oscillator is composed of a double-triode 6SN7 connected so that half the tube functions as a cathode follower in the feed-back loop to drive the other half as a cathode-driven amplifier. The output of the amplifying half of the 6SN7 is applied to the resistance-capacitance network composed of R_1, R_2, C_1 and C_2, and the feedback voltage obtained from across the parallel branch R_2C_2 is used to drive the cathode follower half of the 6SN7.

The frequency of the oscillator is determined by the phase shifting action of the R-C network. The components of this network were chosen so that the temperature coefficients were as low as could be readily obtained. Accuracy of frequency adjustment was obtained by using components of fixed value except for a small portion of C_1 and

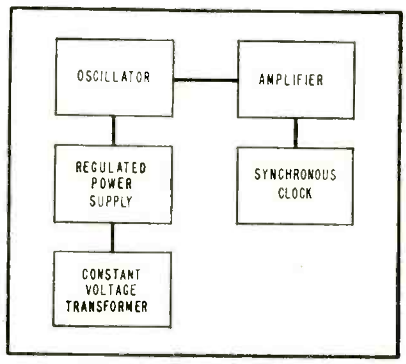
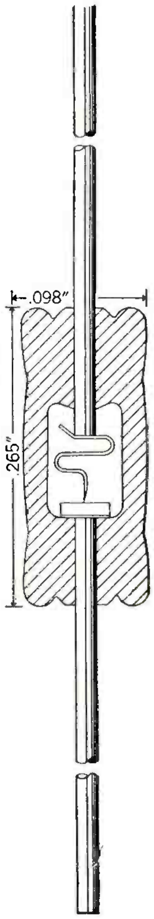


FIG. 2—Arrangement for calibrating oscillator



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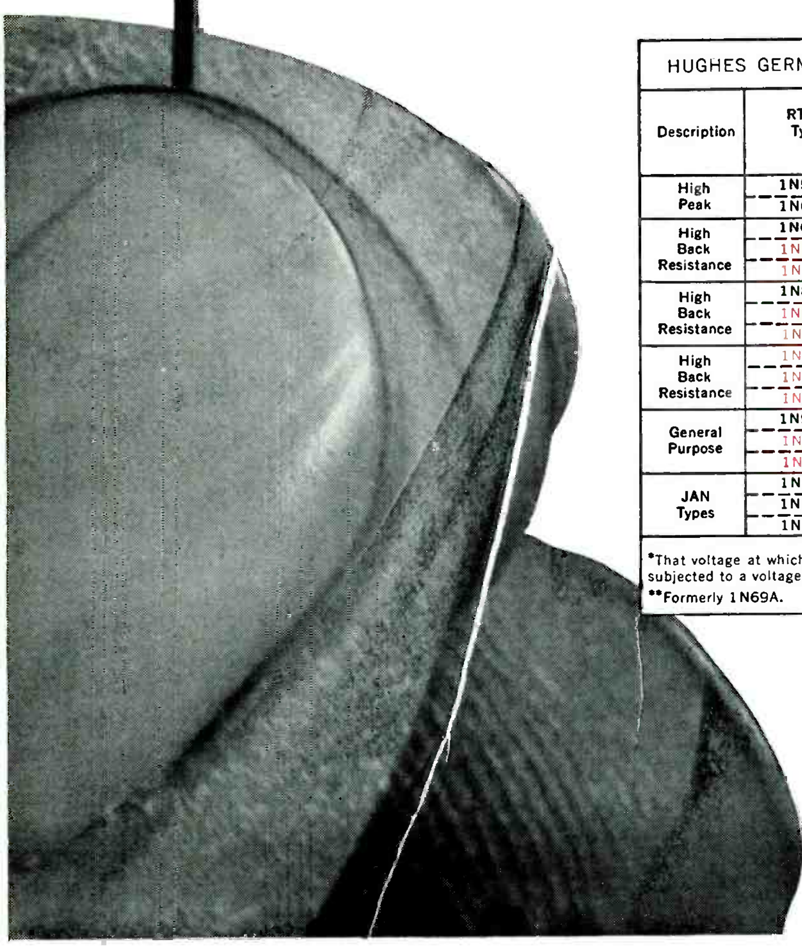

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High Peak	1N55B	190	150	5.0	0.500 @ −150 v	
	1N68A	130	100	3.0	0.625 @ −100 v	
High Back Resistance	1N67A	100	80	4.0	0.005 @ −5 v;	0.050 @ −50 v
	1N99	100	80	10.0	0.005 @ −5 v;	0.050 @ −50 v
	1N100	100	80	20.0	0.005 @ −5 v;	0.050 @ −50 v
High Back 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. New types in red.

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C_2. This portion of the capacitors was chosen to give the oscillator a frequency range of from 59 to 61 cycles per second for the limits of the variable components. The variable components of the capacitors are tuned by means of a 2,500-division antibacklash vernier dial thus making each dial division change the operating frequency approximately 2/2,500 cycle per second.

The common cathode resistor, R_K, is composed of two tungsten-filament lamps and acts as an automatic degeneration control in the feedback loop. This degeneration is accomplished by the resistance-temperature characteristic of the tungsten. The plate load resistor of the amplifying half of the 6SN7 was kept small to minimize the effect of the load and to decrease the harmonic content of the output. The effects of loading on the oscillator was further minimized by the cathode follower 6C5.

The output signal is obtained from the cathode pin of the 6C5. The input impedance of the 6C5 is given by Ryder[7] as $Z_{in} = 1/j\omega C_{in}$ where $C_{in} = C_{gp} + C_{gk}(1 - A)$. This shows that regardless of the load placed on the 6C5 the effect reflected back to the oscillator is minimized.

The oscillator was calibrated by using the output signal to drive a synchronous clock through an amplifier and the clock was checked against the time signals of the Bureau of Standards at one hour intervals. Reasonable care allowed the elapsed indicated time of the clock to be checked to the nearest second. Since this would represent an accuracy of one part in 3,600, the accuracy of the calibration was 1/3,600 × 100 or 0.0278 per cent.

If the time interval used in the calibration had been extended, the accuracy would have increased accordingly. It was possible to repeat the calibration readings to the nearest second even after considerable time had elapsed. The short-time accuracy of the oscillator was checked by operating against a Western Electric 6010B oscillator. When the two instruments were compared with an oscilloscope, a maximum drift of one-half cycle

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over a five-minute period was observed. A block diagram of the connections used for calibration is shown in Fig. 2.

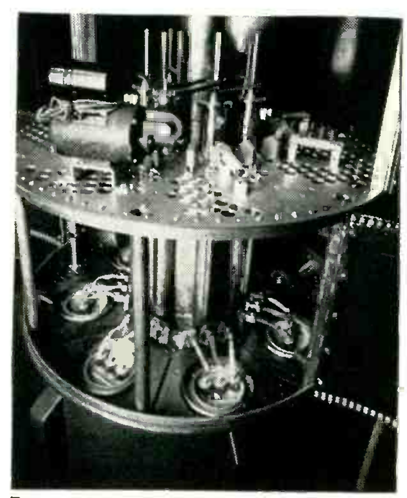
To use the instrument to measure frequency, the output of the oscillator is connected to the vertical amplifier of an oscilloscope and the power source is connected to the horizontal amplifier. The dial of the oscillator is adjusted until the trace on the screen of the oscilloscope is stationary. The calibration curve will then give the frequency corresponding to the dial reading.

If the signal is adjusted so that the trace on the oscilloscope is a straight line, the visual accuracy of the measurement will depend on the focus limitations of the oscilloscope. When a sharp image on the oscilloscope is used, a drift of one degree becomes apparent in the thickening of the trace with the straight line adjustment.

REFERENCES

(1) F. E. Terman, "Radio Engineers Handbook," p 505.
(2) J. D. Ryder, "Electronic Fundamentals and Applications," p 446.
(3) F. E. Terman, "Radio Engineering," p 436.
(4) Cruft Laboratory Staff, "Electronic Circuits and Tubes," p 513.
(5) A. L. Albert, "Fundamental Electronics and Vacuum Tubes," p 374.
(6) P. G. Sulzer, Single-band Audio Generator, ELECTRONICS, p 95, Jan. 1952.
(7) J. D. Ryder, same as Ref. 2, p 446.

VHF CONVERSION AMPLIFIER



Power output of any current 5-kw vhf transmitter can be stepped up to either 25 or 20 kw, depending on the channel, with this RCA vhf conversion amplifier. The equipment consists of aural and visual power amplifier and blower units, aural and visual power supply and filter units, aural and visual control units, vestigial side-band filter and other accessories

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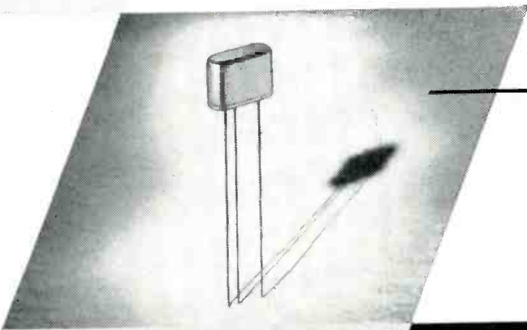
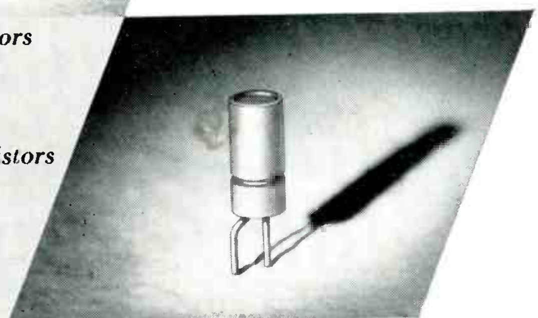


Germanium Transistors

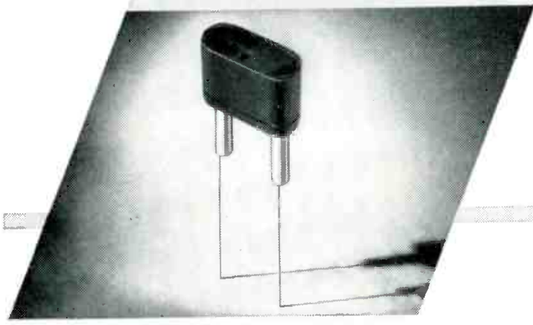
Unequalled in performance and dependability. Point contact type can be made with characteristics to meet your special requirements.

Junction Transistors



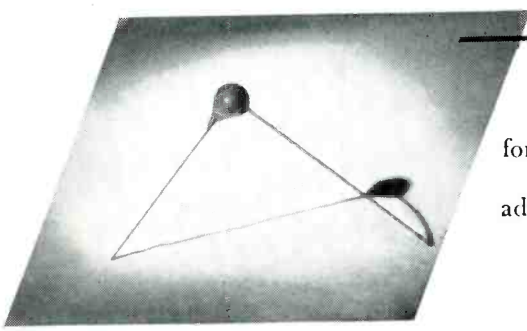
Point Contact Transistors

PN and NPN Photo Transistors



GOLD BONDED

Germanium Diodes



Transistor Products, Inc. Diodes, the smallest germanium diodes made, exhibit more uniform characteristics, higher forward currents, low recovery time, superior high frequency characteristics—offer many advantages for a great variety of applications. *Also available*—Junction Diodes (encapsulated in black plastic case) and Hermetically Sealed Diodes that can be engineered to customer specifications.

Transistor Test Set

A precision laboratory instrument for testing the small signal behavior of all point contact and junction transistors. Purposely designed with great flexibility to insure continued usefulness with new types of transistors yet to be developed.

Write Dept. E6 today for descriptive literature

TRANSISTOR PRODUCTS, INC.

AN OPERATING UNIT OF THE CLEVITE CORPORATION

SNOW AND UNION STREETS, BOSTON 35, MASSACHUSETTS

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Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

Assembly of RCA Victor single-channel uhf selector. Operator is inserting resistor lead in tiny punched slot for grounding to chassis. Simple wood jig supports chassis during assembly work

UHF Chassis Slots

PUNCHED slots in the chassis side walls of a new one-channel uhf television selector serve a number of different purposes in connection with production-line assembly. Two of the slots are precisely dimensioned to serve as exits for two 300-ohm transmission lines. A larger slot serves as a mechanical support for a printed input filter strip; this strip also contains a slot, and the two slots mesh at right angles when the strip is in place.

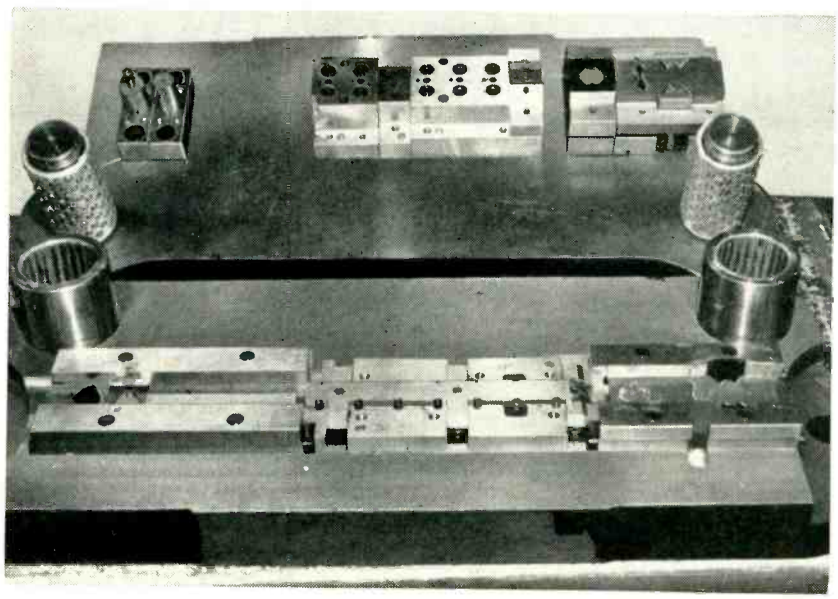
Smaller slots, just large enough for leads, serve as a quick and simple means of grounding resistors and other components to the chassis.

Drawing Integral Eyelets on Tube Sockets

A NEWLY developed die having twelve working stations draws eyelets on metal saddles for tube sockets, eliminating the need for separate individual mounting rivets and punched holes. The die is used in a 35-ton press operating at 120 strokes per minute, hence can turn out 7,200 saddles an hour.

The first two operations are trimming and blanking of the 0.014-inch cadmium-plated cold-rolled steel strip that is automatically fed into the machine. The cup for the plastic socket is drawn next, and wings are bent up to gather material for the eyelets. Three draws are then made on the eyelets, followed by a piercing operation, a final draw, and sizing of the eyelets. The center of the cup is then pierced out and the finished saddle is blanked from the strip.

When crimped to its plastic



Top and bottom dies for producing integral-eyelet saddles for tube sockets. Aligning pins on upper die, surrounded by ball bearings, slide up and down in mating cylinders of lower die. Blank strip stock enters at right, and finished saddles are ejected at left, as indicated by strip shown below

S'matter, Swami, won't it work?

Near-sighted or not, our snake charmer friend should know he can get more out of a wire if it has a well soldered connection. How do we know that? Well, making the right kind of flux core solder for every application has been Kester's sole business for more than 50 years. There's no mystery about Kester Solder, no secret ingredients either. With Kester, quality is the paramount feature . . . the same today as it's always been.

TRIPLE-PLAY! Kester "44" Resin . . . "Resin-Five" . . . Plastic Rosin-Core Solder . . . your best bets . . . with exact core size or flux-content and alloy "tailored" to your requirements.

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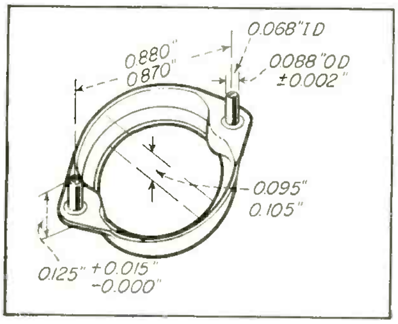
socket at another work position, a socket is obtained that can be securely fastened to a chassis without rivet feed problems. Overall cost is appreciably less than for a comparable assembly having captive rivets, hence the integral eyelet technique offers promise for new mechanized production techniques.



Dimensions of finished saddle having integral eyelets

Interchangeable die sections and open stations make the die flexible for production of different types of similar saddles for tube sockets. Spring-loaded pads keep the strip flat as it passes through the press, preventing damage to drawn eyelets. This new machine tool technique is speeding up press work on tube parts at Sylvania's Emporium, Pa. plant.

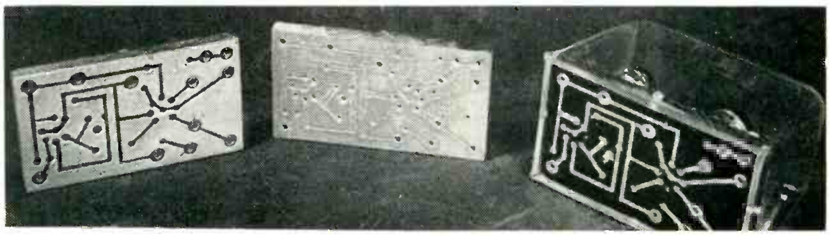
Using Refrigerator as Oven

INSTALLATION of appropriate heating units in an ordinary electric refrigerator converts it into a handy low-cost oven for baking out electronic components. The refrigerator can be an inexpensive secondhand unit in which the cooling mcehanism has failed. The cooling coils can be removed to get additional space inside.

Climbing Flux

THE extra-active noncorrosive liquid flux used in connection with some dip-soldering operations will not stay in an open container, hence stoppers or corks should always be replaced after removing part of the contents. If not done, the liquid will at times climb right up the inside of the bottle and creep out over the top.

Producing Circuits with Molten Metal Spray



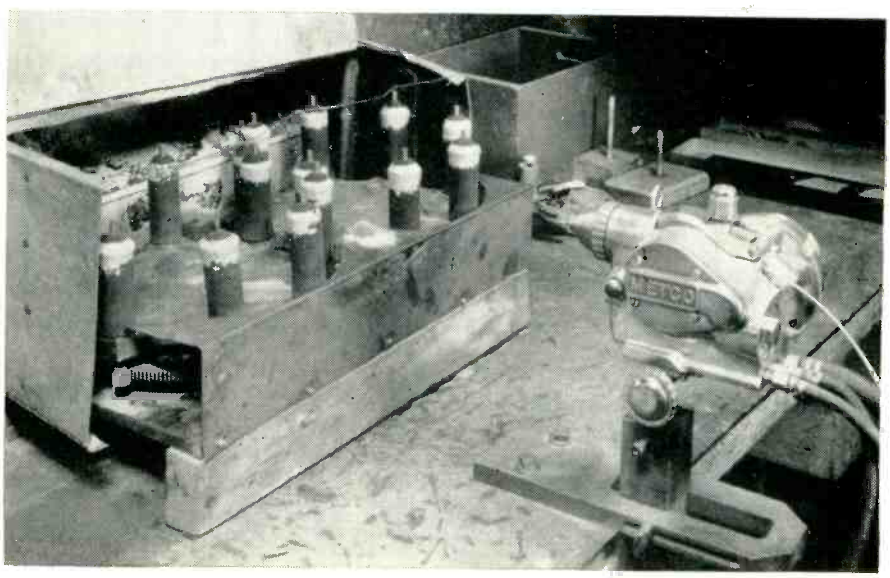
Examples of the three major steps in producing circuit wiring by metallizing. Left—adhesive mask applied to dielectric panel after insertion of eyelets. Center—appearance of masked panel after metallizing. Right—completed amplifier unit after stripping of mask, assembly of components and mounting

A MASS-PRODUCTION process for forming electrical circuits involves spraying molten copper, aluminum or silver on the parts through special masks. As developed by Spraywire Laboratories, Inc., Minneapolis, Minn., the process starts with cutting a stencil coinciding with the wiring design to be produced. This stencil is applied to a dielectric panel and sandblasted to form grooves along the desired wiring location. Molten metal is sprayed through the stencil into these grooves with a standard Metco metallizing gun, and the stencil is removed to complete the process.

The stencils are made from a special masking tape developed for the Spraywiring process by Minnesota Mining & Mfg. Co. The tape is adhesive on one side, and has a sufficiently hard surface to withstand the effects of sandblasting and metallizing. Each stencil is used only once, but cost can be held down in production by die-cutting the stencils in continuous strips.

If feed-through eyelets are applied to the panel beforehand, components can be assembled before the sandblasting operation. The leads exposed on the wiring side will then be sandblasted along with the eyelets and grooves, and the metallizing operation will produce permanent joints. This eliminates the need for soldering.

In a somewhat different application of metallizing for conduction at the Friez Instrument Division of Bendix Aviation Corp., the ends of ceramic resistors for temperature control units are copper-coated with a metallizing gun so that leads may be soldered on. Here it is necessary to hold the preliminary sandblasting and the metallizing to close tolerances in order not to disturb



Setup for spraying molten copper on ends of rotating resistors. Gear drives for the resistors are under the metal housing

PLASTIMIKE

The first all plastic tubular capacitor for use in Radio and TV sets. All plastic case. Mylar* dielectric good to 125°. Epoxy resin seal. Competitively priced with previous types of plastic tubulars. *Du Pont trade mark

GLASSMIKE Jr.

Junior version of CP's famous glassmike, for filter and by-pass use in Radio and TV sets. Glass case, plastic dielectric, good to 100° C. Competitively priced to paper and plastic cased tubulars.

As a result of increased manufacturing facilities Condenser Products Company now offers for the first time

PLASTIMIKE and GLASSMIKE Jr. CAPACITORS

DESIGNED AND PRICED FOR THE QUANTITY PRODUCTION RADIO AND TV CAPACITOR MARKETS

PLASTIMIKE SPECIFICATIONS

VOLTAGE	CAPACITANCE
400 V.	.01 f to 1.0 f
600 V.	.001 f to 1.0 f
1500 V.	.001 f to .05 f

GLASSMIKE Jr. SPECIFICATIONS

VOLTAGE	CAPACITANCE
400 V.	.01 f to 1.0 f
600 V.	.0001 f to 1.0 f
1000 V.	.001 f to .1 f

CP's industry-recognized design and production skills, gained in war and defense production, plus a large increase in manufacturing facilities, enable "CP" for the first time in twelve years to offer quality capacitors to the commercial market at competitive prices. CP's reputation guarantees that for Radio and TV purposes the Plastimike and Glassmike Jr. are the highest quality in the market.

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the essential characteristics of the resistors. Since installing metallizing equipment, production of these resistors has been stepped up 400 percent. Two guns are used in alternate 24-hour shifts.

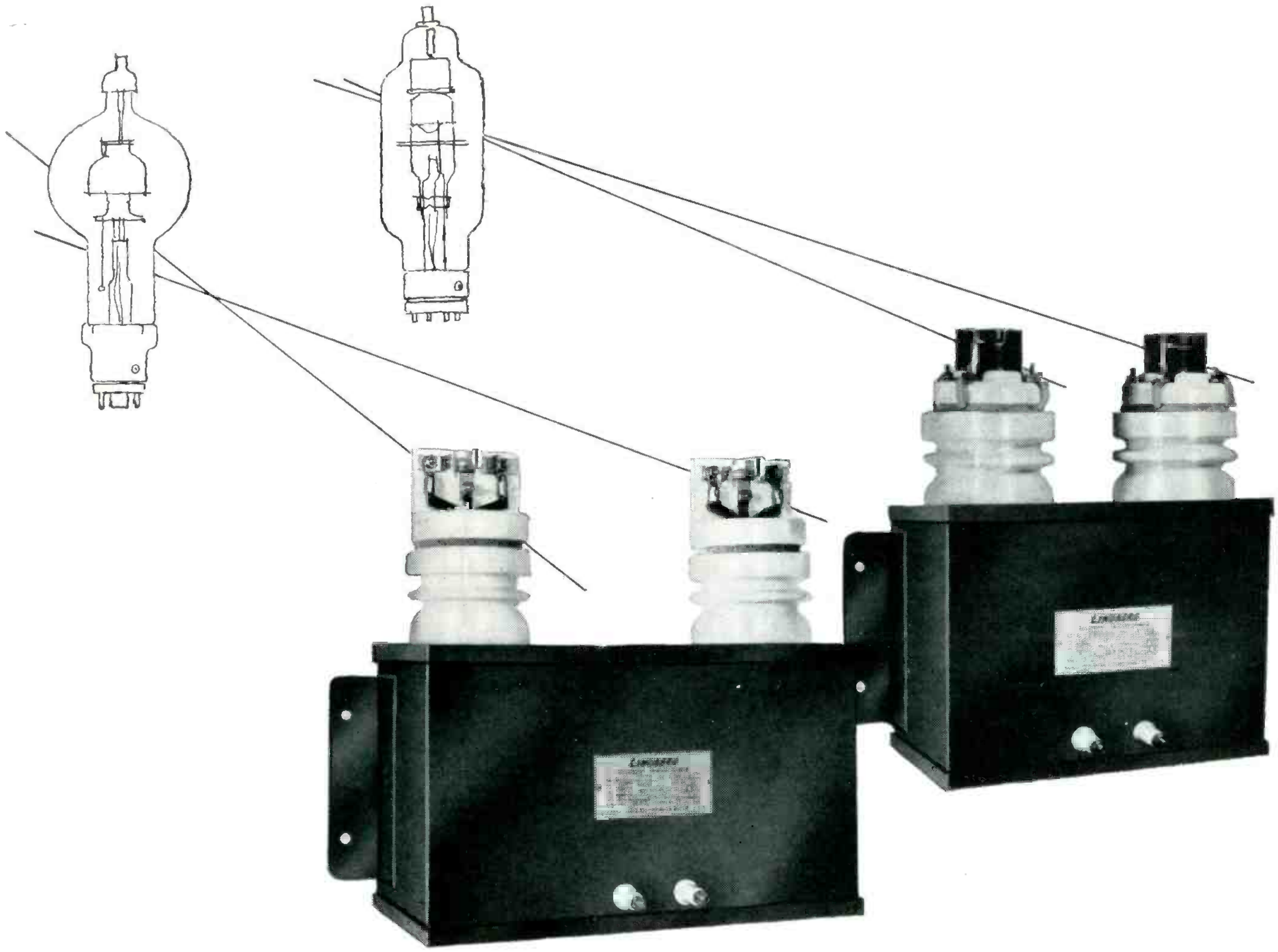
The gun in use is rigidly held in a horizontal position at the edge of the bench by means of a steel stand bolted to the bench. Resistors to be sprayed are inserted 14 at a time in a fixture employing motor-driven gears for rotating the units during spraying. Two large gears mesh together. Equally spaced around each large gear are seven meshing small gears, each rotating one of the resistor holders.

New Electric Arc Torch Cuts Ceramics and Concrete

AN ELECTRIC arc that can be used on nonconductive materials and without a ground connection of any kind is now available from the ChemoTec Division of Eutectic Welding Alloys Corp., Flushing, N. Y. under the tradename Dyna-Trode. The welding rod has two conductors embedded in a hard cement-like material in such a way that a flame-type electric arc about 8 inches long is created in air between the ends of the conductors when the rod is inserted in its special holder and energized. Each rod lasts about 45 seconds and costs about 30 cents. The power source can be any conventional d-c arc welding machine capable of generating 400 amperes or more. Newest development is a smaller rod that will work with a 200-ampere machine.

The 8,000-F temperature of the arc torch is sufficient for piercing just about any refractory material,

Burning through refractory material with new electric arc torch operating from standard welding generator



ANNOUNCING.. *New* ***LINDBERG*** *Dual Filament Transformers!*

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

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

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

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

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

LINDBERG TRANSFORMERS

Transformer Division, Lindberg Engineering Co., 2450 West Hubbard, Chicago 12, Illinois

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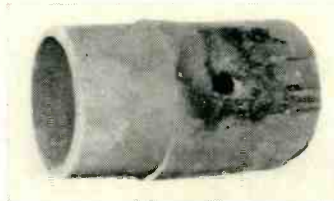


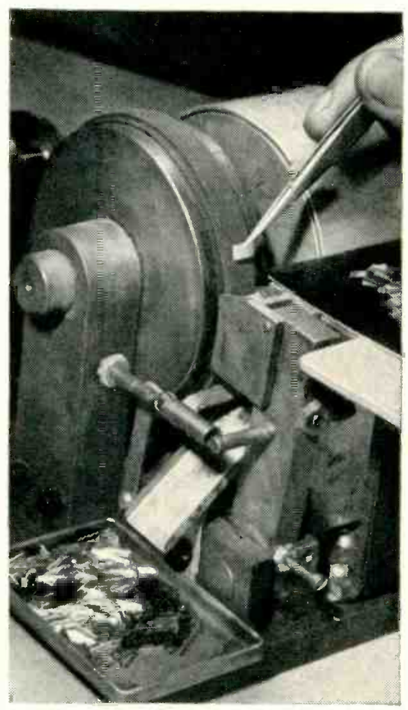
Example of hole made in ceramic bushing with arc torch

including solid stone. For mounting production machinery, holes can be cut in concrete at a penetration rate of 1 to 3 inches per minute, depending on the material. Heavy wire netting or screen can be sliced easily since no contact is needed.

Sleeve-Forming Machine

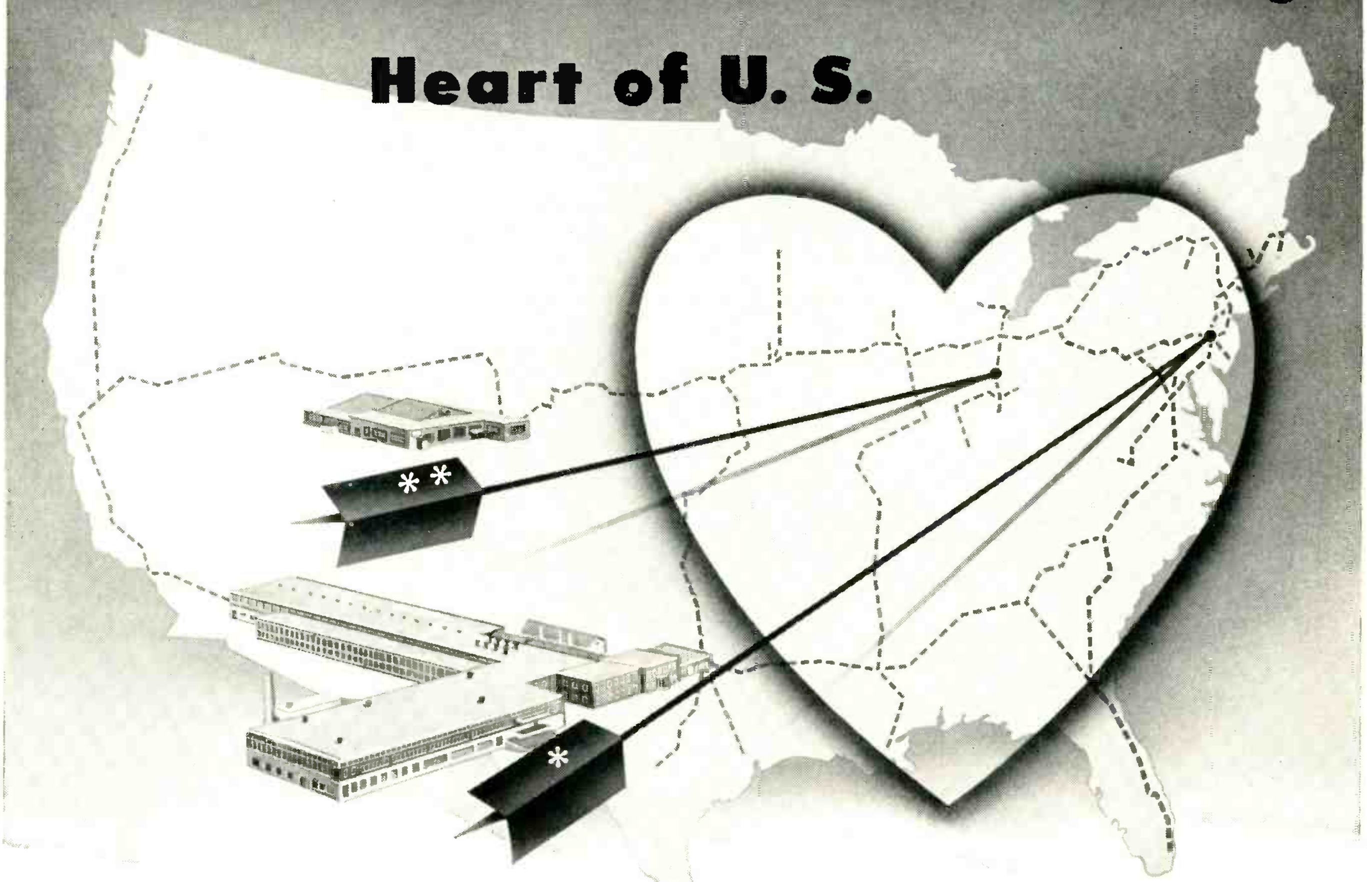
TINY rectangular pieces of Kovar metal are tweezer-fed into an ingenious yet simple machine constructed by production engineers at RCA's Harrison, N. J. tube plant, for rolling into sleeves that are approximately $\frac{1}{4}$ inch long and $\frac{3}{32}$ inch in diameter. The completed cylinder serves as a heat insulator, preventing heat from being conducted away from the sprayed portion of the cathode in uhf pencil triodes.

The flat pieces of Kovar are



Dropping flat piece into sleeve-rolling machine. Finished sleeves drop into tray at lower left

New Plant Locates in Telecasting Heart of U. S.



Things are humming in Wapakoneta, Ohio. There, about 10 miles west of the Dayton-Toledo coaxial cable is the new plant of Superior Tube Company. This plant complements the production capabilities of the Superior main plant, takes care of your ever-increasing demands for television and military purposes.

Superior nickel cathodes are made in a wide range of types, O.D.'s, wall thicknesses and lengths—with or without bead—and in active, normal and passive alloys, depending upon the application and the degree of emission required.

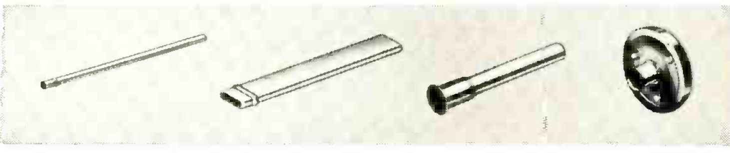
Superior produces both Seamless and Lockseam† nickel cathodes. For many electron tubes Lockseam—made by a patented process from strip stock—has an economic advantage. Superior Seamless shows great advantages in uniformity, close tolerances, and small O.D. for sub-miniature tubes.

Superior equipment is more than matched by the care taken in production. Each melt of alloys is laboratory-checked for emission and performance. Many extraordinary precautions are taken in manufacture to avoid contamination.

Before you order cathodes, first see what Superior engineering, quality, and delivery can do for you.

*Main Superior Tube plant at Norristown, Pa.
**NEW Superior Tube plant at Wapakoneta, Ohio

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



Seamless Nickel Cathode Round, single bead, .045" O.D. x .002" Wall. 27 mm long.

Lockseam† Nickel Cathode Rectangle, single bead, .030" x .100" O.D. x .0021" Wall. 13 mm long.

Seamless Monel, Expanded and flanged. (Exp. to .165"/.168" I.D.—Fl. to .230") .139 O.D. x .005" Wall x 1.100" long.

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

Superior
THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O.D.

Certain analyses (.035" Max. wall) up to 1⅞" O.D.

†Manufactured under U.S. Patents

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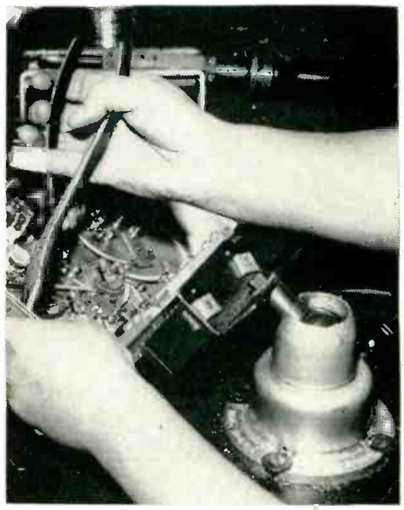
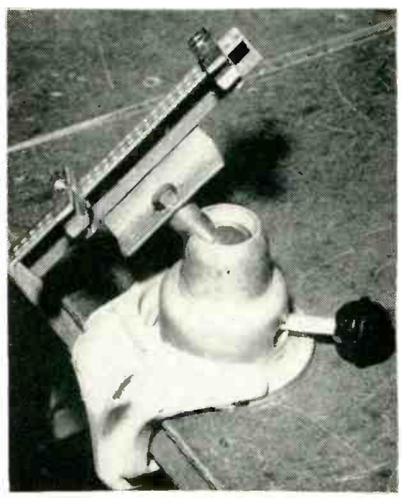
inserted between a steel mandrel and a rubber-faced motor-driven wheel. The mandrel puts an initial curve in the entering Kovar piece. As the wheel continues to rotate, the Kovar is carried downward between the wheel and a concentric fixed rubber block. This block is spaced from the wheel a distance equal to the outside diameter of the finished sleeve. As the Kovar travels down the block, it forms the desired cylinder.

Chassis-Holding Fixtures

FOUR different types of fixtures for supporting a chassis on a ball-and-socket holding tool are illustrated here. The first three, used by Du-



Type of holder used for gripping side of chassis. A screwdriver is required for inserting and removing a chassis. This setup is sufficiently rigid for heavy soldering and assembly work



Closeup of chassis-holding fixture, showing also how C-clamp is used to fasten holding tool to bench

New G-E Electronic Relay: Highly Sensitive to Resistance Changes

SPECIFICATIONS

HIGHLY SENSITIVE

Even a wet thread will provide enough signal to operate this relay.

TWO TYPES OF OPERATION

Relay can be set for either "normal" operation (relay "drops-out" when external resistance is decreased to a value between zero and four megohms*) or "reversed" operation (relay "picks-up" when external resistance is decreased to a value between zero and two megohms*).

*Depending on dial setting.

DIAL ADJUSTMENT

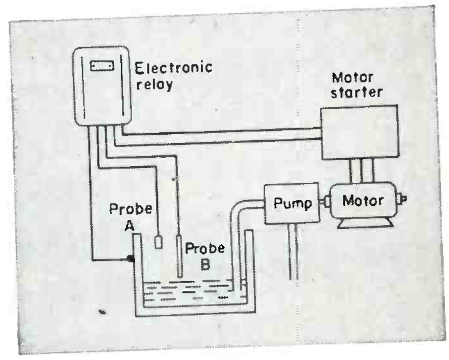
Sensitivity level set by adjusting dial, which can be locked in place. Relay may be remote controlled from as far away as 500 feet.

CONSTRUCTION

Enclosure is weather-resistant and dust-tight (NEMA Type III and V).

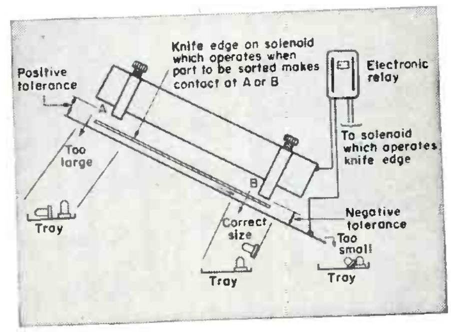
Can Be Used for Liquid-Level Control

This new electronic resistance-sensitive relay can control liquids between two predetermined levels. Relay will start a pump when liquid-level reaches probe A, will continue pumping until liquid falls below probe B. Then it shuts itself off until liquid again reaches probe A. This operation can be reversed to keep the tank full.



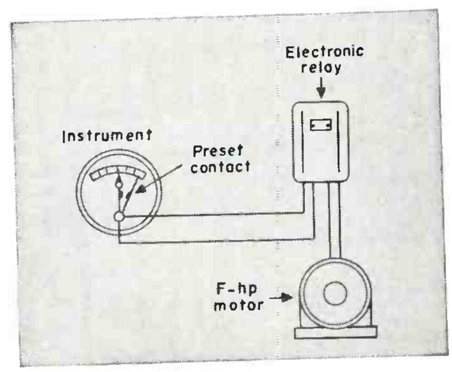
Can Be Used for Sorting Small Parts

Oversize parts touch contact "A," closing electronic relay input circuit. This relay energizes solenoid which directs part into a container for oversize parts. Point of contact "B" is set at standard height less tolerance. Parts touching this contact point are acceptable and are "shot" down another chute. Undersize assemblies do not touch either point and slide to a third tray.



Can Operate from Contact-Making Instruments

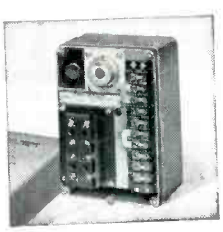
The G-E electronic resistance-sensitive relay is able to amplify even the minute currents carried by the delicate contacts of contact-making instruments. For instance, the relay can be arranged so that it will start or stop a f-hp motor directly when an ammeter, voltmeter, or wattmeter reaches the required meter reading.



PHOTOELECTRIC RELAY CR7505-K100

One of a complete line of devices for all photoelectric applications. Inexpensive, has broad application. Bulletin GEA-3533D.

ELECTRONIC TIMER CR7504-A142



Handles timing over three ranges, .06-1.2, .6-12, 6-120 seconds. Highly accurate, versatile. Bulletin GEA-5255B.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or authorized G-E distributor, or write General Electric Company, Section E785-4, Schenectady 5, New York, for the following bulletins:

☐ Electronic Resistance-Sensitive Relay, GEA-5893
☐ Photoelectric Relay, GEA-3533D
☐ Electronic Timer, GEA-5255B

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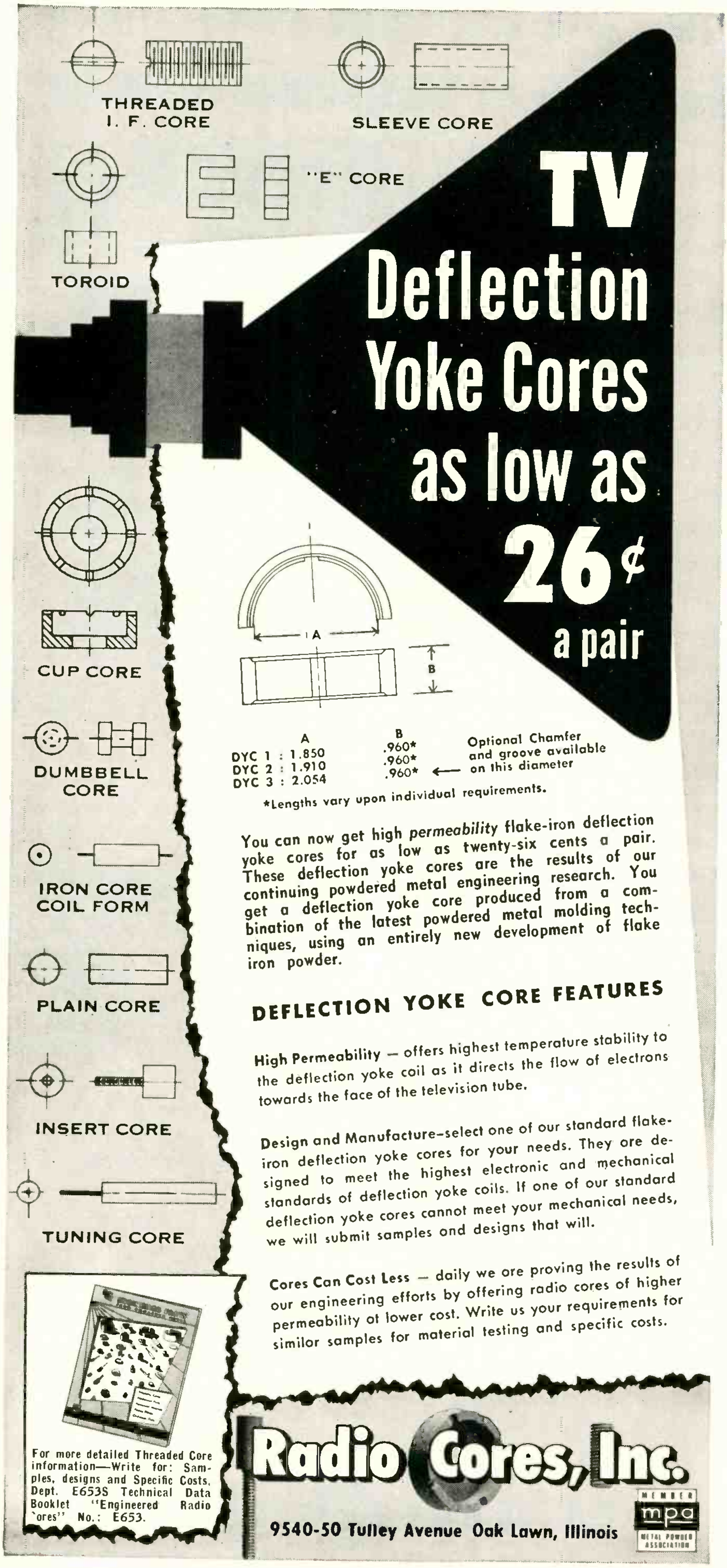
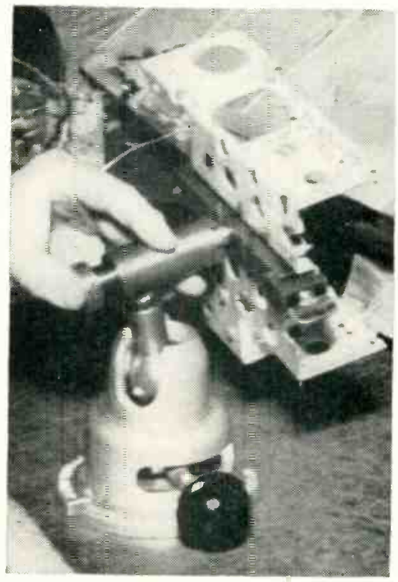
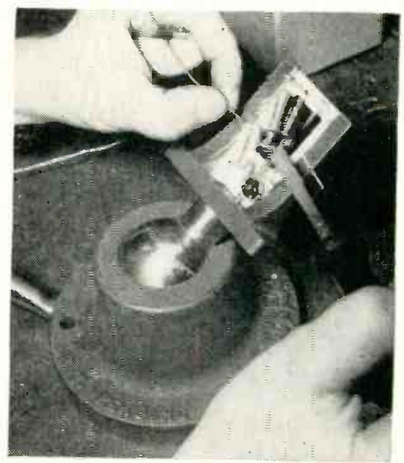




Indexing-type chassis-holding fixture. By pushing end of shaft against spring action as shown, operator can rotate entire chassis to desired new position. Crossbar in shaft drops into slots in outer sleeve of fixture to give rigid locking when thumb is released

Mont, apply to average-size multi-tube chassis units. The fourth, used by Federal, is for sub-miniature equipment.

Also illustrated are different ways of fastening these tools to a bench. The Powrarm Junior tool with a ball-handle locking lever is either fastened more or less permanently with wood screws or tempo-



Combination slide and peg fixture for terminal board subassembly work in connection with subminiature equipment. Terminal board slides in grooves, going down between metal spacing rods inserted in bottom of fixture. Rods on one side serve to space silver-button mica capacitors off the chassis, and rods on the other side space four paralleled ceramic capacitors off the chassis

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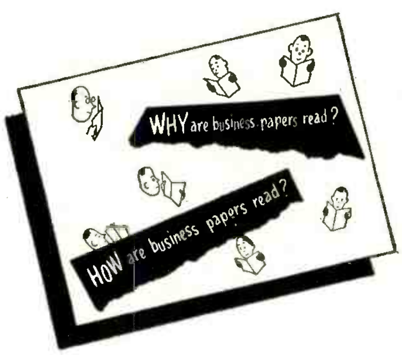


A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet." Room 2710.

McGRAW-HILL PUBLISHING COMPANY
330 West 42nd St., New York 36, N. Y.

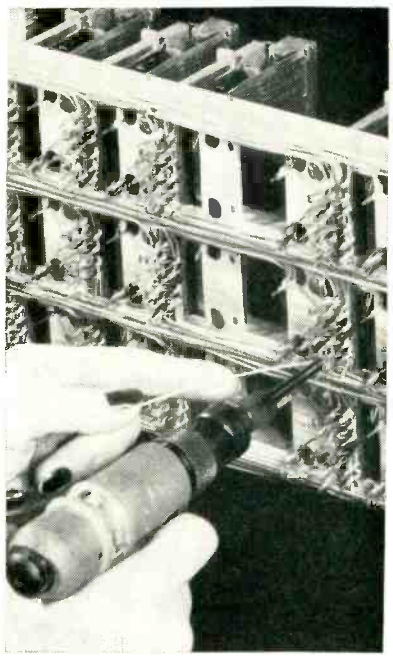
One of a series of advertisements prepared by THE ASSOCIATED BUSINESS PUBLICATIONS rarily with a special C-clamp going over the edge of the bench. The smaller Reypo unit with a locking lever is heavy enough by itself to support a subminiature chassis.

New Wiring Tools Make Solderless Connections

AN AIR or electrically operated wire-wrapping tool, developed by Bell Telephone Laboratories for connecting wire leads to relay terminals, is giving better, more uniform and less costly connections at a much higher production rate than was possible with previous wiring methods. Solderless wrapped connections can be used with a wide variety of materials, including aluminum.

The new tool is now being used extensively in commercial practice by Western Electric Co. for wiring to flat spring relay terminals. Although it was originally expected that tinned terminals and wire would have to be used, with subsequent soldering to give a stable low-resistance junction, it has recently been shown that soldering is not required if certain dimensional conditions are satisfied by the terminal and the wrapping tool.

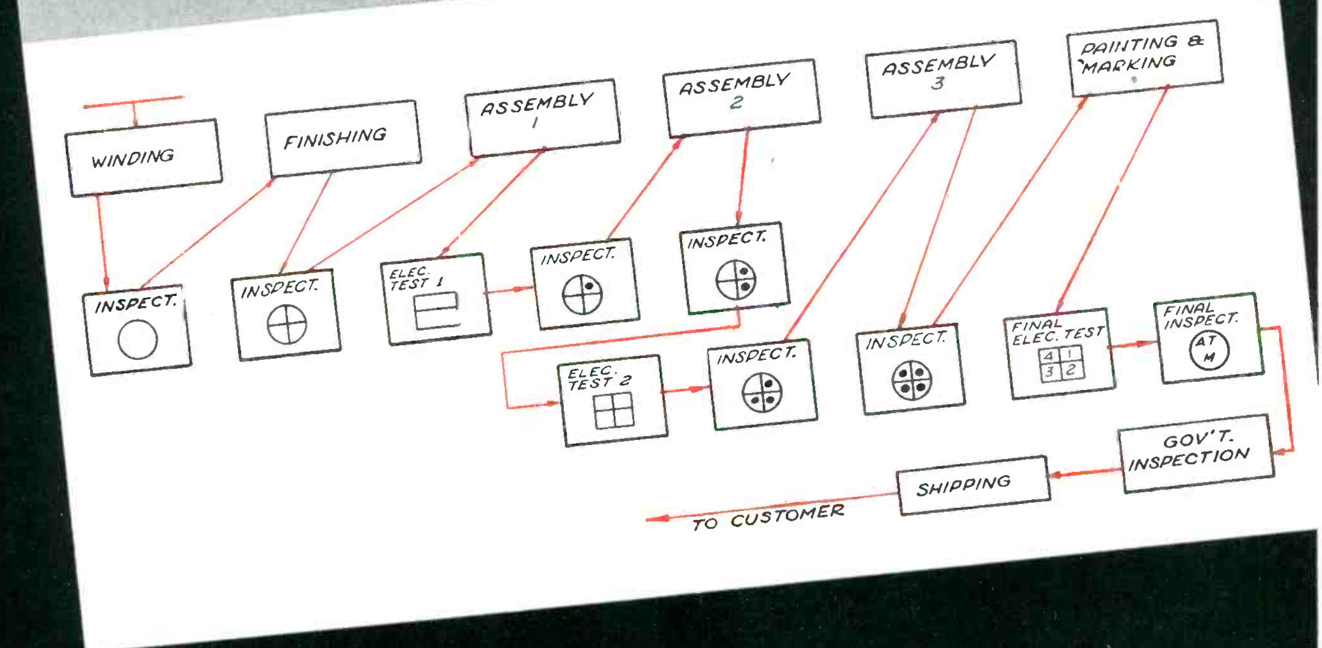
The tool consists essentially of a



Using air-operated commercial version of wrapping tool for making solderless connections to plain rectangular terminals on a relay rack

Quality First

Your Transformer Has To Pass These 10 Inspections



Equipment pictured are samples of the various types of transformers manufactured by Aircraft Transformer Corporation, originators of the famed FORMFLEX

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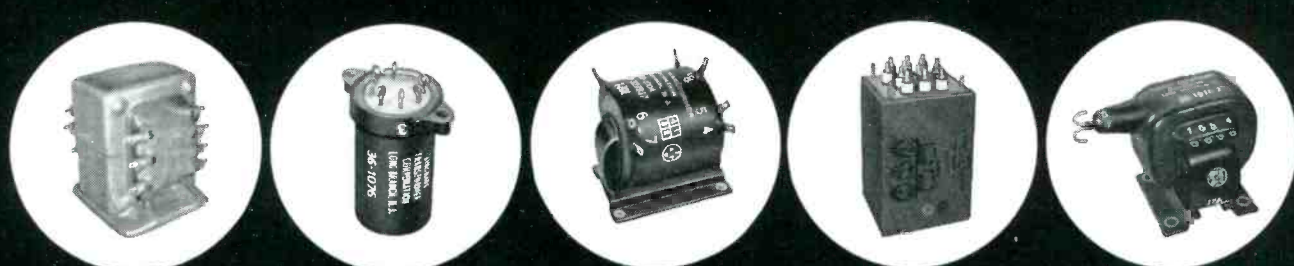

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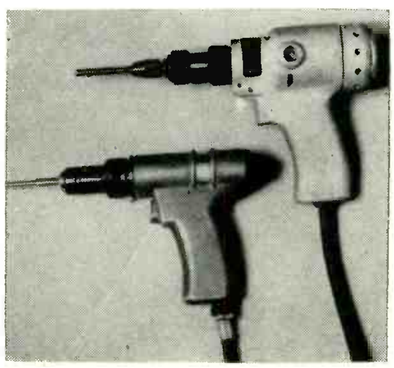
Closeup view of relay base, showing appearance of solderless wrapped connections. The wrapping tool starts its winding at the bottom of the terminal and works outward until it runs out of wire

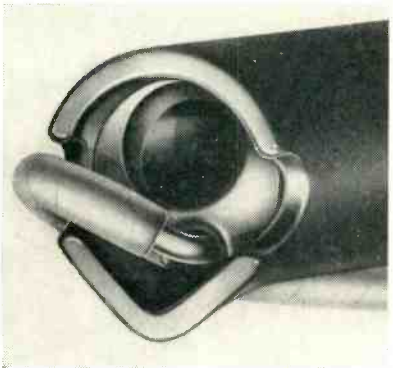
rotatable spindle housed in a stationary sleeve. To make a connection, the bare end of the connecting wire is inserted in the outer groove of the spindle up to the insulation, then bent upward and back along the spindle so that the insulated portion of the wire is anchored in one of the notches in the outer housing of the tool.

The operator holds the insulated wire against the housing with his left hand, then applies the tool to the terminal so that the terminal enters the round hole in the spindle. The trigger-type electric switch or air valve on the tool is then operated, causing the spindle to rotate. This wraps the bare connecting wire around the terminal under tension.

Since the wire is anchored at the



Commercial versions of wrapping tool, with air-operated model below. Both have trigger-type control for starting and stopping the rotation of the inner spindle

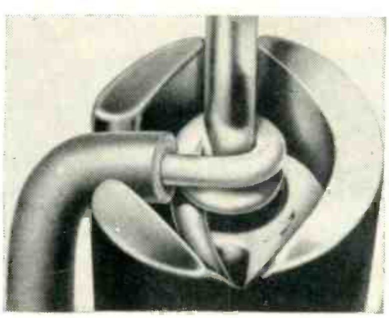


End of wrapping tool, with wire in position ready for wrapping. Wire is inserted in outer slot of spindle as shown, and terminal goes in round hole of spindle

notch, it is free to move only at the bare end. The wire is thus drawn out of the slot to form a helix on the terminal. The number of turns in the helix is determined by the length of the bare wire inserted in the slot of the spindle.

When the end of the bare wire emerges from the slot, the tip extends outward from the helix as a tail. By careful design of the tool, this tail is kept short enough to avoid contact with adjacent terminals in congested areas. The length of the tail is determined by the distance between the slot and the terminal hole in the spindle and, in the case of a rectangular terminal, by the position of the slot at the moment that the end of the wire emerges from it.

Although initial models of the wrapping tool were hand-operated, using a rack and gear to obtain the required rotary motion, the commercial versions make use of either electrical or air power to eliminate operator fatigue and to promote



Muzzle of wiring tool, showing appearance of connection at the instant when two turns have been wrapped around terminal by rotation of the inner spindle in the direction shown by the curved arrow

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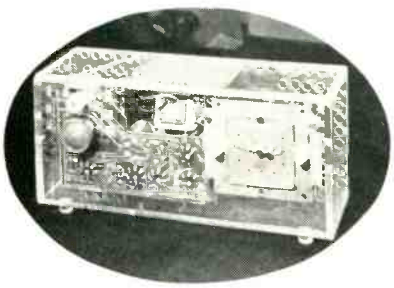

Demonstration model of one of the first commercially successful radios utilizing a prefabricated wiring board furnished by METHODE. Courtesy Hallicrafters Co.

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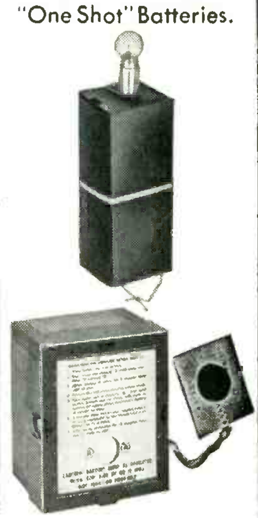

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Example of finished solderless wrapped connection on rectangular terminal

uniformity and speed. Licenses for manufacture of the tool are now being issued by Western Electric Co.

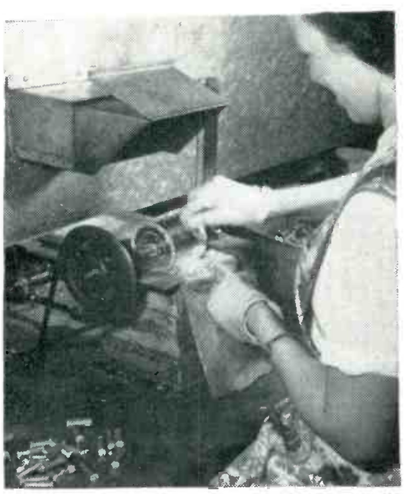
Anti-Stick Coating for Electronic Sealing Electrodes

POLYTETRAFLUOROETHYLENE, marketed under the trade name Teflon, is being used successfully as a coating material where its anti-stick property is needed. In electronic equipment for sealing cellophane, polyetheylene or other sheet thermoplastics, a liner of Teflon on the electrode shoes which contact the material will prevent its sticking to the shoe at the high sealing temperature.

V-Notched Soldering Jig for Capacitor Pigtails

SOLDERING of leads to bodies of paper capacitors is done efficiently at Pyramid Electric Co. with the aid of two production devices.

Aluminum-foil capacitors are pre-



A quick brush across the face of a drum rotating in molten aluminum-alloy solder is sufficient to compress and tin the exposed foil ends of a rolled aluminum-foil capacitor unit

Pigtail is dipped through solder pot with a sweeping motion to minimize pickup of dross on surface. Body of capacitor is in left hand, ready for quick application to lead

pared for pigtail soldering by tinning with aluminum solder. A motor-driven metal drum revolves in a pot of molten solder. Holding each end of the capacitor roll in turn against the face of the cylinder removes oxidation from the exposed foil ends and applies solder before the oxide can re-form. A gearbox under the bench reduces speed to about 100 rpm at the drum.

The duct for drawing off fumes has a hinged door on a sliding hood; when the hood is pushed back, the door swings down over the opening to close it, reducing the load on the vacuum system when the tinning operation is shut down.

Pigtail leads are soldered to the tinned ends of both lead-foil and

Method of pressing capacitor against pigtail held in jig aluminum-foil capacitors with the aid of a V-notched jig. The spiral end of a pigtail is dipped into a pot of molten solder and quickly placed in the slot of the holding jig. The tinned end of a capacitor body is then pressed against the spiral of the lead until the solder solidifies. Two V-shaped notches on the jig serve to position the body of the capacitor and the lead so they are centered with respect to each other. The notched piece for the lead can be adjusted in height as required for any diameter of capacitor body.

Tape Cutting Techniques

THE PROBLEM of cutting adhesive tape into the various lengths required in the manufacture of television receivers is solved in two different ways at Olympic. Both use tools originally made for other purposes, one being a wire cutter and the other an ordinary single-edge razor blade.

Adhesive-backed cork strips that go under the steel clamping band of a picture tube are cut to length with a bench setup built around a model C20 Simplex wire cutter made by Wenco Manufacturing Co., Chicago. The guillotine-type blade of this cutter is operated by a foot pedal. Attached to the bench at the right of the cutter is a yardstick,

Setup for cutting picture-tube cushioning bands

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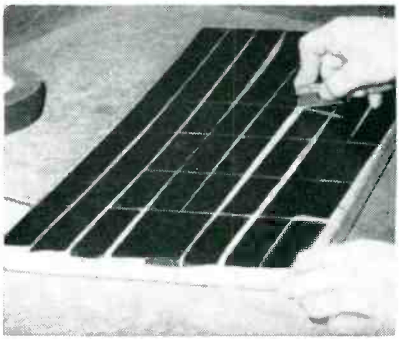


Using razor blade to cut one-inch vinyl plastic tape into short tabs after placing the long strips on a 1 x 10-inch pine board

with a grooved strip of wood alongside it for an adjustable stop. The groove is undercut to resemble a mortise, and the wood stop is cut like a tenon. A locking nut on the stop permits anchoring at the position corresponding to a desired length of tape.

A pipe mounted in a bench vise provides a holder for the spool of tape to be cut. This arrangement is admittedly temporary, and was used only because the vise happened to be there already. The operator merely pulls the tape through the cutter to the stop and operates the foot pedal. The adhesive coating on this tape is protected with strippable cloth, hence cut pieces can be stacked without danger of sticking together.

To cut plastic adhesive tape into strips for fastening deflection yoke leads together, the operator unrolls the tape onto a piece of plywood, cutting each length off the roll with a razor blade. When the board has been covered with these long strips, a few quick cross cuts with the blade divide them all into the desired shorter lengths. The individual pieces are then lifted off the board with fingers as needed. Quantities required here were small enough to justify this unmechanized procedure.

Iron-Clad Soldering Tips

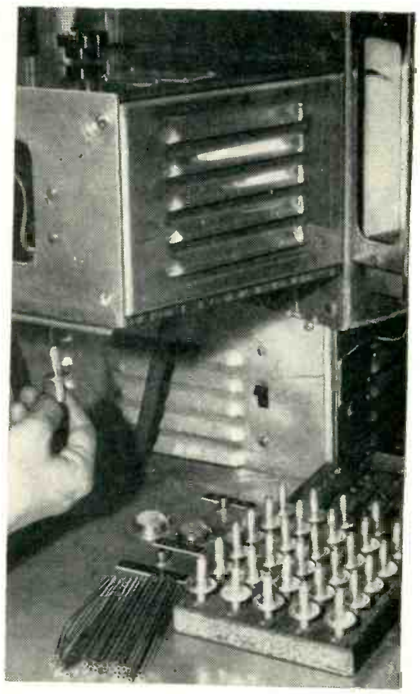
AN IMPROVED process for iron-plating industrial soldering-iron tips increases tip life up to 100 hours in production-line use. A 2-inch-long coating of commercially pure electrolytic iron is electroplated on the tip. Further treatment obviates oxidation and corrosion and in addition prevents amalgamation of the solder and copper.

Another saving with iron-clad tips is reflected in reduced manhours required for reservicing and replacement of soldering tips. The process has been perfected by American Electrical Heater Co. of Detroit and has been successfully tested for over two years under difficult industrial soldering conditions.

Brazing Exhaust Tubes

SOFT copper exhaust tubes for RCA pencil triodes are brazed into the anode sleeves by using an automatically timed induction heater having two heating positions. The operator inserts the exhaust tube in the anode, slips two ring-shaped silver solder preforms over the tube, then pushes the assembly into a water-cooled spring chuck just under the work coil.

The exhaust tube and anode extend beyond the chuck and into a glass sleeve. Hydrogen is pumped through this sleeve to provide a nonoxidizing atmosphere for the silver



Electronic heating setup for silver-brazing exhaust tube to pencil triodes on wood rack at right. Metal box with viewing window provides operator protection. At upper right is hydrogen flow meter brazing operation. The r-f work coil is outside the glass sleeve. A metal cover encloses the entire working chamber. One tube is assembled and loaded while the other is going through its heating cycle at the RCA tube plant in Harrison, N. J.

Aging Television Sets on Cabinet Line

BY PROVIDING power facilities on the final roller conveyor line in the Olympic Radio & Television plant, highly valuable extra minutes of aging are obtained while knobs are being installed and other finishing operations carried out.

Plugging television set into connector that slides in power trough mounted alongside conveyor line

As soon as the chassis and picture tube are installed, the operator plugs the line cord of the set into a Universal Trol-E-Duct, made by Bulldog Electric Products Co., Detroit. The set then tows this connector down the line.

Tube Tester Adapter

WHEN large groups of tubes require testing prior to installation in production-line equipment, use of a special adapter devised by W. M. Savage and R. R. Edinger of the U. S. Naval Air Station in Norfolk

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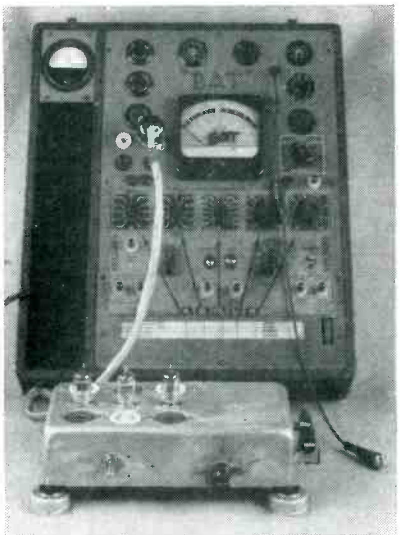

Method of connecting adapter to standard tube tester with cable and plug. This unit has three each of three different types of sockets (4-pin, octal and 7-pin miniature), to permit warming up two tubes while one is being tested

cuts tube testing time in half. This saving in time is achieved by providing additional sockets in which tubes can be warmed up. A switch is used to place any one of the sockets into the test circuit while tubes in the other sockets are warmed up.

An additional feature simulates normal aircraft vibration during the test. This is achieved by mounting inside the adapter chassis a small electric motor having a few drops of solder on one side of its shaft. The adapter is mounted on four two-pound rubber shock mounts, so that the tubes are given a vibration check when the motor is turned on.

Extension Drill Rod

NEED for costly special-length drills for hard-to-get-at drilling locations is reduced through use of a new drill extension rod and a series of 52 small-diameter extension chucks. These chucks permit use of standard-length small drills in the extension rod without time-consuming brazing or soldering operations.

Chuck sizes correspond to standard drill sizes from No. 52 to No. 10 and to fractional drill sizes from $\frac{1}{16}$ inch to $\frac{3}{16}$ inch by 64ths. The anti-slip chucks can be inter-

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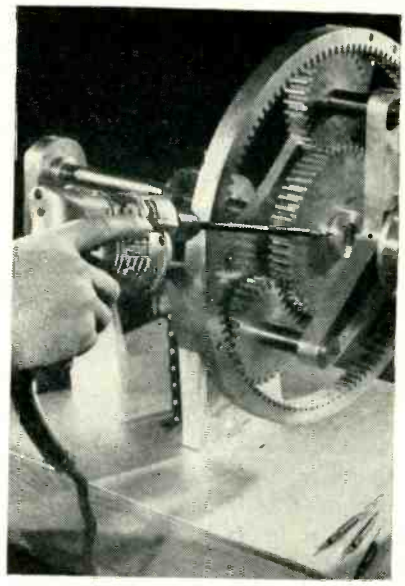


Using drill extension rod with ordinary electric drill. Individual chucks are available for each drill size, as at lower right

changed in a few seconds. The extension rod fits any quarter-inch electric drill or lathe chuck. Manufacturer of the new tool accessory is Beaver Tool Co., Box 298, Huntington, L. I., New York.

Deflection Yoke Production Techniques

PRODUCTION of 70-degree and 90-degree deflection yokes in DuMont's E. Paterson, N. J. plant involves

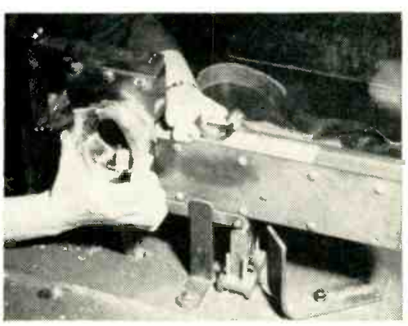
Pressing 90-degree yoke coils to shape

Placing yoke coil assembly in insulation-wrapping fixture, after placing tape on slide, adhesive side up, and placing end of varnished cambric strip on tape

many special techniques developed to maintain quality despite increasingly stringent design requirements for use on large picture tubes.

Yokes for 90-degree picture tubes are wound automatically on special machines in DuMont's plant, tied loosely with tape, dipped in varnish, baked in an oven for about 20 minutes, then quickly transferred one by one to a forming press while still hot. The press squeezes the coil to its precise final shape. Each coil is left in the press about 12 seconds, which is sufficient to cool and set the varnish because the mass of metal in the press conducts heat away rapidly.

Assembly of coils comes next, with Saran sheets between the horizontal and vertical pairs for insulation. Additional Saran insulating sheets are wrapped loosely around the four-coil assembly and anchored with tape. The yoke is then held in the jaws of a special foot-operated roller fixture and the foot pedal



Rotating yoke by hand to wrap insulation around it under pressure. Tape sticks to Saran and pulls the cambric around as the yoke is turned

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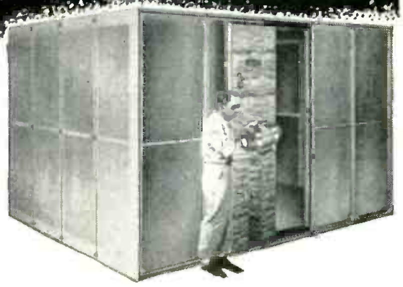

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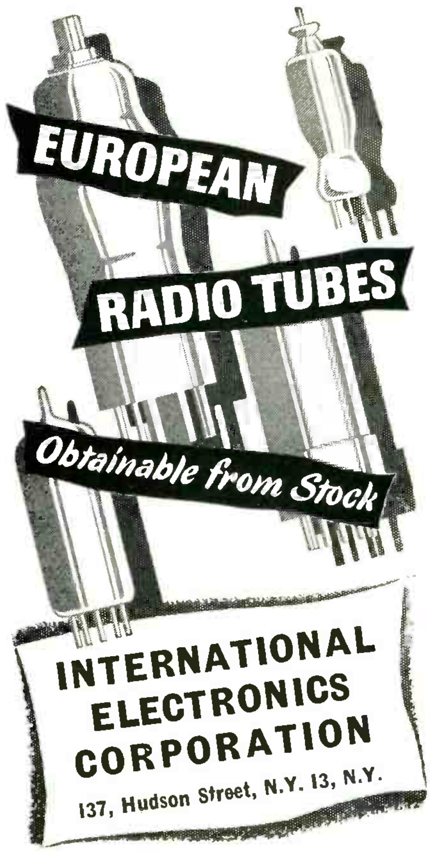

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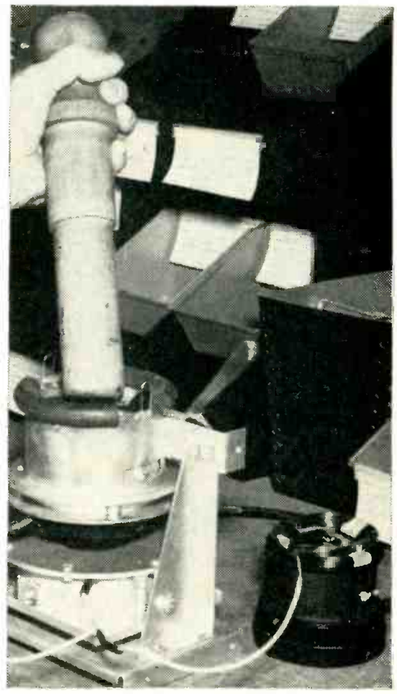
Use of modified banding machine to fasten Ferrite cores around 70-degree deflection yoke

is operated to close the jaws. The rollers bear against the insulation and force it down into the groove of the coils. Rotating the yoke by hand now wraps a previously applied narrow strip of varnished cambric insulation around the yoke down in the groove, to form a smooth bearing surface for the core. Another tab of adhesive tape locks the cambric in position to complete the insulation job.

The two half-sections of the Ferrite core are set into the groove of the yoke and locked in position with a banding machine. This is an adaption of a standard banding machine, in which the operator operates a ratchet lever to tighten the band, then pushes a foot pedal to cut the band after it has been locked.

To adjust finished yokes for minimum cross coupling, a filament transformer is used to energize one

Rotating yoke by hand to wrap insulation around it under pressure. Tape sticks to Saran and pulls the cambric around as the yoke is turned



Wood rod used to keep dirt out of completed yoke assembly during testing of individual coils

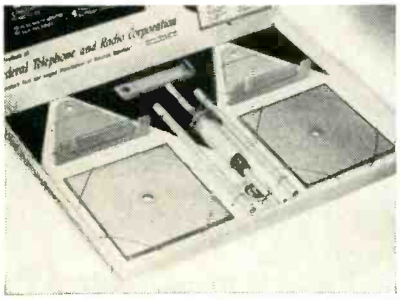
pair of deflecting coils, and the other pair is connected to a cathode-ray oscilloscope. The two pairs of coils are then rotated with respect to each other until the pattern seen on the scope is between masking tape lines indicating acceptable cross coupling. Usually the coils can be turned sufficiently without loosening the clamping band.

After cross coupling has been checked the coils are cemented to keep them in position.

In RCA's Camden plant, a wood rod resembling a potato masher is used to keep the deflection yoke in its correct shape during assembly and to keep out steel particles and dirt that might otherwise get in during testing and damage the enamel insulation on the coil wire. The rod is in two sections, of different diameters, for use on two different sizes of yokes. The wood is turned to give a loose fit, so as not to scratch the coil.

Rectifier Assembly Kit for Pilot Runs

SELENIUM rectifiers needed for experimental work or very small production runs can be assembled to order in a few minutes from component parts available as a kit from



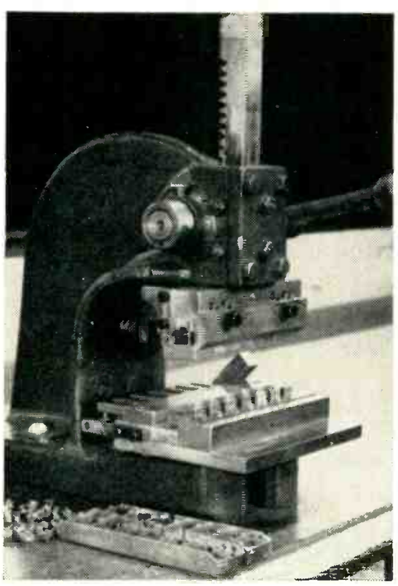
Selenium rectifier kit

Federal Telephone & Radio Corp. Each kit contains sufficient hardware and parts for assembling any one of four different rectifiers—half-wave, full-wave center tap, full-wave bridge-type and full-wave battery charger.

Accompanying instructions, diagrams and tables give assembly procedures and operating ratings for 24 different assemblies. Rectifiers can be taken apart and reassembled to meet modified conditions, thereby permitting equipment design changes without loss of time in reordering and without delays associated with filling of small special orders.

Arbor Press Mounts Subminiature Sockets

SEVEN SUBMINIATURE tube sockets are simultaneously forced into self-locking holes in a chassis for the Signal Corps model PRC-6 transceiver, by using a modified Royersford Excelsior No. 0 Arbor press;



Arbor press modification for inserting subminiature sockets in chassis, as used at Utility Electronics

Want more information? Use post card on last page.

the bottom jig on the press holds and locks the sockets upside down precisely in final positions. The blank chassis is held in the top part of the press by springs. Operation of the press handle then forces the chassis down over the sockets.

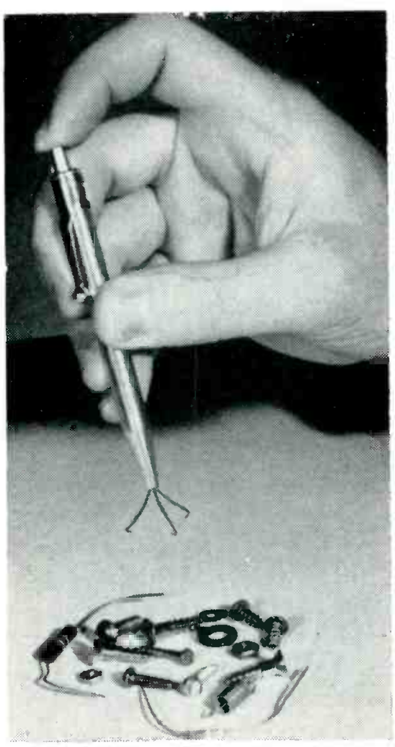
Carbon Tet Dispenser

WHERE carbon tetrachloride is occasionally needed for cleaning metal parts at incoming or outgoing inspection positions, it can be kept in an ordinary window cleaner spray-dispenser bottle ready for convenient use.

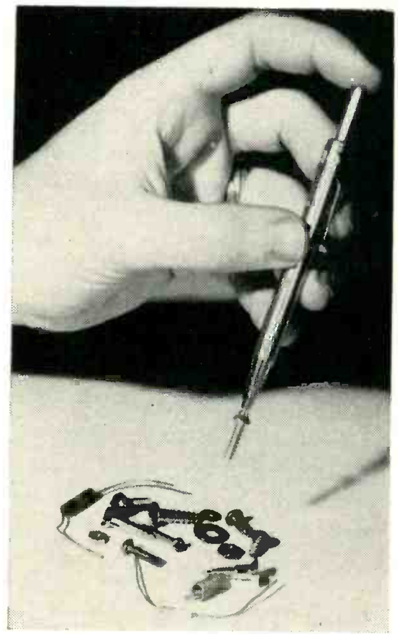
Pick-Up Tweezers

HANDLING of small objects is made easier by new automatic pick-up tweezers about the size of a fountain pen. Depressing the top plunger of the tool causes three hooked spring-steel fingers to extend from the tip and flare out. When the plunger is released any object within the grasp of the fingers is firmly held. Maximum spread for gripping is over one inch.

The new tool, available from Win Sales Co., Forest Hills, N. Y., is ex-



Depressing top plunger spreads pick-up fingers of stainless steel tool

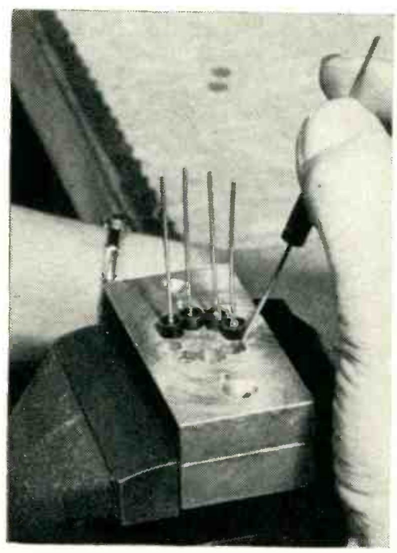


Releasing plunger of tool retracts fingers for gripping screw or other small object

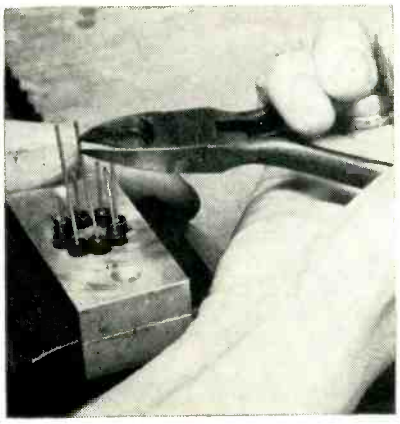
cellent for picking up oddly shaped objects, hot objects, pieces that are difficult to grip or adjust because of their size or shape, and highly polished pieces that must not be handled. It can hold or adjust parts in spaces too cramped for a hand.

Soldering Resistors

THE PROBLEM of connecting eight matched carbon resistors in parallel with practically zero lead length while holding the combined final resistance within 0.6 ohm of the



Inserting resistors in brass jig as first step in obtaining a parallel connection with practically zero lead lengths



Cutting resistor leads to different temporary lengths to facilitate insertion of leads in holes of end plate

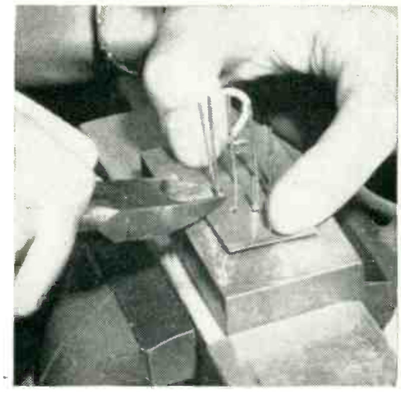
required 51.26-ohm value was solved through use of a unique assembly and soldering procedure in the Clifton, N. J. plant of Allen B. Du Mont Labs, Inc.

The required short leads precluded use of heat-absorbing clips during soldering. To prevent heat from changing resistor values, heat-absorbing blocks are used as assembly jigs. The first block is clamped in a vise and the eight resistors are inserted in drilled holes arranged in a circle, going partly through the block. The bottom leads project down through the bottom of the block through smaller holes.

As the next step, the operator cuts the upper leads each to a different length with side-cutting pliers, to facilitate placing the final end plate over the leads. After the leads have been inserted in the eight holes of this plate, the leads are all cut off flush with the top of the plate and then soldered to the plate. Care is taken to solder as quickly as possible, to minimize heat rise. The copper jig quickly absorbs any heat that does get to

Soldering leads to end plate

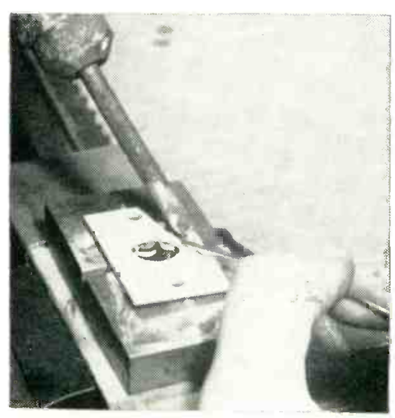
Want more information? Use post card on last page.



Use of spacer sheet as guide for cutting leads at other end of group to final length. Heat-absorbing brass block is divided into two parts so it can be removed after soldering is completed. Finished end plate rests in hole in wood jig clamped in vise

the resistors. After each lead is soldered, carbon tetrachloride is applied to speed cooling; this is done by shaking a brush filled with the fluid over the joint while the solder is still molten, then applying the brush directly.

Next, the group of eight resistors is lifted out of the block and placed upside-down in a wood jig held in another vise. Two brass blocks are now set against the sides of the resistor group. The upward-projecting resistor leads are cut to different lengths as before, a copper spacer sheet is fitted over them to serve as a guide for cutting to the final counter-sunk depth, and the guide sheet is removed. A permanent heat-absorbing core is now placed in the center of the resistor group, the other permanent end plate is dropped over the short leads, and the joints are carefully



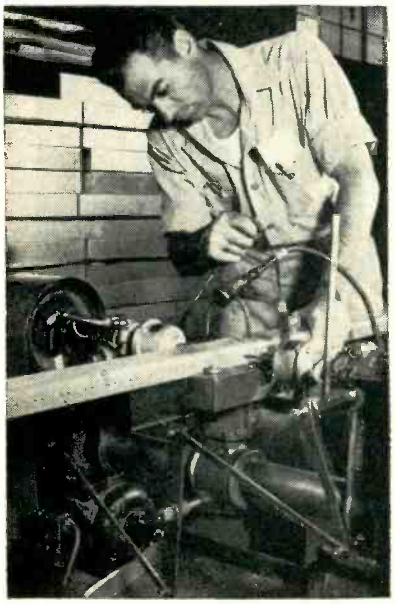
Final soldering operation

soldered one by one just as for the other end. The holes in this plate are countersunk, and solder must be applied carefully so it does not project above the surface. For the intended application, filing of surplus solder was not permissible.

This elaborate assembly technique was necessary because space limitations in the final equipment prevented use of longer leads.

Dual-Head Tapping Machine

TAPPING holes on both sides of U-channels for transmitter cabinets has been speeded up at the Brooklyn, N. Y. plant of Karp Metal Products Co. by the use of two automatic tapping heads mounted facing each other. The pre-drilled channel is placed between the two heads and the holes aligned with the taps. A single control lever is then operated to move both heads toward the channel simultaneously.



Dual-head tapping machine uses single-lever control to speed tapping of holes in U-channels. The W-shaped linkage is in foreground. Dual-outlet coolant pipe is directly over taps

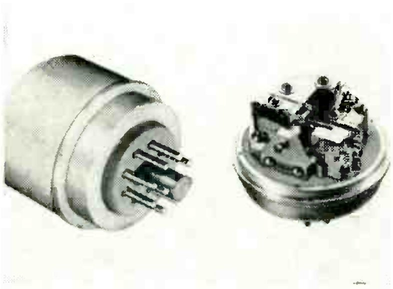
Control of both heads from one lever is accomplished through a W-shaped linkage. Coolant for both taps is brought through a flexible tube to a dual outlet head positioned over the work.

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

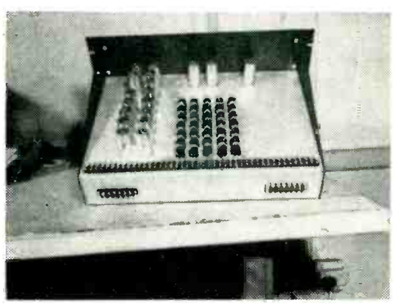
Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Fifty Trade Bulletins Reviewed

OTHER DEPARTMENTS featured for this issue:



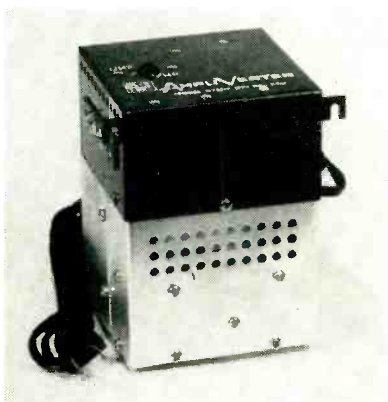
H-F IMPULSE RELAY features high sensitivity

C. P. CLARE & Co., 4719 W. Sunnyside Ave., Chicago 30, Ill. Type T high-frequency impulse relay was developed for use in applications that require a highly sensitive relay completely free from contact bounce and capable of a prodigious number of operations at extremely high speed. This relay has a pull-in time of 120 μsec and a drop-out time of 100 μsec that enable it to follow 2,500 cps; aperiodic to 1,000 cps. In a typical application it has a life expectancy, following a run-in period of 1×10^6 operations, of 5×10^9 operations with a 0.75-ma contact load over a 6-month period without readjustment.



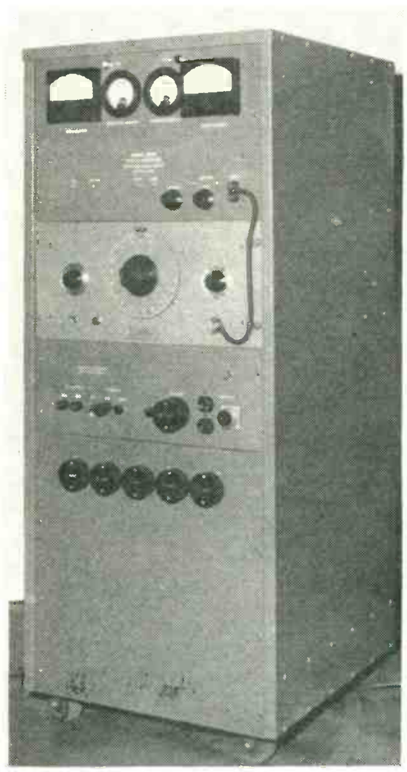
SIGNAL GENERATOR displays characters

WANG LABORATORIES, 296 Columbus Ave., Boston 16, Mass. Model DS-157 character display signal generator supplies all the necessary signals to display any character on the screen of a c-r tube. Every character is formed by properly intensifying the beam when it scans across an area of the screen. Hundreds of different characters can be made available at the same time. Characters are displayed at a rate of 10,000 per second. No control or adjustment is necessary. No special c-r tube is required.



CONVERTER BOOSTER is handy in fringe areas

BLONDER-TONGUE LABORATORIES, INC., 526 North Ave., Westfield, N. J., announces the model BTU-1 Ampliverter, a single-channel uhf converter with more than 17-db gain and a very low noise factor. The unit will produce clear, sharp, snow-free pictures in locations where ordinary converters fail to do so. The new model features three tubes (6AF4, 6BK7A and 6CB6), a germanium mixer and a self-contained power supply. All three sections are fully shielded to minimize oscillator radiation. Double-tuned r-f circuits reject spurious signals and provide correct band-pass and flat response. The Ampliverter has input terminals for both uhf and vhf antennas.

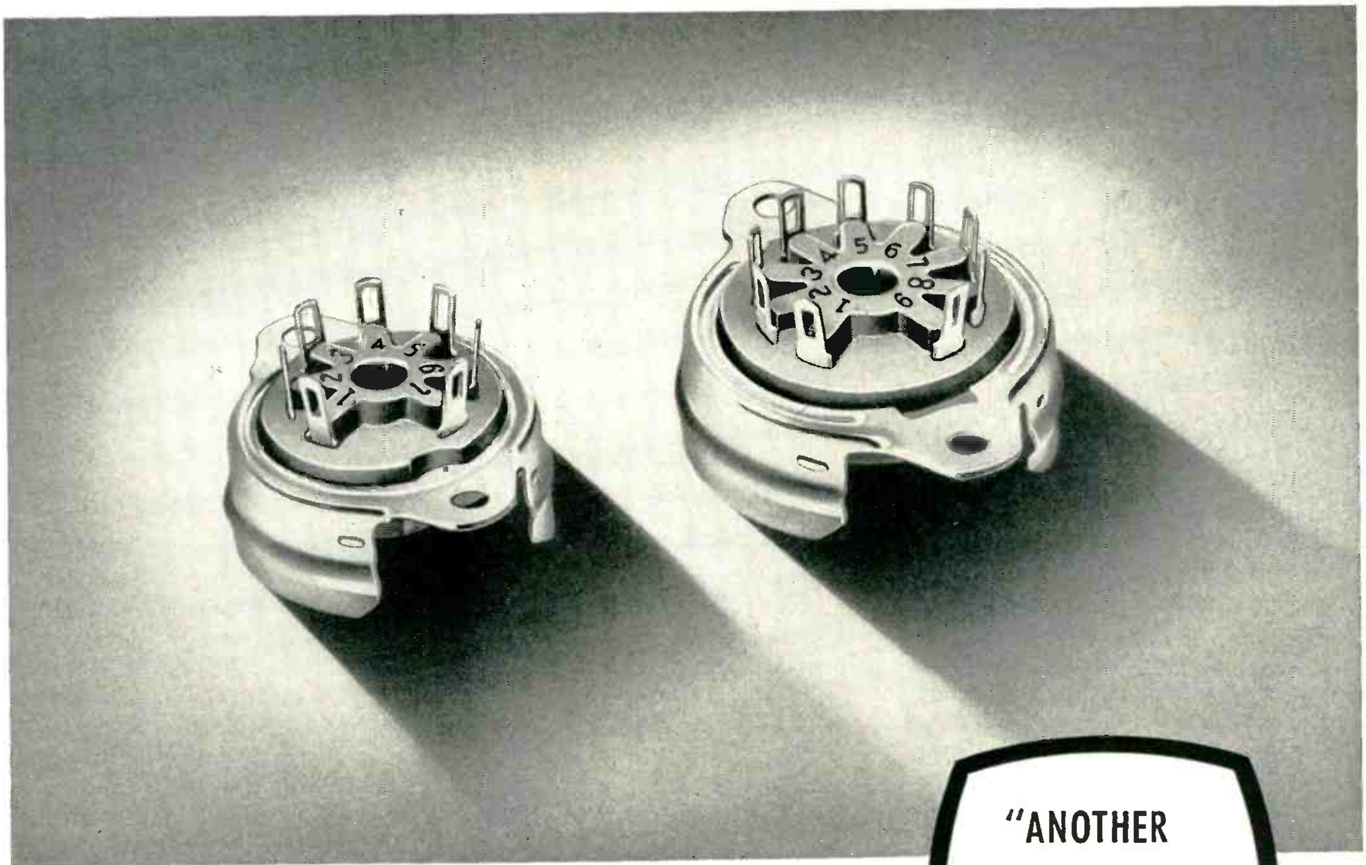


POWER AMPLIFIER is rated at 1,000 w

JOHN FLUKE ENGINEERING CO., 1111 W. Nickerson St., Seattle 99, Wash. Model 200A power amplifier is specifically designed to furnish a source of variable frequency alternating current for component and equipment testing at the frequencies specified for Army and Navy equipment, and at those encountered in foreign power systems. It is rated at a full 1,000 w at 75-percent power factor with distortion of not more than 1.5 percent at unity power factor, and not more than 3 percent at 75-percent power

Ultra High Quality Sockets

FOR UHF APPLICATIONS



Sylvania now offers you highest quality sockets especially designed for UHF applications. Precision engineered throughout to assure minimum inductance.

Shielded bases and contacts are cadmium plated. Low-loss phenolic castings completely inclose tube pins to prevent shunted circuits.

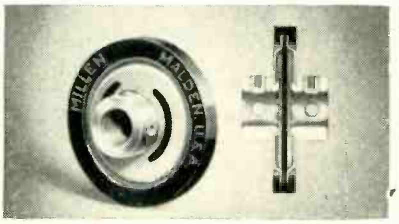
You'll find it pays to insist on Sylvania ultra high quality parts for all your ultra high frequency requirements. For additional information and specifications, write: Sylvania Electric Products Inc., Dept. 3A-1006, 1740 Broadway, N. Y. 19, N. Y.

SYLVANIA

In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, St. Catherine Street, Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

factor, over a 40 to 4,000-cps frequency range. Regulation at unity power factor is 7 percent and output voltage is substantially unaffected for a ± 10-percent line voltage change. Output voltage is adjustable from 0 to 115 v. An ammeter and voltmeter are provided for monitoring the output.



FLEXIBLE COUPLING
has new type insulation

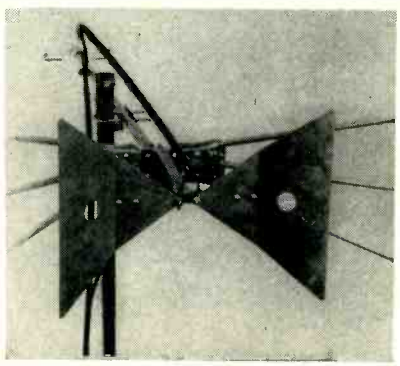
THE JAMES MILLEN MFG. CO., INC., Malden, Mass., has developed an entirely new type of insulated flexible coupling. Instead of the conventional riveted strap assembly, the new coupling is injection molded as a single unit. This method of assembly eliminates back lash, materially shortens the overall length, increases the electrical leakage path and very substantially increases the voltage breakdown rating over couplings of the conventional riveted construction, while maintaining an equally high degree of flexibility and a greater accuracy of hub alignment.

NULL DETECTOR
designed for a-c bridges

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1212-A unit null detector has been designed primarily as a balance indicator for a-c bridges. However, it is useful as a sensitive wide-frequency-range voltage indicator. Its frequency characteristic is flat within about 1 db from 50 cycles to 500 kc and it is satisfactory as an indicator at frequencies from 20 cycles to 5 mc. An approximately logarithmic relationship between meter reading and input voltage gives an on-scale range of about 120 db. The full-scale deflection is about 100 v while a signal of less than 40 μv deflects the meter by one percent of full scale.

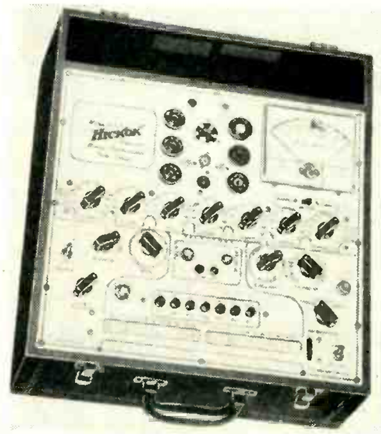
NEW THYRATRONS
are interchangeable

AMPEREX ELECTRONICS CORP., 230 Duffy Ave., Hicksville, L. I., N. Y., announces two improved versions of standard hydrogen thyratrons, types 4C35 and 5C22. The new Amperex types are 6268 and 6279 respectively. Incorporating self-contained and self-regulating sources of hydrogen, these new tubes exhibit a minimum life expectancy of over 1,000 hrs, which is at least twice that of standard types. Both tubes are completely interchangeable with the tubes replaced.



ANTENNA ADAPTOR
is designed for uhf use

CHANNEL MASTER CORP., Ellenville, N. Y. Model 415 Econo-Dapter is a high gain, all-channel, uhf triangular dipole specifically designed to add uhf to the millions of vhf Super Fan installations now in existence. The precise distance is prefixed, and the uhf dipole is veed forward so that it is always parallel to the vhf fan elements that function as a highly efficient sheet reflector. The Econo-Dapter features "free space" terminals that prevent the accumulation of dirt, ice or rainwater between the feed points, which can short out the picture. Its ultrarigid construction prevents vibration that can cause picture flicker.



TUBE TESTER
contains 3 μmho ranges

THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Ave., Cleveland 8, Ohio. Model 533AP tube tester is now available as a radio-tv and communication technician's portable for on-location or shop bench servicing. It is built with patented dynamic mutual conductance circuits to permit tube tests under simulated operating condition for better matching of tubes in tv or other electronic equipments. The unit contains three micromho ranges of 0 to 3,000, 6,000 and 15,000. It includes a new built-in bias fuse to prevent accidental damage to bias potentiometer. Measurements are 16¾ in. wide, 18⅜ in. long and 7½ in. deep, and net weight is 24 lb.

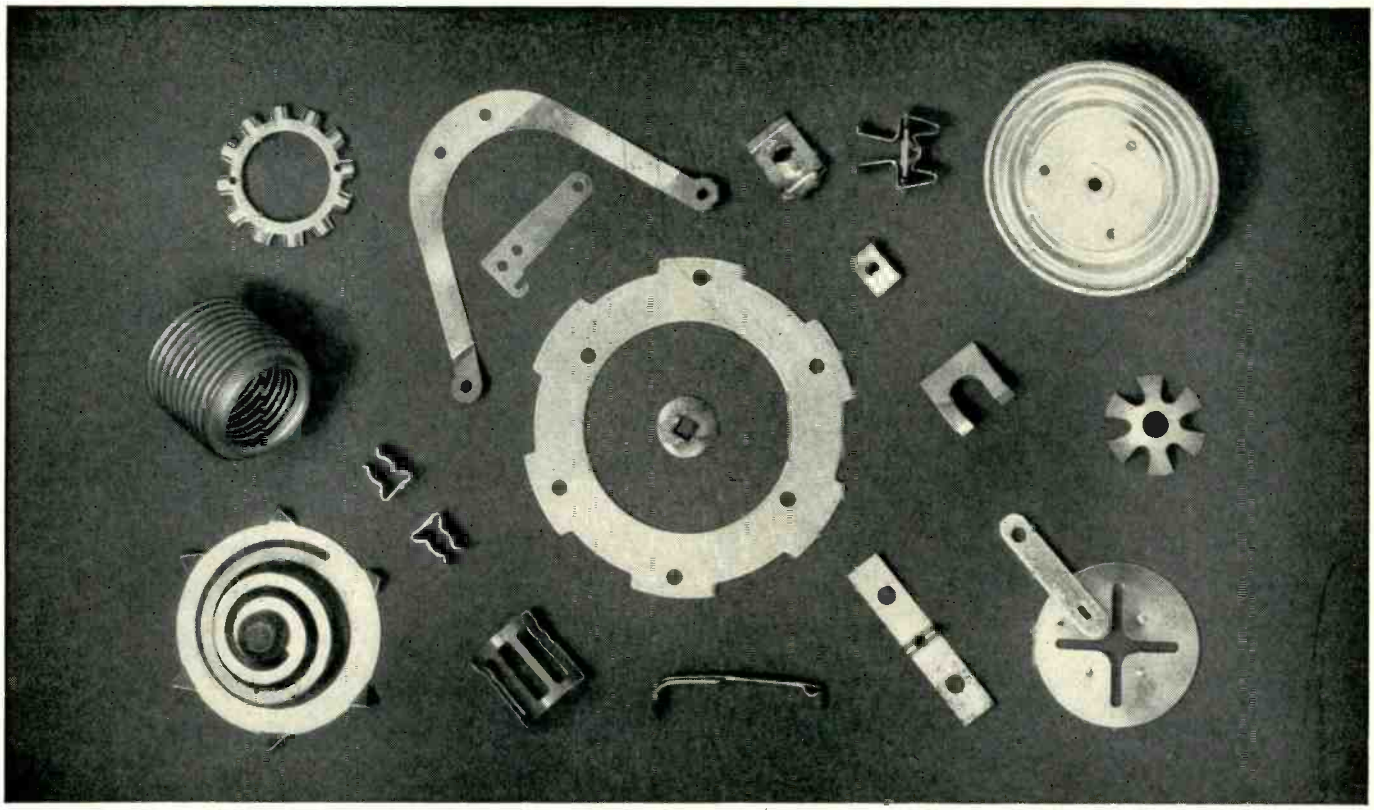
D-C VTVM
has 3-percent accuracy

SCIENTIFIC SPECIALTIES CORP., Snow and Union Sts., Boston 35, Mass. Model VM-81 d-c electronic volt-

for Bridgeport *Service*

BRASS Bridgeport CO.

OFFICES AND WAREHOUSES IN PRINCIPAL CITIES



Reliability is built into many types of electrical and mechanical spring parts with Bridgeport Phosphor Bronze.

Product improvement through . . .

What do you look for in a spring material?

1. **Resilience.**
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3. **High yield strength to withstand considerable deflection without taking a set.**
4. **Good corrosion resistance.**
5. **Sufficient ductility for stamping and forming.**
6. **Good electrical conductivity (if spring carries current).**

BRIDGEPORT PHOSPHOR BRONZE

These properties are engineered into Bridgeport's Phosphor Bronze through proper melting practice, special casting techniques and controlled mill processing. The superior quality of Bridgeport's Phosphor Bronze means superior performance – in electrical applications such as switches, relays, capacitors and controls . . . in mechanical applications such as bellows, diaphragms and lock washers.

Call on Bridgeport's Metallurgical Laboratory for help with your metal specification problems. Contact your nearest Bridgeport office for service.

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In Canada: Noranda Copper and Brass Limited, Montreal

BRIDGEPORT BRASS COMPANY

30 GRAND STREET, BRIDGEPORT 2, CONNECTICUT

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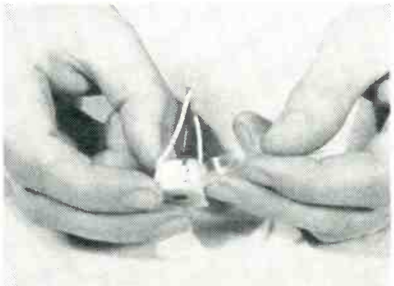
meter is a wide range instrument with excellent stability and high sensitivity. Range is 50 mv full scale to 500 v full scale, d-c; 11 ranges. Input impedance is 50 megohms on all ranges. Accuracy is 3 percent of full scale on all ranges. Power input is 115 v, 60 cycles a-c; approximately 25 w.

TRIODE HEPTODE
is a frequency changer

MULLARD LTD., London, England. A new frequency changer, which should prove of great interest to designers of communications and industrial electronics equipment has been introduced. It is the ECH81 triode heptode on the B9A (noval) base. Featuring high conversion conductance and low noise, it is particularly suitable for use as a frequency changer in a-m or a-m/f-m receivers where its h-f performance is considerably in excess of the company's earlier tubes. The small size also recommends it to designers of modern compact equipment where space is limited.

LAB COIL KIT
contains 10 type C coils

CAMBRIDGE THERMIONIC CORP., 457 Concord Ave., Cambridge 38, Mass., has made available a new coil kit to aid design engineers, lab technicians and others engaged in developing prototypes and pilot models. The kit contains 10 coils of the LS6 size, type C, with silicone Fiberglas collars. The coils cover a range of from 2 μh to 800 μh, the range of each slightly overlapping the next coil in the scale. The kit comes complete with mounting hardware and also contains a chart on the inside top cover listing all data of interest to the designer—information such as inductance range, wire size, number of turns and Q value.



ELECTRICAL TAPE
is only 3 mils thick

MINNESOTA MINING AND MFG. CO., 900 Fauquier St., St. Paul 6, Minn., has announced a new transparent electrical tape only 3 mils thick that combines high tear strength with a high dielectric and excellent noncorrosive properties. Designated Scotch electrical tape No. 5, it has a polyester film backing made from Mylar and a pressure-sensitive, heat-resistant, electrical grade adhesive. Stable under temperatures up to 125 C, the tape is designed for use in fine wire coils, transformers, and in minature electric components. It has an insulation resistance of 100,000 megohms, a dielectric strength of 5,500 v and an electrolytic corrosion factor of 1.0.

BRIDGE INDICATOR
balances measuring bridges

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. Type 615-A bridge indicator permits more rapid, accurate and convenient balancing of measuring

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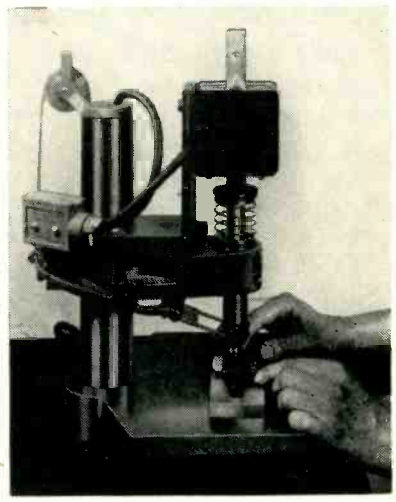
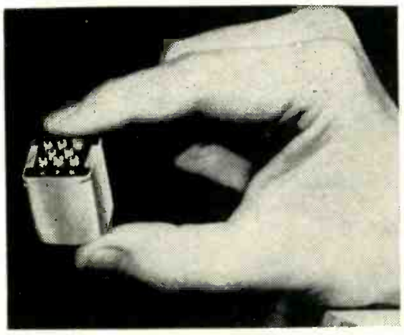
bridges. An approximately logarithmic response allows balancing from coarse to extremely sensitive fine without the frequent range changes normally required with bridges. Since the output is virtually logarithmic with respect to input over a range of 10,000 to 1 (80db), very precise aural null-detection is possible without extreme concentration or strain on the part of the operator even in noisy surroundings. Frequency response is flat from 60 cps to 20 kc. Input voltage ranges of 0 to 1 v and 0 to 100 v are provided. Maximum output is 1 v. Weight is 7 lb, 11 oz.



STAKING MACHINE

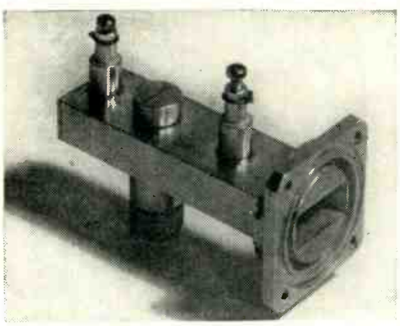
reduces operator fatigue

BLACK AND WEBSTER, INC., 445 Watertown St., Newton 58, Massachusetts, has developed a new, improved all-electric staking machine called Electrostake. The machine is powered by a solenoid rather than the spring-loaded trip hammer used on most conventional stakers. The fast, effortless solenoid operation, plus other features, reduces operator fatigue to a minimum makes possible 25 to 50-percent increase in production and provides complete safety for the operator. A portable machine, the Electrostake is ideal for any assembly-line operation where two or more assembled parts must be pressed firmly together and then staked or riveted with a sharp blow. Typical applications include assembly and subassembly work involved in manufacturing instruments, electrical components, cameras and many other small products.



TINY TRANSFORMER
weighs only 1.3 oz

STANDARD TRANSFORMER CORP., 3580 Elston Ave., Chicago 18, Ill., has announced a line of miniature audio transformers made with nickel steel laminations, with a frequency response of ± 1 db, 30 to 15,000 cps, maximum level 0 db. The Tinytrans are sealed and potted in 7/8 in. square, anodized aluminum cases with phenolic terminal boards. Total height, including terminals, is only 1 1/4 in. The case has two 2-56 threaded inserts, 11/16 in. centers, for easy chassis mounting. The entire transformer weighs only 1.3 oz.



CRYSTAL DETECTOR
for 8,500 to 9,500-mc use

GENERAL PRECISION LABORATORY INC., 63 Bedford Rd., Pleasantville, N. Y., announces availability of a novel tunable crystal detector in RG-52/U or RG-6S/U waveguide. This addition to the company's specialized microwave components is designed for the 8,500 to 9,500-mc range and utilizes two screws for adjusting to optimum vswr. Its simplicity of design and ease of operation represent an advance

 Want more information? Use post card on last page.

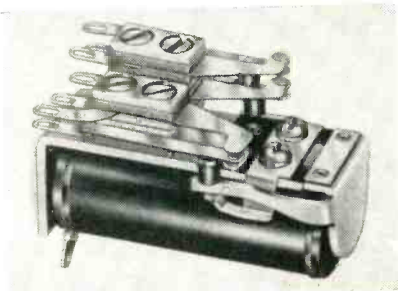
over earlier crystal detector designs.

CABLE HANGER
for mike floor stands

ATLAS SOUND CORP., 1451-39th St., Brooklyn 18, N. Y. Model CH-1 cable hanger is expressly designed to be used with all types and styles of mike floor stands. It enables the mike cable to be quickly coiled and looped over the hook when moving, storing or transporting the mike and stand. The CH-1 is easily and securely clamped to any diameter tubing.

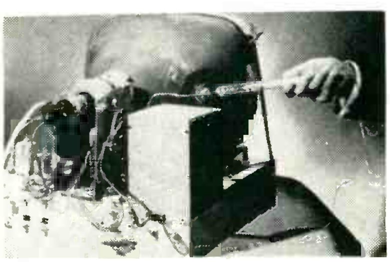
SHUNT BOX
for a-c instrumentation

MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y. Type MV-121 shunt box, when plugged into the MV-12A voltmeter, converts it into a highly-sensative a-c ammeter, covering a very wide frequency range. The shunt box is particularly useful if an oscilloscope is plugged into the output terminal of the a-c voltmeter as this makes it very simple and easy to observe waveshapes of currents.



FAST-ACTION RELAY
features long core design

COMAR ELECTRIC CO., 3349 W. Addison St., Chicago 18, Ill., has announced the T-J relay, a fast-action telephone type featuring a long core design that gives it greater sensitivity and makes it ideal for use in the more complex circuits involving pull-in and drop-out time delay. The relays are available with coils for all standard voltages up to 110 v d-c; contact combinations up to 4-pole double throw, or 6-pole single throw. Standard contacts are of fine silver rated at 150 w, 3 amperes maximum noninductive load. They are thoroughly insulated to withstand 1,000 v a-c.

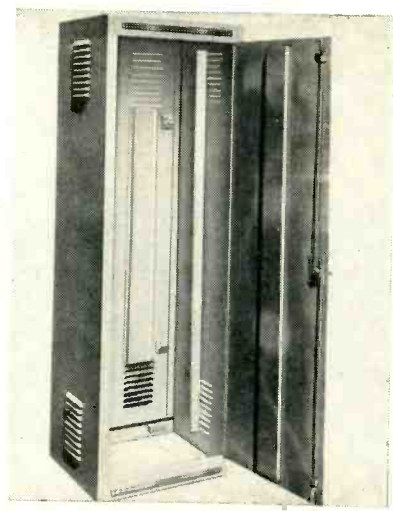


TELEVISION PROBE
is pocket-size voltmeter

AMERICAN RESEARCH CORP., 1504-11th St., Santa Monica, Calif. A voltmeter small enough for a tv service man to carry in his pocket is now on the market. The TV Voltprobe is 10-in. long, needs no outside current to operate, and measures accelerating d-c voltages on a tv tube from 4,000 to 25,000 v. An alligator clip is connected to the chassis of the tv set, and the probe end of the Voltprobe is connected to the second anode by piercing through the rubber protective cap. To get the voltage measurement, the knob on the Voltprobe is turned down until the lamp inside lights. The voltage is then read off a calibrated dial. The measurement can be made without removing the tube or chassis from the cabinet.

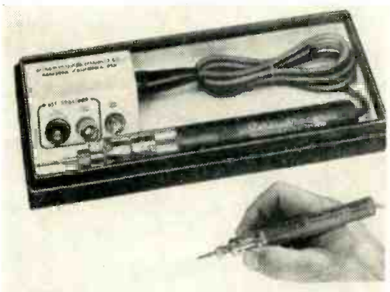
ROSIN CORE SOLDER
is active yet noncorrosive

FEDERATED METALS DIVISION, American Smelting and Refining Co., New York, N. Y., has developed RTS 200, an active yet noncorrosive rosin core solder. Oxide films and corrosion products on the parts being soldered need not slow down operations, because this solder pierces such retarding agents four times faster than ordinary solders. The chemicals used in this new solder are commonly used in industry and have no toxicity factor whatsoever. RTS 200 is available in a wide variety of wire sizes, compositions and quantities.



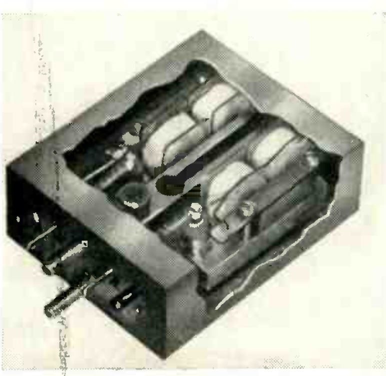
TRANSMITTER RACKS
are rigidly constructed

PREMIER METAL PRODUCTS CO., 3160 Webster Ave., Bronx, N. Y., announces the manufacture of a line of transmitter racks rigidly constructed of 16-gage steel. Panel mounting angles are $\frac{3}{16}$ thick and are tapped 12/24 on universal spacings. Rear doors are hung on loose-jointed hinges and have flush snap catches. The racks are available in two sizes—67$\frac{3}{8}$ × 22 × 18 in. with panel space of 61¼ × 19 in. and 83⅛ × 22 ×18 in. with panel space of 77 × 19 in. A complete catalog of the company's products for the electronic and electrical industries is available.



CIRCUIT TRACER weighs only 2½ oz

Delta Electrical Specialty Co., 1456 E. Walnut St., Pasadena, Calif. Versatile in its use, the new Circuitracer is a compact, 3-in-one convertible, quick-change tester. It is used to quickly locate grounds, opens, or shorts in dead or live circuits. The unit has been designed to trace virtually all types of circuits for continuity and the presence of either d-c or a-c voltage. Live circuits as low as 2 v or as high as 600 v can be tested, as can dead circuits and devices. This pocket-size test laboratory will withstand rugged industrial use, yet weighs only 2½ oz. The location of the signal light in the tip at point of contact makes circuit tracing fast and accurate.



RESONATOR is tiny and weighs 8 oz

Philamon Laboratories Inc., 5717 Third Ave., Brooklyn 20, N. Y., an-

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nounces the model J miniaturized tuning fork resonator having a maximum weight of 8 oz and case dimensions of 1 in. × 2$\frac{3}{16}$ in. × 2$\frac{11}{16}$ in. high. It is available in any frequency from 400 to 2,000 cps and in an accuracy rating of either 1 part in 10,000 or 1 part in 2,000 for operation from −40 C to +85 C. The units are completely temperature compensated and are solder-sealed and evacuated. Their internal silicone rubber mounting plus their external provision for mounting to a chassis via silicone rubber grommets provide excellent shock and vibration isolation. Due to their high effective working Q of approximately 10,000, these resonators provide an excellent means for generating accurate fixed audio frequencies.

COMMUNICATIONS PLUG is a 3-conductor type

SWITCHCRAFT, INC., 1328 N. Halsted St., Chicago 22, Ill. The No. 480 Littel-Plug, most commonly used in military communication and industrial equipment, features a one-piece tip rod which together with the sleeve, dead ring and ring sleeve are assembled into the mold as inserts; providing a finished plug with complete continuity of thermoplastic insulation between all the metal parts of the plug. Design and material are strictly in acccordance with specification JAN-P-642. This Littel-Plug is a 3-conductor type, 0.2065-in. diameter sleeve, and mates with such jacks as the JAN type JJ-033. It is furnished with 3

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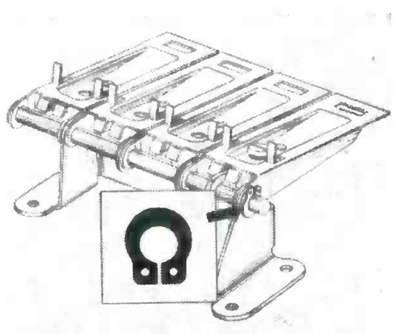
tinned terminals fastened by screws.

COLD CHAMBER
simulates high altitudes

BOWSER TECHNICAL REFRIGERATION, Terryville, Conn., is now manufacturing a walk-in chamber that is capable of simulating altitudes from sea level to 80,000 ft and can produce a climb rate of 5,000 ft per minute. It can be used for testing radar antennas. With an interior free working space of 9 ft × 9 ft × 7 ft high, the chamber can be cooled from 140 F to −76 F in two hours and heated from −76 F to 140 F in one hour with a temperature control of ±2 deg. Humidity range is up to 95 percent. Illustrated is one of the chambers being loaded for delivery.

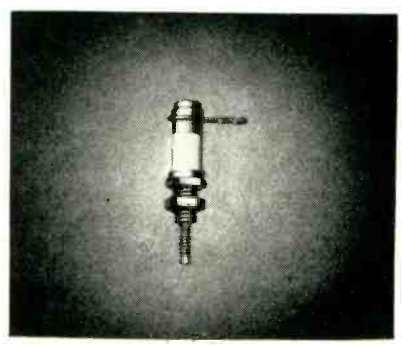


LOCKING COLLAR
designed for small shafts

WALDES KOHINOOR, INC., 47–16 Austel Place, Long Island City 1, N. Y., has added to its line of retaining rings a low-cost fastener that provides a positive shoulder, secure against thrust and vibration. Designated as the series 5555 Truarc grip ring, the retainer can be assembled and disassembled in either direction on a straight ungrooved shaft with Truarc pliers. The basic design principle of complete circularity around the periphery of the shaft, and the ring's unusually large radial width combine to exert considerable frictional hold against axial displacement. Sample rings for shaft diameters of $\frac{1}{8}$ in., 3/6 in., $\frac{1}{4}$ in., $\frac{5}{16}$ in. and $\frac{3}{8}$ in. are available upon request.

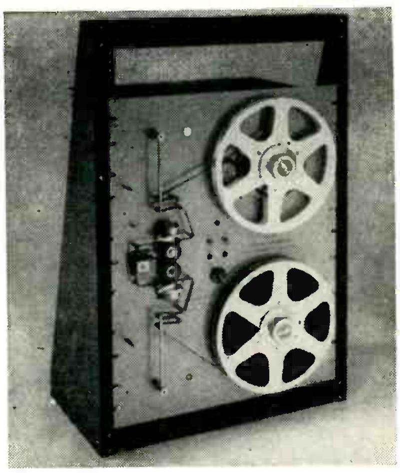
TV ATTENUATOR
handles excessive signals

VIDAIRE ELECTRONICS MFG. CO., Lynbrook, N. Y., is manufacturing a new tv attenuator that eliminates overloading due to strong signals. Known as Tel-Atten, the new unit was designed to reduce buzz in intercarrier sets, and most cross-modulation effects. It also features 1,000-to-1 change in signal reaching antenna posts and vernier adjustment for all signal areas. The instrument was designed for all tv sets troubled with excessive signals such as poor synchronization, multiple images, buzz in sound and beats in picture. Installation is simple for it connects with only three leads and is mounted with just two screws. Model A-2 measures only $3\frac{5}{8}$ in. x $2\frac{3}{8}$ in. x $1\frac{1}{4}$ in.



CAPACITOR
has new tunable element

CAMBRIDGE THERMIONIC CORP., 457 Concord Ave., Cambridge 38, Mass., has announced a new tubular, variable ceramic capacitor, CST-50, that incorporates a tunable element of new and unusual design. Because of this feature which practically eliminates losses due to air dielectric, a large minimum-to-maximum capacitance range (1.5 to 12 μμf) is realized—surpassing that of capacitors many times larger in physical size. The CST-50 stands only 19/32 in. high when mounted, is less than ¼ in. in diameter and has an 8-32 threaded mounting stud. The mounting stud is split so that the tuning sleeve can be securely locked without causing an unwanted change in capacitance. The CST-50 is provided with a ring terminal that has two soldering spaces.



TAPE HANDLER
records and plays back

POTTER INSTRUMENT CO., INC., 115 Cutter Mill Rd., Great Neck, N. Y., has announced a new high-speed, low cost magnetic tape handler for digital data handling and general computer recording and playback. One unique feature of the device is its ability to start and stop intermittently within 5 milliseconds from external signals thus making it possible to record, play back or compare blocks of information. Fully reversible drive at speeds of 15 and 30 inches per second is provided. New photoelectric proportional servo tension controls provide uniform tape tension over the recording head at all speeds. Independent reel drives, controlled by the servo systems, assure freedom

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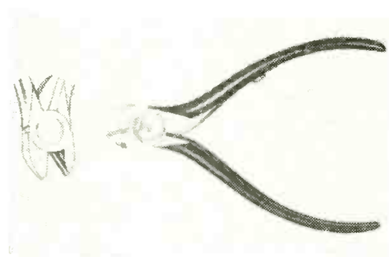
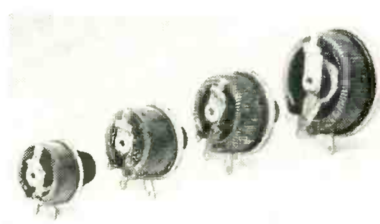
from tape breakage or spilling on quick reverses.



COMPACT PLIER
for printed-circuit use

MATHIAS KLEIN & SONS, 3200 Belmont Ave., Chicago 18, Ill., offers a compact new plier that meets the specialized needs of printed circuit wiring. The plier is designed with special fitted knives that shear and crimp the wire in one operation. The crimped wire holds the loose parts in position, permitting fast and efficient dip soldering of the exposed wire ends in the circuit. In use, the plier is conveniently held with the handles in an upright position. The 45-deg working angle of the knives against the printed circuit permits visual inspection of the shearing-crimping operation.

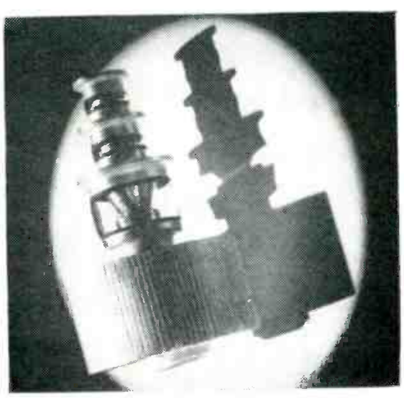


POWER RHEOSTATS
have deep ceramic cores

TRU-OHM PRODUCTS, 2800 Milwaukee Ave., Chicago 18, Ill., has added three new power rheostats to its line. Sizes available now are 50, 75, 100 and 150 w. Each of the models incorporates an extra deep ceramic core on which the resistance wire is toroidally wound and bonded in place with vitreous enamel. This construction results in better heat dissipation and a more conservative power rating. Positive and constant brush pressure is provided with an exclusive torsion spring assembly. Other features include rugged mechanical design for long rotational life, minimum backlash, low contact resistance and smooth, uniform windings for practically step-less resistance control.

D-C POWER SUPPLY
has 0.1-percent regulation

LAWN ELECTRONICS Co., East Freehold Rd., Freehold, N. J., is now in production on the model 630-A regulated d-c power supply. The unit features 0.1-percent regulation, less than 1 mv ripple and less than 0.5-ohm output impedance. The output voltage is continuously variable from 0 to 600 v with either the positive or negative terminal grounded, and the unit will supply up to 300 ma at any voltage setting. The unit also features a bias supply variable from 0 to −250 v stabilized to 0.1 v and a 6.3-v 6-ampere center-tapped filament supply. Dimensions of the unit are 19 in. wide × 8¾ in. high × 10½ in. deep.



RING SEAL TRIODE
has ratings to 110 mc

MACHLETT LABORATORIES, INC., Springdale, Conn., announces the ML-6258, a forced-air-cooled ring seal triode incorporating a high-efficiency radiator. Designed specifically for r-f heating application in the 2 to 3-kw range, but well adapted to a-m, f-m and tv transmission, it has plate input and dissipation ratings of 7 kw and 3 kw

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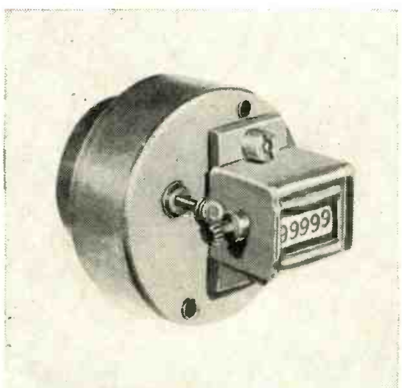
respectively. Its stress-free thoriated tungsten filament operates at 12.6 v, 27 amperes. Maximum ratings apply to 110 mc. The tube is also available in an integral anode water jacket, water-cooled model and in a version designed for use with the company's quick-change automatic seal water jacket.

DEFLECTION YOKES that feature five leads

HALLDORSON TRANSFORMER CO., 4500 No. Ravenswood Ave., Chicago 40, Ill., has available two new deflection yokes featuring R-C network flexibility. A fifth lead (four are conventional) is interconnected with components in the yoke to provide external rearrangement of the network to suit different tv set requirements. With the DF601 and DF602, all network variations are easily accomplished without digging into the yoke—the lead ends merely being properly combined during the yoke installation.

POTENTIOMETER features self-balancing

GRAY & HULEGUARD, INC., 930 North Hancock Ave., Los Angeles 46, Calif. A group of electronic units, suitable for flight tests and laboratory use, are available for high speed measuring and indicating of test signals. A basic assembly of these units includes one of three types of comparators, an amplifier and a master indicator. Interchangeable comparator units accommodate commonly used elements for sensing temperature, pressure, strain, resistance and acceleration. Suitably calibrated dial faces are available for the indicator. For remote observation a repeat indicator unit is added to the assembly. Separation of the components of this self-balancing potentiometer into interchangeable units permits economical multipurpose setups for measurement and indication of a wide variety of input signals.



INDICATORS
show elapsed time

VOCALINE CO. OF AMERICA, INC., Bristol Motor Div., 90 Coulter St., Old Saybrook, Conn. A new line of running time indicator series ET-1 for industrial or laboratory application is being made available in the following two models: ET-1A counts to 99,999 hours by hours; ET-1B counts to 9,999.9 by tenths of hours. Utilizing the Circle B motor, this low-cost series features compact, extremely small size—2-in. diameter × 2⅛-in. depth—that can be readily adapted for panel or unit mounting. This standard series operates on 115 v 60 cycles but can be easily altered for use with other voltages. Among uses for the series are determining equipment operating time for guarantee purposes and indicating hours of oper-

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ation facilitating periodic lubrication and maintenance.

DECADE ATTENUATOR
for audio and video

THE DAVEN CO., 191 Central Ave., Newark 4, N. J., has available the series 790 attenuation network. This type decade attenuator is particularly useful in gain and loss measurements on filters, transformers, amplifiers and associated transmission equipment, for both the audio and video range. This decade is a direct-reading precision noninductively wound attenuation network designed for operation over the 0 to 1-mc range. Use of precision noninductive resistors and a specially designed circuit reduces frequency discrimination to a minimum. Networks are available for various impedance requirements.

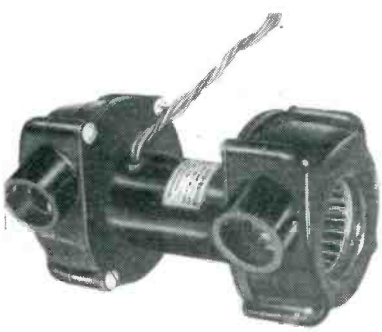
POWER SUPPLY
has twin regulation

UNIVERSAL ELECTRONICS CO., 2012 Sepulveda Blvd., Los Angeles 25, Calif., has available a new twin-regulated power supply, model 520 AT. The unit features two entirely separate regulated power supplies in one housing, each supply giving 0 to 500 v d-c at 0 to 200 ma at any setting. Two 4½-in. meters may be switched to monitor either supply. Supplies are each floating above their chassis, hence may be used in a variety of ways to give positive or negative outputs or connected in series to give 0 to 1,000 v at 0 to

200 ma. Also furnished are two 6.3 v a-c outputs at 8 amperes each.

H-V POWER SUPPLY
has 500 to 1,500-v output

SCIENTIFIC SPECIALTIES CORP., Snow and Union Sts., Boston 35, Mass. The PS-22 electronically regulated supply is designed for use with photomultiplier tubes, counters and other devices requiring a closely regulated, well stabilized voltage. Output is 500 to 1,500 v, conservatively rated for 1-ma load. The output voltage changes less than 0.05 percent from zero to full load. Input power is 115 v; single phase, 60 cycle a-c; approximately 50 w.



MINIATURE BLOWER
weighs only 26 oz

INDUCTION MOTORS CORP., 55-15 37th Ave., Woodside 77, N. Y., has announced the type BC1615B-12 miniature blower for cooling various types of electronic equipment. The blower is built to deliver 22 cfm free air at 115 v, 60 cycles, single-phase power supply. It weighs only 26 oz and operates in temperature range from −65 to +85 deg. Designed to rigid Air Force specifications, it can be used in cooling radar equipment, amplifiers units, transmitters, oscillators and other electronic equipment. The motor is built to close toler-

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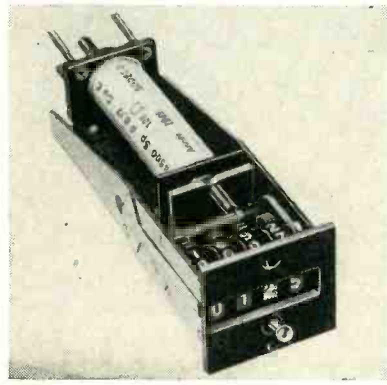
ances. All rotating parts are dynamically balanced, and precision shielded ball bearings are used to assure longer life.

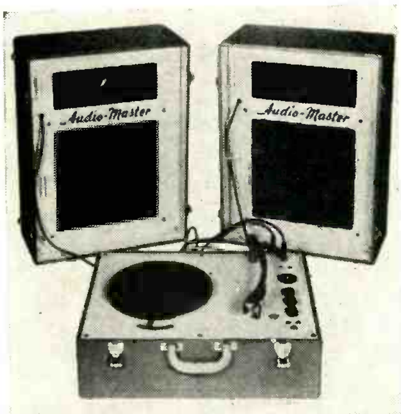


IMPULSE COUNTER
is electrically actuated

LANDIS & GYR, 45 W. 45th St., New York 36, N. Y., announces a compact, electrically actuated impulse counter designed for flush panel mounting where space requirements are at a premium. The entire assembly is about 4 in. long, and mounts through a panel opening about ¾ in. high and 1¼ in. wide. Any of seven different coils are available for impulse voltages between 4 and 60 v d-c (or rectified a-c). Power requirements range between 1.4 and 2.5 w, depending on voltage used. Maximum counting rate is 10 impulses per second. Minimum impulse duration is 40 milliseconds. Minimum break between impulses is 50 milliseconds.

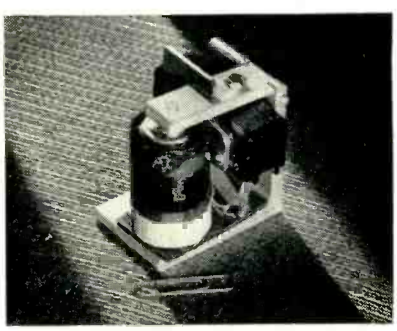
TEST CLIPS
are nylon insulated

INDUSTRIAL DEVICES, INC., Edgewater, N. J. Model 1410B nylon-insulated test clips provide positive clip connection to all standard phone-tip test prods. The new test clips incorporate a phosphor-bronze spring collar that accepts the standard prod with an electrically and mechanically positive grip. The clips are fully nylon insulated to allow shockproof, short-circuit proof operation in excess of 600 v. The molded-to-shape nylon eliminates the need for bulky rubber boots while providing a greater degree of insulation since even the nose of the clip is fully covered with insulating material.



RECORD PLAYER
combined with p-a system

AUDIO-MASTER CORP., 341 Madison Ave., New York, N. Y., has available the A-M 54 high-powered record and transcription player combined with a p-a system. It features an a-c push-pull high-gain amplifier with approximately 10-w output and is equipped with a 12-in. loudspeaker. The player has a 3-speed motor for 33⅓, 45 and 78-rpm records, a twist crystal cartridge fitted with two permanent needles for all records and transcriptions from 7 to 17½ in., an input for microphone, variable volume and tone control, and a special mixer that permits simultaneous use of record and microphone.



SNAP-ACTION RELAY
is mechanically stable

THERMO INSTRUMENTS CO., 1175 El Camino Real, Belmont, Calif. Positive, chatter-free circuit opening

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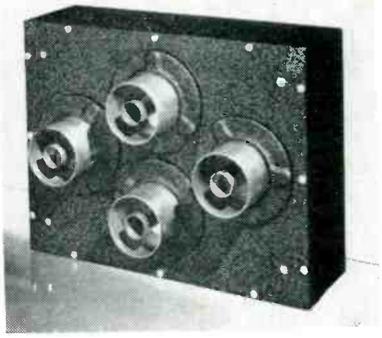
and closing under slowly increasing or decreasing currents are features in the new type C snap-action relay. It employs a type BA2R snap-acting switch having characteristics particularly suitable for inductive loads and those involving high inrush current. This construction makes the relay practically immune to shock, vibration or tilting. Single-pole contacts, which can be wired for either normally-open or normally-closed conditions, are rated for 20-ampere steady state currents and 75-ampere inrush currents on voltages up to 460 v a-c. Physical construction is such as to provide a combination of extreme mechanical stability and a large-cross-section magnetic path that makes the relay relatively insensitive to variations in operating voltage.

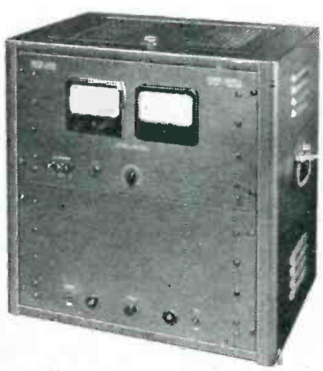
OSCILLATOR is packaged blocking unit

AMERICAN MACHINE & FOUNDRY Co., 1085 Commonwealth Ave., Boston, Mass., has available the packaged blocking oscillator, a cased, plug-in unit that includes a transformer and other circuit compounds, with a socket for the miniature tube mounted on top of the case. Small core loss resulting from use of a ferrite core in the transformer permits high peak currents, and the high permeability permits the required inductance to be achieved with fewer turns, minimizing interwinding capacitance to allow faster pulse rise time. Currently available are: type PBO-1 for 0.-1-sec pulses with 0.01-sec rise time, and type PBO-2 for 2.0-sec pulses with 0.04-sec rise time. Dimensions of oscillator unit are 1⅛-in. diameter by 4$\frac{1}{16}$-in. overall seated height, including tube and shield.



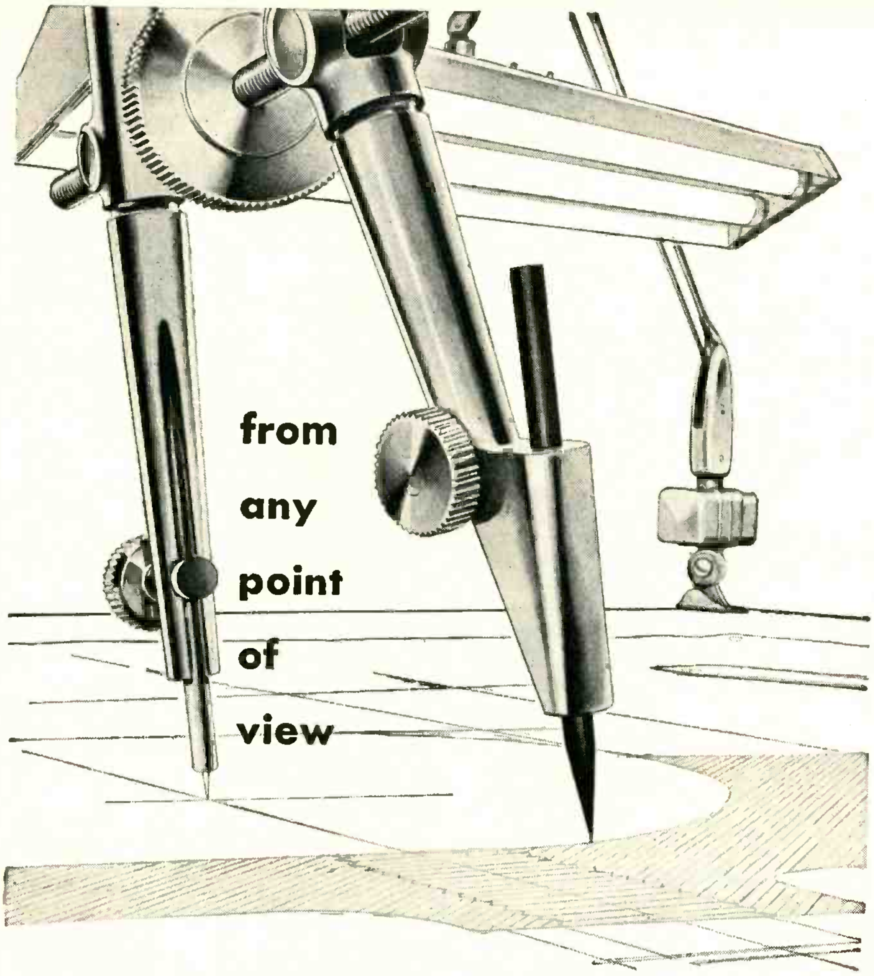
COAX SWITCH
is manually actuated

THOMPSON PRODUCTS, INC., 2196 Clarkwood Rd., Cleveland 3, Ohio, has developed a manually actuated coaxial switch for 3⅛-in., rigid line tv station application. At frequencies to 320 mc the switch has a maximum vswr of 1.1 and cross-talk in excess of 60 db. Its characteristic impedance is 51.5 ohms. It weighs approximately 27 lb and has a minimum life of 100,000 actuations.

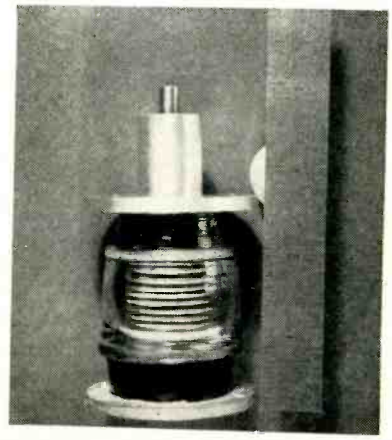


POWER SUPPLY
has low ripple voltage

KEPCO LABORATORIES, INC., 131 Sanford Ave., Flushing 55, N. Y. Model 3200 voltage-regulated power supply is continuously variable from 1 to 13 v and delivers from 0 to 10 amperes continuous duty. In the 1 to 13-v range the output voltage variation is less than 0.5 percent for both line fluctuation from 105 to 125 v and load variation from minimum to maximum current. Ripple



voltage is less than 10 mv. Cabinet height is 22¾ in., width 21¾ in. and depth, 15¼ in.



SMALL CAPACITORS are rated at 3 and 5 kv

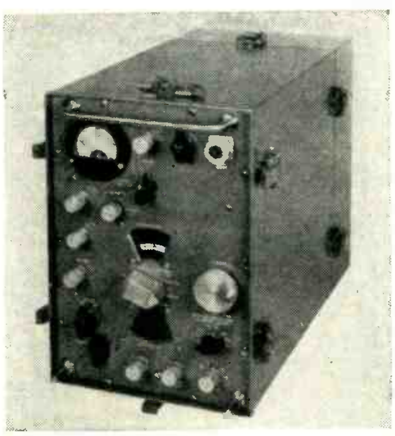
JENNINGS RADIO MFG. CORP., P. O. Box 1278, 970 McLaughlin Ave., San Jose 8, Calif. A full line of miniature vacuum capacitors in fixed and variable types, rated at 3 kv and 5 kv, are characterized by their small physical size, negligible power factor and extremely wide capacitance ranges. The unit illustrated has a 4 to 250-$\mu\mu$f range.

MINIATURE RESISTOR has 1-percent tolerance

DALE PRODUCTS, INC., Columbus, Neb. High power resistance in a minimum of space is offered by the new 250-w miniature resistor. It is sealed against moisture with a special silicone treatment, and then finished in a die-cast black anodized radiator-finned housing for maximum heat dissipation. The resistance element is completely welded from bolt terminal to bolt terminal. Standard tolerance is 1 percent, but tolerances as high as 0.5 percent can be furnished if necessary. Temperature coefficient is substantially flat. Resistance shift is less than 0.00002 per deg C.

PICTURE MONITOR
for universal studio use

ALLEN B. DUMONT LABORATORIES, INC., Clifton, N. J. Type 5281-B, a 17-in. picture monitor that features compactness, excellent performance and versatility, may be operated on either the composite picture signal or separate sync signal. It is designed for use in announcing booths, film rooms, client's rooms or as a cueing monitor. Due to the automatic frequency control of the unit, it will detect sync generator faults not noticed on monitors of the triggered sweep design. The unit is entirely self-contained and mounts in a standard RTMA rack, requiring only 15¾ in. of vertical space.



NOISE METER
has 8 frequency ranges

EMPIRE DEVICES, INC., 38-25 Bell Blvd., Bayside 61, N. Y., is now producing the model NF-114 noise meter. It has a frequency range of 0.15 mc to 80 mc in 8 bands, and frequency ranges are switched by means of a turret. Two tuned r-f amplifier stages are employed throughout for high sensitivity and optimum rejection of spurious responses. Three i-f frequencies are used—0.125 mc, 0.455 mc and 6 mc. A built-in impulse generator produces flat output to 100 mc. A vtvm

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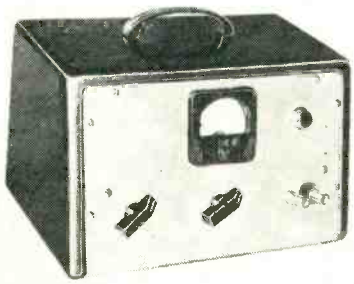
indicates carrier or true peak voltage. As an alternate means of measurement, aural slide-back operation is provided. The meter will operate on dry batteries or a-c. It measures 13½ in. × 8½ in. × 12½ in.

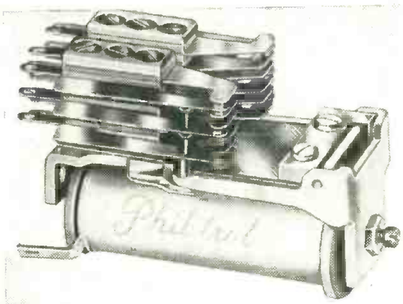
COIL WRAP
is strong and flexible

The Electro-Technical Products Div. of Sun Chemical Corp., Nutley 10, N. J., has announced a new product that has already demonstrated its acceptability by manufacturers of rotating equipment when used as a coil wrap. Electro Flexoglas has high dielectric and mechanical strength plus exceptional flexibility that is not lost at elevated temperatures. These features broaden its scope of usage as layer and phase insulation as well as barrier insulation for motors and transformers. It is available in 0.010 in. and 0.012 in.



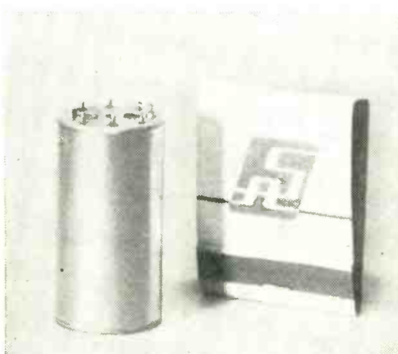
STEP OSCILLATOR
has 17 fixed frequencies

Pulse Techniques, Inc., 1411 Palisade Ave., West Englewood, N. J., announces a new step oscillator providing 17 fixed frequencies at the turn of a single knob. Weighing only 7 lb, the instrument is extremely portable for field maintenance, while its accuracy, stability and low distortion make it equally valuable in the lab and for production line testing of amplifiers, filters and recorders. A new gain stabilizing circuit holds amplitude variations over the entire frequency range to less than ±0.2 db. Use of toroid coils helps assure an overall frequency stability of better than ± 1 percent. Signal-to-hum ratio is more than 60 db.



RELAY
is compact and sensitive

PHILLIPS CONTROL CORP., Joliet, Ill. The 62A relay is finding wide acceptance in a variety of products because of its compactness, capacity and exceptional sensitivity. It measures $2\frac{9}{16}$ in. in length, $1\frac{1}{8}$ in. width and overall height will vary. The relay is available with 18-ga palladium contacts rated at 3 amperes, but can be provided with other types of contact for rating up to 6 amperes, noninductive. The 6QA is also available with a plug-in adaptation for use in panel and annunciator racks. Complete data may be had for the writing.



TINY GYROSCOPE
is hermetically sealed

SANDERS ASSOCIATES INC., 137 Canal St., Nashua, N. H. Model 7 subminiature rate gyroscope is less than 1 in. in diameter, 2 in. long and weighs only 3 oz. It is hermetically sealed for use in aircraft, guided missiles, radar antenna stabilization and similar applications. The rotor spins at 24,000 rpm on

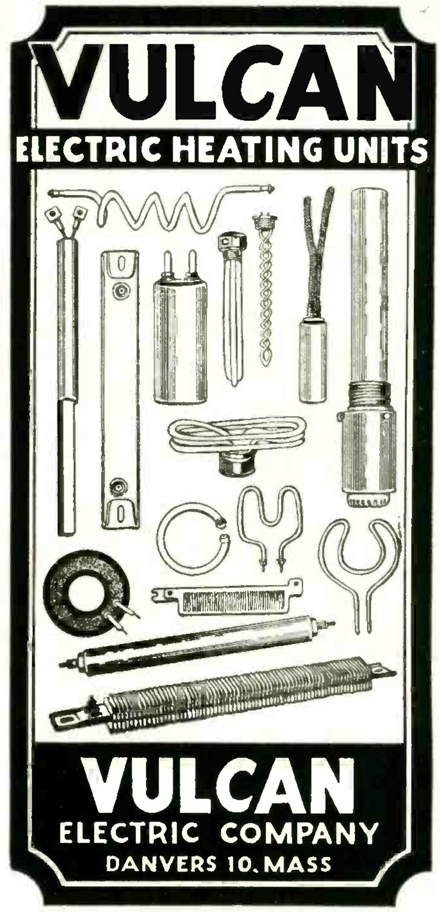
6.3 v at 400 cycles. The a-c pickoff provides an output of 14 mv per deg per second input. Maximum output occurs at an input of 420 deg per sec. The gyro resonates at 85 cps with a 0.5 damping factor.

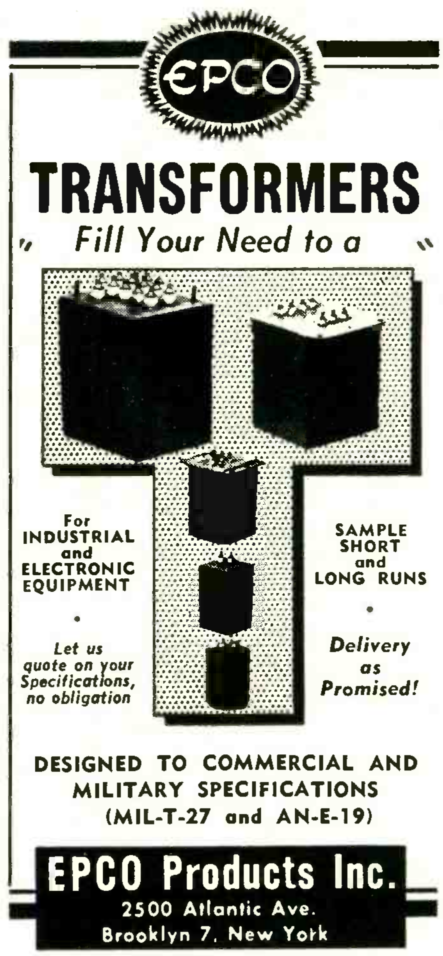
Literature

Junction Transistor. Federated Semi-Conductor Co., 66 Dey St., New York 7, N. Y. A single-page bulletin covers the RD2525 n-p-n junction transistor. Characteristics of the unit described, which include a collector dissipation of 50 mw and a minimum alpha of 0.99, are particularly suitable for grounded emitter operation. The bulletin data give ratings, typical operation, a collector voltage and current chart, dimensions and price.

Filter Reactor Tube. Hytron Radio & Electronics Co., Danvers, Mass. Bulletin E-199 gives mechanical and electrical data and characteristics charts for the type 6216 filter reactor tube, an electron tube of beam power design that has miniature 9-pin construction. When used in appropriate circuits, the tube described replaces the iron-core filter choke, particularly in airborne and vehicular electronic equipments, thus materially reducing the weight and space normally required by the iron-core choke.

Printed Circuits. Methode Mfg. Corp., 2021 W. Churchill St., Chicago 47, Ill., has published a new printed circuit handbook entitled "Utilization of Prefabricated Wiring." The 32-page booklet provides comprehensive and detailed engineering information to those interested in applying printed wiring techniques to electronic equipment. Among the subjects dealt with are present applications of printed circuitry, layout of wiring schematics, selection of materials and components, Underwriters' re-





quirements, drafting of conductor patterns, tooling and fabricating considerations, service techniques, production and test equipment, and multiple assembly and soldering methods.

Liquid-Level Control. Thermo Instruments Co., 1166 El Camino Real, Belmont, Calif. A single-thyratron electronic liquid-level control operating without radio frequency from a single capacitive type probe is described in a folder, Form LL4-453. The publication illustrates the single-unit control, the probe, and alternative schematic arrangements for installation. Specifications are included.

Instrumentation. Tektronix, Inc., P. O. Box 831, Portland 7, Oregon. Short Form catalog No. 5302 gives illustrated descriptions of a wide variety of instruments. Included are seven different types of oscilloscopes, two square wave generators, an amplifier, two preamplifiers, a time mark generator and a series of waveform generators. Prices for all are listed.

Tube Booklet. Radio Corp. of America, Harrison, N. J. An up-to-date catalog of electron tubes describes 495 different receiving types and kinescopes that have their chief application in radio and tv receivers. Entitled "RCA Receiving Tubes for A-M, F-M and Television Broadcast" (Form No. 1275-F), the booklet contains characteristics of each type, together with socket connection diagrams arranged for quick and easy reference. Information on tv picture tubes is presented in a special chart that lists and describes 45 types. Each tube type is listed in numerical-alphabetical sequence, according to its type designation.

Plastics for Engineering. Dixon Saddle Co., P. O. Drawer 7, Bristol, R. I. A recent brochure is descriptive of Rulon bearing material that is slippery throughout, from outer skin to inner core, (containing no oil, graphite or other substances usually referred to as lubricants); Teflon extrusions and moldings supplied in a variety of forms for a variety of applications; and

Teflon DL-1, a development of pure Teflon to meet low cost requirements. Applications, typical properties and availabilities are included.

Carrier Terms. Lenkurt Electric Co., 1113 County Rd., San Carlos, Calif., has issued a character study of carrier equipment and dictionary of carrier terms in bulletin EB-101. Definitions of 150 terms commonly found in telephone and telegraph carrier equipment literature are given. The 16-page booklet also includes a general discussion of carrier equipment theory.

VHF Receiver. Collins Radio Co., Cedar Rapids, Iowa. A 4-page folder illustrates and fully describes the 51M-6, a vhf communications receiver that has a single preset crystal-controlled channel and is designed for unattended, continuous aeronautical ground station reception of a-m radiotelephone signals. Technical specifications are included.

Picture Tube Substitutes. Transvision, Inc., New Rochelle, N. Y., has released a newly revised picture tube interchangeability replacement guide. The list shows popular types of picture tubes that may be used to replace hard-to-get types, noting such modifications (if any) that should be made when direct replacement is difficult.

X-Ray Analysis. North American Philips Co., Inc., 750 South Fulton Ave., Mt. Vernon, N. Y., has available a new folder containing two reprint articles entitled: "How X-ray Diffraction Gets Answers to Difficult Questions" and "Catalysts: The Inside Story." Illustrated with photos and charts, the new folder discusses x-ray diffraction work with clays, rubber, plastic polymers, boiler scales and catalysts. In the case of catalysts, fourteen approaches for x-ray studies are listed.

Engineered Mounting Systems. Robinson Aviation Inc., Teterboro, N. J. The 16-page Visualizer bulletin No. 750 illustrates the development of all-metal engineered mounting systems for the maximum vibration isolation and shock protection of electronic equipment. By visual means, the bulletin defines vibration and shock, shows the effect of vibration on equipment, what can be done about vibration, and the application of MET-L-FLEX (knitted stainless steel wire) as the resilient and damping element. It explains vibration control from theory to practice and shows the development of the single and dual-stage systems from the classical example of an equivalent mechanical system.

Telemetering Booklet. The Bristol Co., Waterbury 20, Conn. Bulletin M1710 contains information on the use of the company's Metameter telemetering instruments for remote recording, indicating, and totalizing of electric variables over distances ranging from a few feet to many miles. Timely information and engineering data are included on the subject of modern telemetering methods. The company's new electronic Dynamaster transmitters and receivers are described and information is given on various methods of transmission, including carrier current, microwave, vhf and uhf radio and multiplexing. A number of typical installations of Metameter telemeters are illustrated and described.

Sound Recording Tape. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. Output versus bias current curves for Scotch brand magnetic recording tapes are discussed in "Sound Talk" bulletin No. 21 recently announced. Graphs are included on which the curves of 12 different Scotch brand magnetic tapes are shown, representing four basic tape constructions. The bulletin is available upon request.

Components Catalog. The Victoreen Instrument Co., 3800 Perkins Ave., Cleveland 14, Ohio. A new 8-page catalog of components is now being distributed. It contains detailed specifications, illustrations, typical circuits and applications for the company's components including: vibrators,

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vibrator power supplies, subminiature tubes (electrometers, corona regulators and special-purpose tubes), voltage regulators, current regulator tubes and resistors.

Electronic Facilities. AiResearch Mfg. Co., Los Angeles, Calif. Booklet 4-0-1 covers the available electronic facilities and activities of the company. Newly compiled, the booklet gives a detailed account of the company's electronics group in the laboratory and on the production line. More than 60 pictures complete the 16-page booklet.

Electronic Wattmeter. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. A new 2-page bulletin describes the model 110 electronic wattmeter. It includes complete specifications and full description of features, which include a range of 0.3 to 9,000 watts, 20 to 3,000-cps response, unusual convenience and accuracy in measuring low impedance devices.

Radiotelephone Equipment. Kaar Engineering Corp., Middlefield Road, Palo Alto, Calif., has completed a comprehensive summary catalog covering all its mobile radiotelephone equipment. The equipment presented in easy-reference form is designed for use in the 152 to 174-mc band, the 25 to 50-mc band and the 1,600 to 6,000-kc band. The company's complete line of accessories is included in the catalog.

Recording Potentiometers. Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Wayne and Windrim Aves., Philadelphia 44, Pa. Three new 4-page specification sheets describe and illustrate ElectroniK recording potentiometers. Specification sheet 160 covers circular chart recorders; sheets 164 and 165 cover single and multiple record strip chart recorders. Construction and engineering details are included.

Hermetically-Sealed Relays. General Electric Co., Schenectady 5, N. Y. General purpose hermetically-sealed relays for electronic applications are described in bulletin GEA-5729A. The two-color publication uses photographs, specification charts, and dimensional diagrams in discussing the application, performance and features of the relays, which are designed to meet or better all provisions of MIL-R-6106, Joint Military Service specifications for relays, and to meet performance requirements of MIL-R-5757B.

Teflon Catalog. The Polymer Corp. of Pennsylvania, Reading, Pa. The latest technical data on Teflon for the chemical, electrical and electronic industries is available in an 8-page catalog. Applications and possibilities for the material are described in detail along with Teflon's outstanding properties and characteristics. The booklet is illustrated with a complete set of tables, charts and sketches. A special summary deals with design considerations in using Teflon while extra help is offered through a technical service section on the cover. The booklet catalogs Polypenco Teflon in the forms of rod, tubing, slab and tape with specifications on size, shape and tolerance.

V-T Electrometers. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. Vacuum-tube electrometers are the subject of a new 8-page bulletin. Nineteen application diagrams are included, plus a full description of accessories, which permit measuring a wide range of d-c voltages, currents as low as 10^{-14} ampere resistance to 10^{16} ohms.

Facility Brochure. The Victoreen Instrument Co., 3800 Perkins Ave., Cleveland 14, Ohio, announces the availability of a new 16-page booklet entitled "Creative Engineering and Production Facilities." This is a pictorial presentation of the development, engineering and production facilities in the company's four divisions.

Inverter-Amplifier. Allegany Instrument Co., 1000 Oldtown Rd., Cumberland, Md. A single-page bulletin illustrates and gives tech-

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nical specifications of the model 305 inverter-amplifier. The low-drift d-c amplifier described may be used with wire strain gages, load and pressure pickups, accelerometers and thermocouples. Size of the unit discussed is 6½ in. × 6½ in. × 9 in. deep, and weight is 7 lb.

Universal Bridge. The Clough Brengle Co., 6014 Broadway, Chicago, Ill. A single-sheet bulletin illustrates and describes the model 712 capacitance-resistance-inductance bridge, a general-purpose miniaturized instrument having a basic 2-percent accuracy. Weighing 14 lb and occupying the cubic space of a vtvm, the unit discussed is designed for field maintenance applications, or for use in the lab where bench space is at a premium.

R-F and Pulse Connectors. Diamond Mfg. Corp., 7 North Ave., Wakefield, Mass. The recent 48-page catalog 53 is intended to be used as a guide for the procurement of r-f and pulse connectors by personnel of development laboratories, equipment manufacturers, procurement agencies and field installations. Engineering and electrical data are supplied for each connector of a particular type, and each is accurately described and cross-referenced with the tabulated data required to facilitate the selection of compatible cables and connectors.

Spectrophotometers. Beckman Instruments, Inc., South Pasadena 1, Calif., has released bulletin 303-59, a 28-page catalog of ultraviolet and visible spectrophotometers, picturing all sample cells and other accessories. The two-color brochure contains detailed descriptions and illustrations of the model B and DU spectrophotometers—precision instruments that measure and identify substances by passing light through them. Such auxiliary units as the flame, reflectance and fluorescence attachments also are described. The catalog features an extensive section treating the complete line of the company's spectrophotometer cells, interchangeable sample compartments and cell adapters. A composite price list-index is also furnished.

Magnetic Amplifiers. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y., has available a booklet on its line of magnetic servo amplifiers that are adjustable and permit the user to stabilize his servo loop over wide ranges of performance requirements, load conditions and gear ratios. Also given is information on a standard line of high-gain push-pull magnetic amplifiers, saturable transformers, and 400 or 60-cps servo systems.

Connectors. Coaxial Connector Co., 35 No. 2nd Ave., Mt. Vernon, N. Y. A 4-page catalog contains an illustrated technical description of the company's line of UHF and BNC series connectors, as well as its 12 types of waveguide flanges. The UHF series described are for small and medium-sized cables and are generally satisfactory at frequencies up to 200 mc with some voltage reflections. The BNC series covered are for use where the peak voltage does not exceed 500 v, and where frequency applications do not exceed 3,000 mc. Also listed are what the individual waveguide flanges mate with.

Vidicon Components. Radio Corporation of America, Harrison, N. J. A new 16-page booklet supplies technical information on deflection-circuit components for the type 6198 Vidicon, the new small camera tube for industrial tv applications. Used in the recommended circuits shown in the booklet, these components feature characteristics that provide good sweep linearity, high deflection sensitivity, efficient coupling between circuits, proper focusing and accurate alignment of the electron beam. A copy of Form No. CTV-1016 may be obtained on request.

Transistor Solders and Fluxes. Division Lead Co., 836 W. Kinzie St., Chicago 22, Ill. A 2-page bulletin describes a number of transistor solders and fluxes that are already in use by a number of manufacturers. Outstanding in the line discussed is the No. 335 that can be used to solder copper-plated, unplated etched, or unplated unetched germanium—and which contains no ammonium compounds to hasten stress cracking of delicate copper, brass or phosphor-bronze parts.

Locknuts. Industrial Fasteners Institute, 3648 Euclid Ave., Cleveland 15, Ohio, has published a 24-page bulletin sponsored by 21 manufacturers of locknuts. A study of the descriptions and illustrations included will provide useful information leading to successful application. Names of the companies manufacturing each individual type of locknut are given.

Carbon Monoxide Detector. Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N. Y. A 12-page booklet tells about the company's advanced carbon monoxide detector. Included are special features such as automatic operation, unitized construction and quality instrumentation; a functional description that gives illustrations and operation data; component and panel information; specifications, and suggested and notable installations.

Hermetic Sealing. General Hermetic Sealing Corp., 99 East Hawthorne Ave., Valley Stream, L. I., N. Y., has just prepared a new 4-page folder on "The Why and the How of Hermetic Sealing" for electrical and electronic components and assemblies. Typical applications as well as facilities are described. Copies are available on request.

Permanent Magnets. Thomas & Skinner Steel Products Co., Inc., 1122 E. 23rd St., Indianapolis 5, Ind., has released a catalog listing its complete line of standard permanent magnets. Available in Alnico 2, 3 and 5 for use in a wide range of industrial applications, the standard magnets listed may be ordered from stock to aid designers and engineers who want magnets quickly to produce working models for experimental purposes, to fulfill moderate production requirements, or to adapt to a standard application without tooling delays. Ask for catalog No. 1252.

Sound Recording Tape Coatings. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. The magnetic properties of Scotch brand sound recording tape coatings is the subject of "Sound Talk" technical bulletin No. 22 now available. The bulletin discusses the properties of four basic types of magnetic coatings manufactured by the company, including 14 different magnetic tape constructions and two sprayable dispersion magnetic coatings. It is intended especially to provide design engineers and experimenters with data to determine field intensities necessary to magnetize the various tape coatings, as well as the resulting magnetic flux. Four graphs are included in the bulletin showing typical hysteresis loops and magnetization curves for the four basic types of magnetic coatings.

Printed Circuit Guide. Centralab Division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. Printed Electronic Circuit Guide No. 2, revising and up-dating the original guide, has been announced. In the guide listing section over 100 users of printed electronic circuits are listed with 445 different manufacturers' part numbers. Complete testing data are given so that the units covered can be checked to make sure they are in good operating condition. Also included is a guide showing the number of each type of unit now in use.

Control Instruments. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrim Aves., Philadelphia 44, Pa. Catalog 1530, "ElectroniK Controllers," comprises 56 fact-filled pages describing all types of the company's control instruments that are used to measure and control a multiplicity of process variables. Included are detailed specification and control action descriptions and ratings for both electric and pneumatic type controllers. The literature also presents

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engineering data on the Electr-O-Line and Electr-O-Pulse electric control relays.

Speech Equipment. Collins Radio Co., Cedar Rapids, Iowa. Catalog 111 is a 48 page booklet covering the company's line of speech input consoles, remote equipment, rack mounted equipment, test and monitoring equipment, antenna accessories, racks and panels, custom equipment and turntables and transducers. The units described are illustrated and indexed.

Small Bobbin Winder. Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill., has available a catalog sheet illustrating and describing the new model 38-A miniaturized bobbin winder. Of special interest are the slow-start feature that avoids possibility of wire breakage, and the instant resetting automatic counter that saves time by permitting instant resetting of the winding cycle by merely touching a lever.

Metal Pretreatment. Specialty Coatings, Inc., Division of Thompson & Co., 1085 Allegheny Ave., Oakmont, Pa. A new six-page folder describes Vinsynite pretreatment for all types of metals. It includes details of the manner in which Vinsynite is used in finishing six different types of metal products for good paint adhesion and corrosion resistance. It also gives test data to show that Vinsynite is unaffected by severe distortion and exposure to standard ASTM salt spray test.

Tape-Wire Recorder Replacements. Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill., has prepared a tape-wire recorder replacement guide, listing 63 models of 22 companies manufacturing tape and wire recorders. The guide is published to fill a need for authoritative information on power transformer, filter choke and audio output transformer replacements. Manufacturer and model number, manufacturer's part number and Stancor part numbers are listed for all models included in the guide.

Coaxial Fittings. Coaxial Connector Co., 35 No. 2nd St., Mt. Vernon, N. Y., is offering a cross index of Army-Navy coaxial fittings in a handy 22 in. x 14 in. wall chart. This useful quick-reference guide lists designations from government part numbers to equivalent manufacturers' part numbers.

Circuit Selectors and Stepping Relays. G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio. Bulletin 353 CSR contains engineering data on Ledex circuit selectors and stepping relays. A complete description of the product, its method of operation, mechanics of control, both selective and stepping, Cascade Master-Slave homing circuit diagram, spark suppression, types of mountings, rectifiers and remote Selsyn circuit are just a few of the many subjects discussed and illustrated in this informative bulletin.

Electron Tube Interchangeability. Lewis and Kaufman Ltd., 50 El Rancho Ave., Los Gatos, Calif. Leaflet Form 253 provides interchangeability data on a series of Los Gatos electron tube types. Each tube in the series is covered with a brief type description and list-price information as well as a tabulation of the existing tube types with which it is directly interchangeable.

Printed-Circuit Components. Radio Corp. of America, Harrison, N. J., has available an 8-page booklet covering printed-circuit components designed for use in tv receivers utilizing intercarrier-sound systems and having picture i-f and sound i-f carriers of 45.75 mc and 41.25 mc, respectively. The components illustrated and described feature high gain, full bandpass response and excellent skirt selectivity. Dimensional diagrams and response characteristics are shown.

Dynamic Tape Tester. Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N. Y., recently published a

bulletin illustrating and describing its dynamic tape tester, a precise, coordinated function generator that is applicable to the computer and control field. The unit described consists of six plug-in type function plate assemblies driven from a common synchronous motor shaft through a gear train; and a reversing clutch is provided for rewinding the tape at the conclusion of a run. The equipment discussed is designed for 115-v, 60-cycle operation.

Transformer Catalog. Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y., has available a 4-page catalog illustrating and describing a line of hermetically-sealed transformers designed to MIL-T-27 specifications. In the line described are military standard filament transformers, military standard plate and filament types and military standard audio types; also filter reactors. Detailed specifications and prices on all types are given.

Component Developments. Aerovox Corp., New Bedford, Mass. A recent bulletin deals with electronic component developments, particularly high-temperature metallized-paper capacitors, Aerofilm capacitors, electrolytics operating above the present 85 C range, and new micas for working temperatures up to 125 C. Also included is information on duct-type noise-suppression capacitors, subminiature bypass capacitors, miniature bathtubs, Borofilm resistors with temperature coefficient of 100 ppm or less, hermetically-sealed ceramic-case Carbofilm resistors, high-voltage plate assemblies and ceramic capacitors, and printed-wiring development.

Sound Analyzer. Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass. A single-page bulletin gives an illustrated description of the type 420-A sound analyzer. The unit discussed features filters that are adjustable separately in half octaves, portability, small size, light weight and versatility. Technical specifications, response curves and prices are included.

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PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

IRE Takes Part In Study Of Bureau Of Standards

THE Institute of Radio Engineers has nominated William L. Everitt, radio authority and Dean of the College of Engineering, University of Illinois, to serve on a committee of scientists formed, at the request of Secretary of Commerce Sinclair Weeks, to evaluate the present functions and operations of the National Bureau of Standards in relation to the present national needs.

The nomination came as a result of telegrams sent by Secretary Weeks to leading scientific and engineering societies requesting each to select one of their members to serve on the committee. M. J. Kelly, president of Bell Telephone Laboratories, will serve as chairman.

Dr. Everitt's nomination was made only after assurance had been received from Secretary Weeks that the committee will operate under the National Academy of Sciences, that it will not be concerned with personnel relationships between the National Bureau of Standards and the Department of Commerce, and that the report of the committee will be made public.

Dr. William L. Everitt has had a distinguished career as engineer, educator, consultant and author of text books and scientific articles in the radio field, and has held teaching posts at Cornell University, University of Michigan and Ohio State University.

ELECTRONICS AND PLASTICS SHARE HONORS

Two industries whose interests are closely allied, electronics and plastics, shared honors at an awards luncheon in Hollywood, Calif., sponsored by the Plaskon Division of Libbey-Owens-Ford Glass Company. Awards of merit were presented to Glen E. Swanson, president of Standard Coil, and Mr. Wilcox, founder and president of Wilcox Plastics, Inc., on the occasion of the production of the 100 millionth Standard Coil television tuner board using alkyd plastic segments molded by Wilcox. Left to right are Mr. Swanson, Dr. Lee de Forest, inventor of the electronic tube, who presented the awards; Henry W. DeVore, Plaskon sales executive and Mr. Wilcox

OTHER DEPARTMENTS featured for this issue:

RTMA Adds New Members

THE RTMA board of directors approved the membership applications of nine new companies as follows:

Adler Communications Laboratories, Continental Electronics Corp., Dale Products Co., Microwave Associates, Inc., Morgan-Rhein, Inc., Square Root Manufacturing Corp., Tempo T-V Products Co., Translite Electronics Corp., and Varian Associates.

Overseas Businessmen Survey U.S. Electronics

IN A 5 week, 4,000-mile tour of 20 U. S. manufacturers in 18 cities, from Massachusetts to Iowa, a group of 9 visiting business men from 7 foreign countries covered a cross-section of the U. S. electronics industry. The international group, all foreign representatives of Ad. Auriema, Inc., independent exporter and sponsor of the "Observatour", observed the latest developments in the U. S. electronics industry, and obtained information on U. S. merchandising techniques.

One of the plants visited was the Stevens Paper Mills, Inc., which makes capacitor paper. The group also attended the IRE Show during its run in New York and expressed amazement at the size of the industry as represented by the hundreds of exhibits.

Philco Plans Canadian TV-Radio Plant

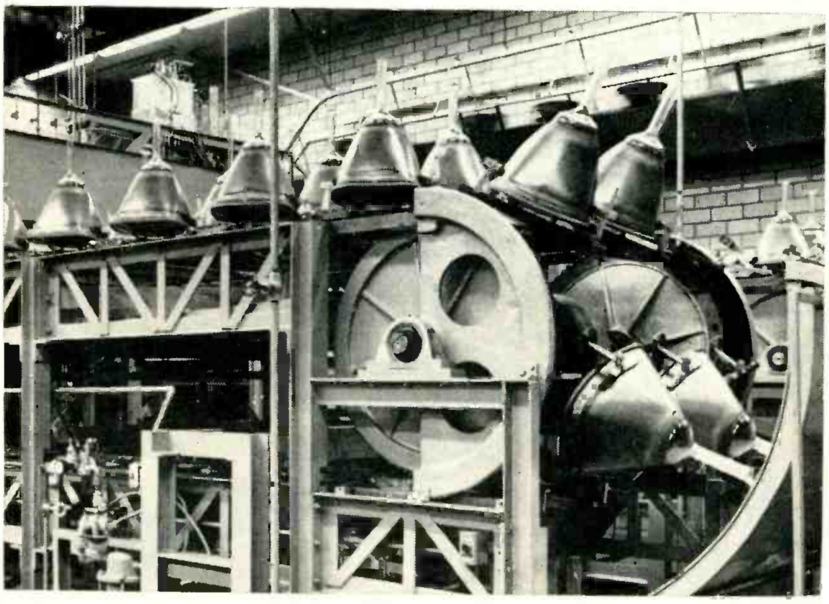
PHILCO CORP. announced plans for a new plant to manufacture television and radio receiving sets in the


WORLD'S MOST WANTED AUTOCHANGER
BSR
Music lovers everywhere are demanding the Monarch—the new idea in automatic record changers. Never before have they had such fidelity of tone; completely automatic selection of all records—12", 10" and 7"; such ease of operation and unfailing reliability.
Many leading set makers fit the Monarch as standard—your request for information will bring full details by return.
Birmingham Sound Reproducers Ltd., Old Hill, Staffs. Grams: 'Electronic Old Hill, Cradley Heath.'

suburbs of Toronto, Canada.

According to an announcement by Sydney L. Chapell, president of Philco International Corp., the manufacturing facility will be erected this year within the planned community of Don Mills. All production and administrative activities now conducted in the plant in Toronto will be transferred to the new site early in 1954.

Ground will be broken immediately. When complete, it will have 81,000 sq ft of floor space.



Screen-settling machine begins to roll as . . .

Westinghouse Expands In The Tube Field

IN TWO NEW PLANTS Westinghouse has undertaken the manufacture of an extensive line of electronic tubes. At Bath, New York, 145,000 square feet of working surface will produce the receiver tube line; at Elmira, New York, 40 miles away, 365,000 square feet of plant will produce tv picture tubes and industrial, broadcast and x-ray tubes. Also, at Elmira, a pilot operation is set up for semiconductor production.

Not yet in full swing, the Elmira plant is turning out 2,000 picture tubes a day, with three shifts of about 130 workers total. The assembly line consists of an efficient conveyor belt layout, leading from nearly automatic machines that seal in the faceplates and necks. In other nearly automatic machines, the phosphor screen is added (above). Finally, in long automatic furnaces the tubes, each on a separate vacuum stand, are heated, evacuated and sealed off.

Appointment of two Westinghouse executives to newly created posts has been announced by E. W. Ritter, vice-president in charge of the Electronic Tube Division.

John G. Thompson fills the position of product manager at the Bath plant, and Franklin P. Hinman is assigned to duties of product manager at the Elmira plant.

A. George Rogers has been appointed manager of operations for the Westinghouse Television Radio Division, Metuchen, N. J.

Mr. Thompson, in his new position, is responsible for coordinating all engineering, manufacturing and sales activities of the receiving tube section of the division. Mr. Hinman is responsible for coordinating power tube engineering, manufacturing and sales at the Elmira plant. His duties also include direct management of power tube manufacturing.

Mr. Rogers, a veteran of 26 years in the electronics industry, has had extensive experience in engineering positions which included design, test and quality control assignments. In administrative posts, he has directed plant organization, production planning and standardization of inspection and manufacturing techniques.

RCA May Establish Service Lab In Japan

AN electronic industry service laboratory for the assistance of RCA licensees may be set up in Japan, according to B. E. Shackelford, director of the license department of RCA International, who is in Japan to study the question of establishing the lab and also the possibility of a manufacturing investment by RCA in the country.

It is reported that RCA has, at present, license agreements with 17 Japanese firms.

Baker To Receive RTMA Medal Of Honor

W. R. G. BAKER, chairman of the National Television System Committee and director of the RTMA Engineering Department since 1934, was unanimously chosen by the RTMA Board of directors as recipient of the second annual RTMA Medal of Honor for outstanding contribution to the radio-tv and electronics industry.

He was nominated for the award by the annual awards committee headed by Leslie F. Muter, and will receive the medal at the RTMA convention in Chicago, June 15-18.

The award was established last year to provide industry recognition of the person, company or organization which has made an outstanding contribution to the advancement of the industry. The first Medal of Honor was awarded to Brig. Gen. David Sarnoff, chairman of the board of Radio Corp. of America.

Dr. Baker also was chairman of the first National Television System Committee which in 1941 proposed to the FCC the present transmission standards for black and white television. The present National Television System Committee is engaged in conducting field tests of a compatible color television system developed by the committee following the pooling of technical infor-

MAGNETIC AMPLIFIERS · INC

announces

The New MA Automatic Universal TRANSISTOR CURVE TRACER

USES: Designing transistor circuits—comparing, matching and selecting—detecting anomalies—studying effects of temperature, age, normal usage, overloading—detecting failures and cause

FEATURES: Tests NPN, PNP, Junction, Point Contact Transistors — flexible to accommodate new types.

Dynamically plots entire family of curves simultaneously on standard laboratory DC oscilloscope.

Function switch selects: output or transfer curve in grounded base or grounded emitter connection.

Calibrating axis generated internally as integral part of display are always in correct quadrant.

Automatic or manual operation by means of stepping relay.

Curves displayed in any quadrant—origin always indicated.

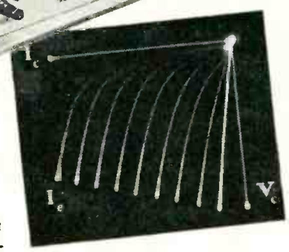
Retrace not blanked — anomalies easily seen.

3% accuracy independent of scope drift and calibration.

Measures current gain.

Simple in operation, trouble free circuitry—compact in size.

Transistor forming attachment available.



Specifications:

TRANSISTOR TYPES: **NPN-PNP — Junctions — Point Contacts**

TRANSISTOR CONNECTION: **Grounded base or grounded emitter**

SWEEP VOLTAGE: **0-100 volts**

BIAS CURRENT: **Zero plus eight equal increments. Stepped automatically or manually.**

FIXED BIAS CURRENT INCREMENTS: **10, 20, 50, 100, 200, 500, 1000 microamperes**

CONTINUOUSLY VARIABLE BIAS CURRENT INCREMENTS: **0-1 milliampere**

MANUAL BIAS RANGE: **0-8 milliamperes**

BIAS CURRENT METER: **0-100, 200, 500, 1000 microamperes full scale 0-2, 5, 10 milliamperes full scale**

TRANSISTOR CURVES: **Output (V_c vs. $I_c | I_e$); Transfer (V_e vs. $I_c | I_e$)**

VERTICAL CALIBRATOR: **0-1, 10, 100 volts**

HORIZONTAL CALIBRATOR: **0-1, 10, 100 volts**

QUADRANTS: **I, II, III, IV**

LOAD RESISTANCE: **100-10,000 ohms**

ACCESSORIES FURNISHED: **Transistor receptacle**

The MA TRANSI-MAG*—a new standard Transistor Magnetic Amplifier

to work with our standard line of magnetic amplifiers. Input sensitivity: 0.1 volt or better.

CALL OR WRITE FOR COMPLETE INFORMATION AND LITERATURE TODAY

Specify MA for these reliable standard components

- ADJUSTABLE MAGNETIC SERVO AMPLIFIERS
- MAGNETIC AMPLIFIER SERVO SYSTEMS
- PUSH-PULL MAGNETIC AMPLIFIERS
- MAGNETIC VOLTAGE REGULATORS
- SATURABLE TRANSFORMERS
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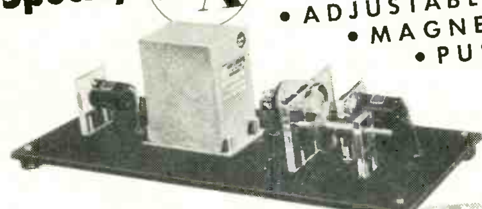
- DEMODULATORS



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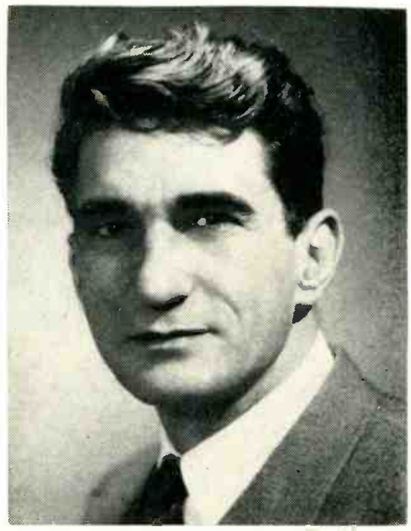
mation by all tv manufacturers.

Dr. Baker, who recently testified before the House Interstate and Foreign Commerce Committee, was highly lauded by chairman Charles Wolverton (R.,N.J.) for his great service to the industry and to the government in directing the NTSC's recent activities in color television.

Raytheon Appoints New Radio-TV Head



Henry F. Argento

THE appointment of Henry F. Argento as vice-president and general manager of Raytheon Television and Radio Corp., was announced recently by C. F. Adams, Jr., president of Raytheon.

Mr. Argento has been with Raytheon since 1932, and has most recently served as assistant vice-president and assistant manager of Raytheon's power tube division.

Graduating from Harvard with a degree in physics, he entered business as a research engineer at the Radio Frequency Laboratory, Boonton, N. J., in 1931. A year later he joined the Raytheon organization.

General Maude Heads USAF Research Center

MAJ. GEN. RAYMOND C. MAUDE, formerly director of Air Force Communications at Headquarters, U. S. Air Force, has assumed command of the Air Force Cambridge Research Center at Cambridge, Mass., according to an announcement by Lt. Gen. Earle E. Partridge, commanding general of the Air Research and Development Command in Baltimore.

Recently appointed deputy commanding general of the Air Force Cambridge Research Center, General Maude succeeded Maj. Gen. James F. Phillips as commanding general of the Center. General Phillips is retiring from active duty after 30 years of continuous service with the Army and Air Force.

Appointed director of Air Force Communications in the summer of 1951, Gen. Maude has guided U. S. Air Force communication-electronics activities through a period of intensive expansion.

During World War II, Gen. Maude served in Europe as communications officer of the Ninth Bomber Command and later as director of communications for the 29th Tactical Air Command. In August, 1945, he was named communications officer of the U. S. Air Forces in Europe.

Fairchild Appoints Missile Director

Francis J. Gaffney

THE appointment of Francis J. Gaffney to the post of director of engineering for the Guided Missiles Division of the Fairchild Engine and Airplane Corp. was announced by Edwin A. Speakman, general manager. Mr. Gaffney, who was general manager of the Polytechnic Research and Development Company, is widely known for his work in the field of microwave measurement and pulse circuit techniques. During World War II he headed the

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Test Equipment Group in the MIT Radiation Labs from which came many wartime advances in radar and microwave equipment.

After the war, Mr. Gaffney joined the Polytechnic Research and Development Company as chief engineer. He became general manager in 1950.

Pioneer Constructs New TV Picture Tube Plant

CONSTRUCTION of a new plant for manufacturing tv picture tubes will be started for Pioneer Electronics Corp. of Santa Monica, it was announced by L. M. Parrish, president.

Located in West Los Angeles, the new plant will have 30,000 sq ft of enclosed space and 20,000 sq ft of paved ground for parking, loading and for potential expansion.

Proposed Pioneer Plant

It is expected that the new plant will add a 500-percent increase to the company's production of 1,500 picture tubes a week.

The building will cost an estimated $200,000 to build. Pioneer will invest an additional $250,000 in new equipment. Special-purpose vacuum tubes for aircraft manufacturers, now made in a separate building, will also be produced in the new plant.

Hobbs Elected V-P Of Harvey-Wells

MARVIN HOBBS, who recently joined Harvey-Wells Electronics as director of engineering, has been elected vice-president and a member of the board of directors.

From 1950 to 1952 Mr. Hobbs was on the staff of the Office of the Secretary of Defense, as director of the Electronics Division of the Munitions Board and the Defense Department member of the Electronics Production Board. Prior to that period, he spent 20 years in the industry in engineering positions with RCA, Scott, General Motors and Zenith. During World War II he was chief of the Electronics Branch, Radio and Radar Division, War Production Board, and operations analyst on the staff of the Far East Air Forces.

Marconi Opens Tube Plant In Italy

A NEW factory for making electronic tubes has begun production at Aquila, Italy. Belonging to the "Marconi Italiana" company, the plant makes transmitting tubes and receiving tubes. Two hundred workers are now employed and the number will be gradually raised to 300 in the course of a year.

Hoffman Names Whitney Assistant To President

Marvin G. Whitney

MARVIN G. WHITNEY has been appointed as assistant to president of Hoffman Radio Corp. with current assignment on television engineering, quality control and product design, according to an announcement by H. Leslie Hoffman, president.

A graduate of Rensselaer Polytechnic Institute, he was with RCA in various product and plant manager capacities for the period of 13 years. This included broadcasting and industrial equipment manufacturing at the Camden, N. J. plant and later government equipment manufacturing in the same factory

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and more recently in the new RCA engineering plant at Moorestown, N. J.

Olympic Buys Electrona

R. BOWLING BARNES, president of Olympic Development Company, subsidiary of Olympic Radio and Television, Inc., announced the acquisition of the Electrona Corp. of Irvington, N. J.

The Electrona Corp. will continue operations at its Irvington laboratories under the direction of Carl Bosch, who becomes vice-president and director of research of Electrona. It will be directly affiliated with the Olympic Development Company.

Carl Bosch, who received his doctorate from the University of Berlin, and his staff are currently engaged in both civilian and military research work with particular emphasis on radiation detection.

Crawford Elected Radiart President

Harry C. Crawford

OCTAVE BLAKE, president of the Cornell-Dubilier Electric Corp. and chairman of the board of its subsidiary, the Radiart Corp., announced the election of Harry C. Crawford as president of the Radiart Corp., replacing L. K. Wildberg.

Mr. Crawford has been associated with Cornell-Dubilier and Radiart for the past 8 years as works manager as well as comptroller and assistant treasurer. He

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was industrial engineer for 2 years with Douglas Aircraft and spent 5 years as vice-president and sales manager with International Piston Ring Co., coming there from Thompson products where he served 20 years as business manager of their automotive parts replacement division.

Iron Fireman Goes Electronic

WHAT has been known as the Heating Control Division of Iron Fireman Manufacturing Co. will now be designated the Electronics Division, Frank S. Hecox, company vice-president and treasurer recently announced.

The division will continue to manufacture electrical controls and other items of Iron Fireman equipment, Hecox stated. The new name was selected to eliminate local confusion with other Iron Fireman operations and to reflect an expansion into components for electronics systems and other types of electrical instruments. "Our plan for the next five years will lead us more and more into the electronics field in addition to our continuing research and development on electrical motors and automatic controls," Hecox declared.

Mitchell Elected President Of RCA Communications

ELECTION of Thomas H. Mitchell as president of RCA Communication, Inc. was announced recently by Brig. General David Sarnoff, chairman of the board of RCA.

Mr. Mitchell, executive vice-president of RCA Communications since 1944, succeeds H. C. Ingles who retired at the age of 65. Mr. Ingles has served as president for 6 years, having joined RCA Communications soon after his retirement in 1947 as a Major General and Chief Signal Officer, U. S. Army.

A graduate of the U. S. Naval Academy at Annapolis, Mr. Mitchell entered the communications field in 1927. He worked for two years in the Pacific sales division and engineering department of RCA Communications, and in 1929 became district manager for the Radio-marine Corp. of America in Los Angeles. In 1930 he transferred back to RCA Communications where he held increasingly important posts.

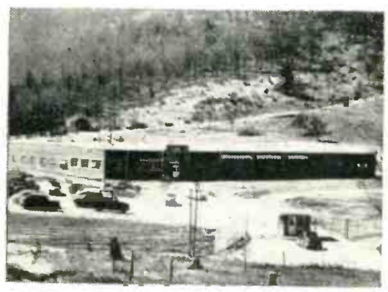
After service as a Colonel in the Army Communications Service during World War II, Mr. Mitchell rejoined RCA Communications as General manager and soon after was elected executive vice-president.

European Firm Expands

ISOFIL S. A., connected with Aismalibar S. A. of Switzerland and Spain, will produce filaments for lamps, radio tubes, x-ray tubes and other products in San Paulo, Brazil. Swiss capital will be 50 percent, represented by machinery and equipment.

Production Starts In New IRC Plant

PRODUCTION is already underway in the $200,000 plant of the International Resistance Co., located on a 66-acre site in Asheville, N. C. Operating at full strength, the plant



New IRC plant

will employ approximately 500 persons of which the majority will be women. H. J. McCaully, formerly assistant to IRC's executive vice-president, will manage the Asheville plant.

Raytheon To Merge Radio-TV Subsidiary

RAYTHEON Television and Radio Corp. will be merged into the Raytheon Manufacturing Corp., the parent company, as of the close of business on May 31, 1953, it was recently announced. The merger will coincide with the beginning of the new fiscal year on June 1, 1953.

In announcing the planned merger, C. F. Adams, Jr., president of Raytheon, said, "this action will complete the integration of all the company's operations into a single corporate structure. The television, radio and government business now being carried on by Raytheon Television and Radio Corp. will be continued as a divisional operation of the parent company, comparable to its other operating divisions with its headquarters continuing to be in Chicago. The merger will not affect the internal management structure of the new division, its policies or any of its personnel or distributor-dealer arrangements."

DuMont Named Microwave Distributor For Motorola

THE Television Transmitter Division of Allen B. DuMont Laboratories, Inc., has been named as sole distributor for Motorola microwave equipment for the tv broadcast industry, it was announced recently by James B. Tharpe, national sales manager of the DuMont division.

Dunbar Joins Dalmo Victor

Allen S. Dunbar

ALLEN S. DUNBAR, for the past 3 years senior research engineer for the Stanford Research Institute, has joined Dalmo Victor Company as assistant director of research, the San Carlos electronics firm an-

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nounced recently.

Mr. Dunbar, 31, works in the field of microwave optics and on the theory of doubly curved antenna reflectors, in which capacity he has been a consultant to Dalmo Victor.

From 1946 to 1949 he was a research scientist for the Naval Research Laboratory and from 1943 to 1945 he was a staff member of the antenna group at the MIT radiation laboratory.

Burroughs Seeks To Change Its Name

IN PROXIES mailed to its 29,000 stockholders throughout the world, the management of Burroughs Adding Machine Company has proposed that the organization's 48 year-old name be changed to Burroughs Corporation. If adopted, the new name will be put into effect by the company as rapidly as legal requirements can be accomplished.

Mr. John S. Coleman, president, explained that Burroughs Corporation carries the essential name of the founder, but does not have the limitations of Burroughs Adding Machine Company.

"Years ago, the present company name was completely adequate," Mr. Coleman said. "The organization built adding machines. That was all."

Today Burroughs produces a wide array of equipment for business and the government, including electronic instruments for scientific use and precision navigation, firing control and sighting instruments and systems for the Armed Services.

Mr. Coleman pointed out that the physical growth of the company had paralleled its growth beyond its early single-line manufacture of adding machines.

"This growth has been greatly accelerated since World War II," he said. "In the six years since 1947, our plants have increased from 5 to 15, and our employment from 10,000 to 20,000."

Sonkin Joins Stanford

DR. Simon Sonkin of City College of New York has been appointed professor in Stanford University's microwave laboratory, and will handle radio-frequency and tube problems connected with the 1,000,000,000-volt linear accelerator in the laboratory.

John Ruze Heads Gabriel Labs

John Ruze

APPOINTMENT of John Ruze as director in full charge of the Gabriel Laboratories was recently announced by John H. Briggs, president.

The new director became head of the antenna design section at Signal Corps Engineering Laboratories during World War II. In this position he directed the development and design of many radar and IFF antenna systems.

In 1946 he joined the Air Force Cambridge Research Center where he served as assistant chief of the antenna laboratory. Here he specialized in microwave optics, especially wide-angle metal-plate lenses and high-gain steerable antenna arrays.

John K. West Elected A Director Of NBC

ELECTION of John K. West as a member of the board of directors of the National Broadcasting Company was announced recently by Brig. General David Sarnoff, chairman of the board of RCA and NBC.

West is vice-president in charge of the western division of NBC

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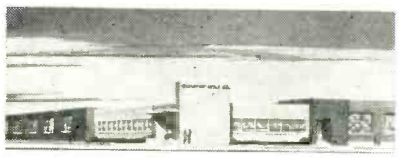
with headquarters in Hollywood, a post he has held since 1950. General Sarnoff said that Mr. West's election to the NBC board of directors was not only in recognition of fine performance of his duties but also of the growing importance of the West Coast in radio and television broadcasting.

Mr. West has long been associated with RCA, having been engaged in sales, advertising and public relations for the RCA Victor division beginning in 1930. He was named vice-president in charge of public relations for the RCA Victor division in 1947.

Quam-Nichols Plant Ready In July

THE Quam-Nichols Company's new factory and executive offices on Chicago's South Side will be fully occupied by mid-July, according to Matt Little, president.

A feature of the new plant is the experimental and development laboratory designed by J. P. Quam, board chairman of the company and inventor of many of its products.



Quam-Nichols factory

The new building will have more than twice the productive capacity of the old plant. Moving from the present plant will begin in late May, with full production in the new plant scheduled for July 20, at the end of the summer vacation periods.

Corning Appoints Five To New Division

FIVE major appointments in Corning Glass Works and the establishment of a new operating division in the company were announced recently.

Three new officers, John L. Hanigan, Frederick H. Knight and Henry H. Sayles were elected vice-president, secretary and assistant secretary respectively. Thomas

Waaland was appointed director of industrial relations and John F. G. Hicks was made general manager of the newly formed International Division of Corning Glass Works. The International Division will consolidate under one head all foreign activities of the company, including export sales, foreign licenses, exploration of new overseas markets and relations with Corning's foreign subsidiaries and associates.

TelAutograph Buys Electrotechnic Corp.

LOUIS R. KURTIN, chairman of the board of TelAutograph Corp., announced that the firm has completed negotiations for the complete purchase of Electrotechnic Corp. of Azusa, California.

Purchase of the facilities of Electrotechnic will augment the research and manufacturing capacities of TelAutograph and supplement the electronic manufacturing operations of the concern.

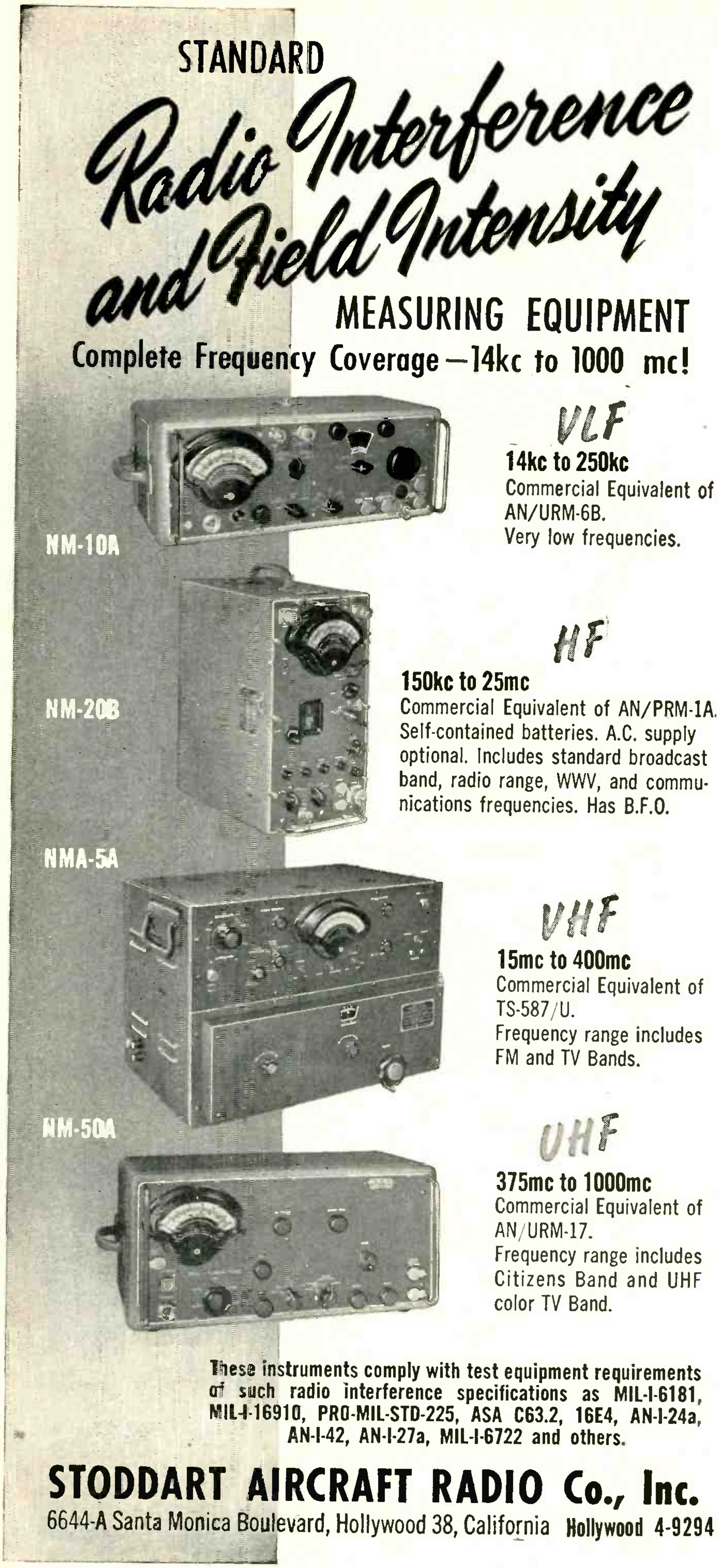
Electrotechnic will operate as a wholly owned subsidiary of TelAutograph Corp.

General Dry Batteries Appoints Byrom

James L. Byrom

GENERAL Dry Batteries, Inc., Cleveland, has appointed James L. Byrom to the new position of director of engineering, it was announced recently by president Walter A. Onorato.

The position was created, Mr. Onorato said, as part of a broad



program to strengthen the company's functional organizations and to expand all phases of engineering activities in producing its full line of dry-cell batteries.

For the past 5 years Mr. Byrom has been vice-president and general manager of the Chandler-Evans Division of Niles-Bement-Pond Co. at West Hartford, Conn. Before that, he served 4 years with Underwood Corp. as chief engineer and 14 years with National Carbon Co. in Cleveland as head of the machine development department.

New Heppner Plant

A SECOND plant has been opened by Heppner Manufacturing Co., Round Lake, Ill. Located in Mendota, Ill., the new plant is devoted exclusively to manufacturing ferrite rod antennas and flyback transformers.

Becker Joins Ampex

Carl H. Becker

CARL H. BECKER, German physicist and audio engineer, has joined the staff of the Ampex Electric Corp., the firm recently announced.

From 1930 to 1943 he was chief sound engineer and physicist for UFA, German motion picture producer. While with UFA he developed stereophonic film-recording.

When the German government banned the production of civilian films in 1943, he organized Stereophone Ltd. in Bavaria. He was president of the organization until he came to the U. S. last fall.

At Stereophone, a research, development and manufacturing organization, he was directly connected with such activities as the analysis of explosive sound pressures with stereophonic equipment, bombsight and release equipment, magnetron transmitters and power supplies for magnetrons and klystrons and the acoustical control of torpedoes and guided missiles. The company also manufactured complete film studio equipment and was engaged in the development of magnetic video recording.

Allemang Made V-P Of Planning For Philco

HERBERT J. ALLEMANG, management consultant who joined Philco as a corporate officer in 1951, has been appointed vice-president in charge of planning for Philco Corporation, it was announced by William Balderston, president.

In his new capacity, Mr. Allemang will be responsible for the long-range planning of manufacturing facilities, organization and operations of Philco.

Cardwell Appoints Engineering Director

John A. Doremus

RALPH H. SOBY, president of the Allen D. Cardwell Mfg. Corp., recently announced the appointment of John A. Doremus IV as director of engineering.

Mr. Doremus, formerly chief engineer, Carrier and Control Divi-

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sion, Motorola, Inc., will be responsible for the company's engineering research as well as engineering supervision of government projects.

Aircraft Engineering Gets Electronic Division

AN electronics division has been established at the Oakland, California Airport plant of Aircraft Engineering and Maintenance Co.

According to Douglas F. Johnson, president, the unit will produce component parts of electronic devices and communication equipment. The company will handle final assembly of parts and do research.

Grand Elected Chairman Of Granco Products

Jack Grand

JACK GRAND has been elected chairman of the board of directors of Granco Products, Inc. The company was recently organized for the design, manufacture and distribution of converters for uhf television reception and uhf measuring instruments.

Mr. Grand has been associated with the electronics industry for 30 years in merchandising and manufacturing.

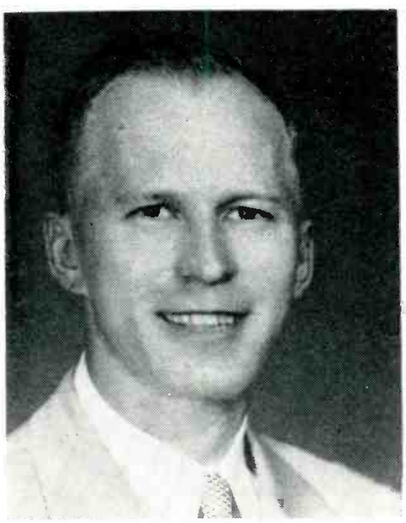
General Electrosonics And Segalock Merge

GENERAL ELECTROSONICS, INC. has merged with Segal Lock and Hardware Co., Inc. according to a joint announcement by G. Emerson Pray, president of General Electrosonics, and Meade Johnson, president of Segal Lock. The merger is expected to provide the electronic industry with an immediately large new resource.

Under the plan of the merger, Mr. Pray and Capt. L. B. Blaylock, vice-president of the company, who was formerly in charge of the research and design section of the radio division of the Bureau of Ships, will continue in the active management of General Electrosonics. However, the factory will be consolidated at the plant of the Norwalk Lock Company, major producing subsidiary of Segalock.

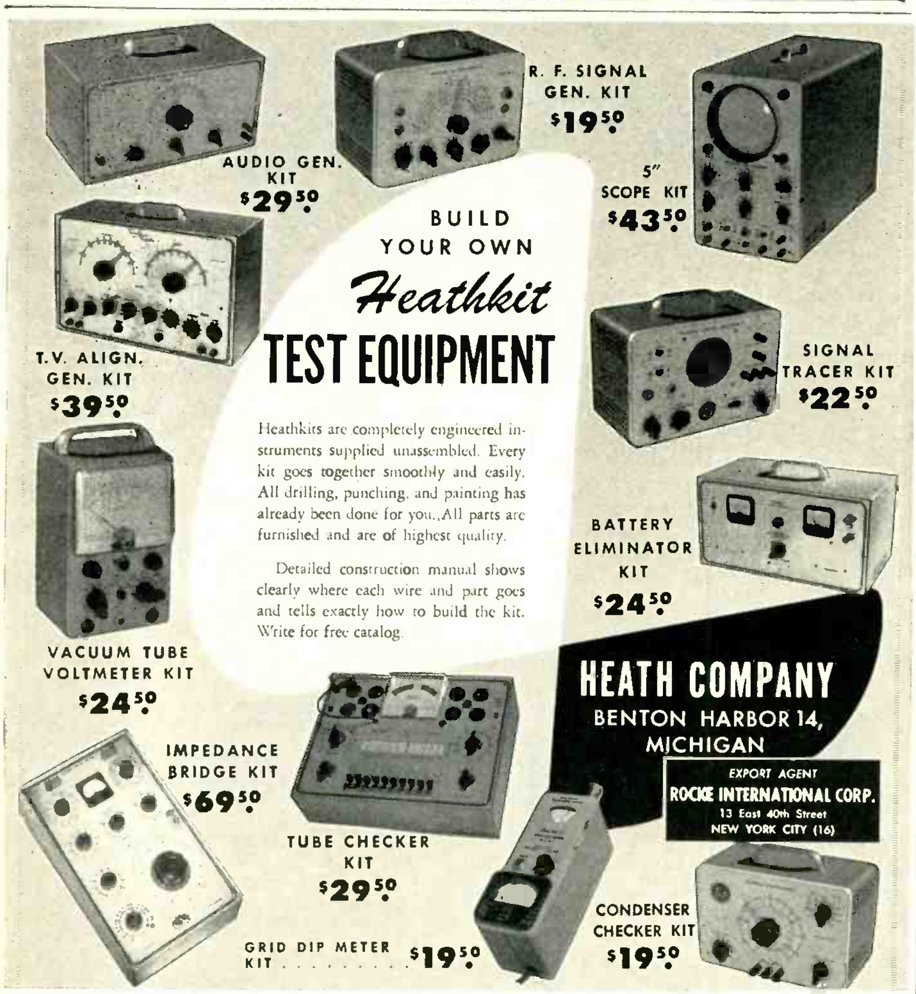
According to Mr. Pray, the merger was undertaken to provide the organization with the enlarged manufacturing facilities needed for rapid expansion. The Norwalk Lock Company was interested in expanding into the electronics field. The merger offered a means to acquire an organization of engineers with special knowledge of current electronic developments plus fully equipped laboratories and test equipment which could not be duplicated in less than a year of assembling and purchase.

Svihel Heads Kuljian Electronics Department



Bernard T. Svihel

A NEW electronics division has been established by the Kuljian Corp. with Bernard T. Svihel in charge. He comes to the company with over 15 years experience in the radio and electronics industry, having

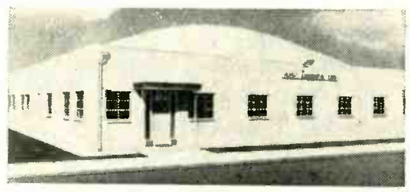


been responsible for extensive design and research work in analog computers, differential analyzers and servo-mechanisms.

A graduate of the University of Minnesota, Mr. Svihel was for 6 years a member of the electrical engineering staff at MIT, where he served for a time as a project engineer in charge of the MIT Rockefeller differential analyzer. For 4 years he was with the Franklin Institute in charge of electronic computation and simulation.

Perkin Moves Into New Plant

THE Perkin Engineering Corp. has announced its move into a new 10,000 sq ft plant in El Segundo, California.



New Perkin plant

The plant is fully equipped with modern machinery and facilities for the production of the company's line of electronic equipment.

Boonton Names Gilman Chief Engineer

THE appointment of Samuel Gilman as chief engineer of Boonton Radio Corporation has been announced by G. A. Downsbrough, president and general manager. Mr. Gilman was formerly associated with American Machine and Foundry and with Westinghouse Electric.

Leeds & Northrup And S.A. Integra Merge

THE FORMATION of Integra-Leeds & Northrup Ltd., Birmingham, England, is jointly announced by Charles S. Redding, president of Leeds & Northrup and Maurice Bouffart, managing director of S. A. Integra, Liege, Belgium.

The new firm succeeds to the

business formerly conducted in Birmingham under the name of the Integra Co., Ltd., which was a branch of the Liege firm and for some years has been the English agent for L&N products. That business will be expanded to include the manufacture of the products of both Leeds & Northrup and S. A. Integra. Ownership of Integra-Leeds & Northrup Ltd. is shared by Leeds & Northrup and the owners of the former Integra Co., Ltd. Managing director will be Jean Register, previously manager of the Birmingham firm. Mr. Redding will be a member of the new company's board of directors.

"Creation of the English company," say its spokesman, "will strengthen the long-standing and cordial relationships of S. A. Integra and Leeds & Northrup. S. A. Integra will act as agents for both the American firm's and the new English firm's products in Belgium."

Hallock Advances At Bardwell & McAlister

Robert D. Hallock

ROBERT D. HALLOCK has been advanced from the position of chief engineer to plant manager of Bardwell & McAlister, Inc., according to John N. Valianos, executive vice-president. In this new capacity Hallock will be in charge of both engineering and production.

Prior to joining Bardwell & McAlister, Mr. Hallock was associated with Solar Mfg. Co., Standard Coil

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Products Co. and Airesearch Mfg. Co. as a design engineer in the electronic divisions of these companies.

Transformer Engineers Acquire Miller Corp.

THE business of William Miller Corp., has been acquired by the Transformer Engineers group, also of Pasadena. The new company, William Miller Instruments, Inc., will continue to manufacture the Miller line of recording oscillographs and related equipment as well as specialty transformers manufactured by Transformer Engineers. E. E. Hoskins is president of the new company. He has been president of Transformer Engineers since 1945, and prior to that was vice-president and chief engineer of Consolidated Engineering Corp. George W. Downs, formerly vice-president and chief engineer of William Miller Corp., is vice-president and E. M. Graham, former treasurer of Transformer Engineers, is treasurer of the new company.

William Miller plans to devote his time to his other interests which include Applied Physics Corp. and Research Engineering Corp. of Pasadena.

JFD Opens New Plant

THE NEWEST addition to the JFD Manufacturing Co. was recently opened in Brooklyn, N. Y. The new all-brick building provides 140,000 sq ft of additional space for the expanding firm.

OTHER NEWS

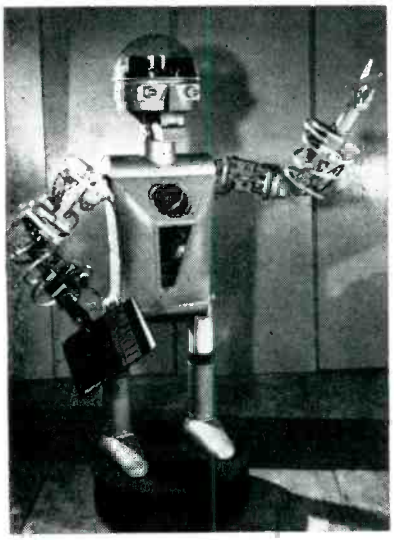
Clendenin Ryan Of IT&T Enters Governorship Race

AT A meeting of the board of directors of the International Telephone and Telegraph Corp., Clendenin J. Ryan resigned as a director of the corporation in order to enter the race for the governorship of New Jersey as a candidate of the Independent Voters Party.

Mr. Ryan, who has served on the board since December 1948, has taken an active interest in the corporation's affairs. In offering his resignation, he said that his tenure had afforded him a great deal of satisfaction and further stated:

"It is with a feeling of profound regret and reluctance that I offer my resignation from the board of directors of IT&T, but I see no other course."

Garco Joins Garrett



Garco

GARCO, a 5½-foot, 250-pound robot created by Harvey Chapman, a Garrett Corp. engineer, has joined the company to demonstrate its products. His brain is a modified temperature regulator which operates his right arm through an electronically controlled servo-mechanism. He has solenoids to move his jaw and lip, step motors to rotate his eyes and a two-way transmitter to give him a human voice. His electronic brain is a basic servo-system multiplied 6 times. Six channels include subminiature potted two-stage amplification units, one for each channel.

MIT Offers Courses On Computers, Transistors

THE potentialities of modern electronic processing systems will be emphasized during a two-week special summer program on digital computers and their applications from August 24 to September 4 at MIT.

The program is especially de-

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signed, according to Ernest H. Huntress, director of the MIT summer session, for those unfamiliar with digital computers who must determine how newly-available computing systems can be applied to their problems and the advantages that might accrue.

To bring industrial engineers current information in the rapidly expanding field of transistors, MIT will also offer a special summer program in transistors and their applications from July 20 to 31.

The aim of the program will be to define those areas in which the transistor may have immediate application and to make some prediction of its future. Approximately one-fourth of the MIT summer program will be devoted to a development of the theory of the operation of transistors, starting from familiar physical principles.

A third course, presenting a formalized theory for the analysis and synthesis of feedback control systems, will be given at MIT from June 22 to July 3.

GE Surveys TV Service Work

SEVENTY percent of radio and television setowners responding in a market research survey completed recently by General Electric's Tube Department reported that the quality of the service work done on their sets has been either good or excellent, John T. Thompson, manager of replacement sales for the department, said recently.

Seventy-eight percent of the setowners felt that the charges for parts and labor were reasonable, Mr Thompson said.

While comparative figures are not available, Mr. Thompson said that in his opinion the new figures represent a considerable improvement over past years. He attributed the improvement to a concerted effort by the service industry to improve the quality of its work and increased public awareness of the tremendous problems that the rapid growth of television has posed for the service industry.

The survey covered setowners in cities and towns of all sizes in all television areas, and only setowners who had had service work done on their sets in the last six months were contacted.

The following figures representing the overall results of the GE survey: Quality of service: 78 percent, reasonable; 22 percent, high. Speed of service: 44 percent, fast; 43 percent, average; 13 percent, slow.

The survey also showed that 90 percent of the setowners contacted had their repairs done by a service dealer or service department of an appliance store, and that only 7 percent had repairs done under a service contract.

VOA Needs Engineers

THE Voice of America has vacancies for unmarried radio engineers to operate its new 1,000-kilowatt standard-band stations on Okinawa and the Philippines. A shortage of family-type housing precludes consideration of additional applications from married engineers at this time.

Salaries range from $4,323 to $5,907 per year, depending on education and experience, plus allowances and transportation.

Applicants must be single, between 25 and 35 years of age, holders of first class radio telephone licenses and must have had at least 3 years experience with standard-band or short-wave broadcasting transmitters.

Applications should be addressed to: Office of Facilities Manager, International Broadcasting Service, Department of State, 251 West 57th Street, New York, N. Y.

ICS Offers Course In Industrial Electronics

A NEW COURSE in industrial electronics has been announced by the International Correspondence Schools of Scranton, Pa.

The course is designed to meet the needs of engineers and technicians, electrical, mechanical, civil and chemical, who wish to take advantage of the applications of electron tubes in their own fields. Estimated average study time required for the completion of the course is 800 hours.

NEW BOOKS

A Machine Wiser Than its Maker

BY NORBERT WIENER*

THE last ten years have seen the emergence of a new point of view on communication as well as a new point of view on automata as communicative mechanisms. The work in these fields may already be divided into two stages. The earlier stage was that in which my own work figured, and in which Claude Shannon, who has been one of the most original contributors, was devoted to the elucidation of the notion of communication itself, to the theory and practice of the measure of communication, to the study of control as a phenomenon of an essentially communicative nature, and in general to the grammar of the new science which I have called cybernetics.

Dr. Ashby's work represents a chapter of cybernetics, the inception of which dates back to the earliest days of the science, and which is devoted not so much to the first questions of definition and vocabulary of ideas, but to those questions of the philosophy of the subject which involve the specific properties of cybernetic systems and which, although they go back to the definitions, represent questions of fact and of logic which go considerably beyond the definitions.

Among the questions with which he concerns himself are: What is learning? In order for a machine to be able to learn, does the capacity for learning have to be put into the machine by a highly specific organization, or can machines with a large measure of random organization show the phenomena of learning? Can a machine be wiser than its maker?

All of these questions may be asked at two different levels. On the purely biological level, they represent considerations which have haunted the biologist ever since his science passed beyond the level of a purely theological justification; in particular, they concern the very

* Editor's Note. This essay by Dr. Wiener is the result of his reading W. Ross Ashby's new book "Design for a Brain," published late in 1952 by John Wiley & Sons, Inc. New York, 260 pages, $6.00.

vital core of the problems of evolution and more particularly of Darwinian evolution by natural selection. On the mechanical level, these problems arise in connection with the much more limited man-made machines, and concern the restrictions to which man must submit himself when he deliberately usurps the functions of the demiurge.

Man-made vs Nature-made Machines

Giving all possible weight to the greater capacity and adaptivity of structure and function which nature's machines show in comparison with those of human manufacture, the man-made machines have added a new weapon of natural experiment and conceptual experiment to the armory of science. Just as the fruit fly seems to have been made explicitly for the purpose of changing genetics from the science of secular observation, which it would necessarily be if it were confined to man and the larger domestic animals, into a science compatible with the space and time limitations of the small biological laboratory, so the machines bid fair to reduce our study of biological processes of learning and adaptation, of individual development and evolution, to a scale on which we can handle these elusive concepts with something of the certainty and precision of the physical and engineering laboratory. Among the scientists who are not merely talking in these terms but actually doing something about it, Dr. Ashby is well to the forefront.

The main concept of natural selection as applied by Darwin to the theory of evolution is that the flora and fauna of the earth represent a pattern which has been arrived at as a residual pattern rather than by any direct process of striving for perfection. They do not represent a block of marble emerging into the shape of perfect sculpture under the hands of the creative artist, but rather one of those wind-sculptured pillars of sandstone which adorn the canyons of Utah. The fortuitous vicissitudes of erosion have added up to make these pillars of stone over into the guise of castles and monuments, and even of human and animal figures. Yet their beauty and imaginative significance is not like that of a painting—in the eye of the artist, but like that of a Rorshasch blot—in the eye of the beholder. Similarly the apparent theodicy hinted by the glory and the aptness of the infinite complexity of nature is, according to Darwinism, merely what is left of a random process of growth and change when its softer and less durable manifestations have been worn away by the sands of time and the weakness of their own futility.

Stability, a World Characteristic

There is another way in which nature shows residual patterns which is related to that of natural selection but in which the emphasis is a little different. Since the time of the Curies, we have known that atoms of certain elements undergo a progressive metamorphosis. If we take an atom of radium, then at some time or other it will undergo a metamorphosis in which it gives off radium emanations. We cannot say when this change will take place, for it seems to occur in a random manner. But we can say that within a certain time—called the half-life of radium—the probability that the change has taken place will be one-half.

Now the radioactive elements do not undergo simply one change, but a succession of changes into other elements, each with its own half-life. The elements with a large half-life may be said to be stable, while those which a short half-life may be said to be unstable. If we follow an element through its various changes it will in general spend a long time as elements with a large half-life and a short time as elements with a short half-life. The result is that if we consider this process to take place over a long period of time we shall find the elements with large half-life more frequent than those with a short half-life. This means that a survey in which we observe elements by frequency rather than follow a single atom in time is likely to miss the highly radioactive materials of short half-life. As a consequence, we find that stability is characteristic of the larger part of the world. Thus the absence of unstable forms, which we find in the biological series because of their incapacity to survive in the struggle for existence, appears in radio-active evolution because the unstable forms are run through so quickly that we do not notice them to the same extent as we notice the more stable forms.

One of the results of this statistical preponderance of stability in the universe is our very small knowledge of what happens in the critical periods of instability. For example, we have a well known effect, discovered by Arthur Compton, that when a photon hits an electron, the electron and the photon both jump off in directions which are only statistically determinable. There is at least a suspicion that what really happens is that the uncoupled electron and photon enter into a coupling over a period too short for us to determine what is really happening, and are then dropped from this coupling through weaker and weaker couplings, each taking its own course. Physicists like Bohm have suggested that what in fact happens is not so indeterminate as this, but that we have a very complicated succession of events occurring during that minute period of time when the particles are near together which determines the way they are to go later. If this is true, then a large part of our most essential physics is unknown because we run through it so quickly and we have no record of that.

As to these two sorts of natural selection, namely natural selection by the destruction of the unfit, and natural selection by the extremely rapid manner in which we run through the unstable, the latter is the one indicated when we have phenomena of conservation which prevent the mere removal of the unstable. Ashby considers highly complicated machines where the different elements are coupled to one another in something of a random manner so that we know something about the statistics of coupling and very little about the detail. These machines would in general be explosively self-destructive if we did not introduce into them safety elements similar to what we call amplitude limiters in electric circuits. These limiters have the effect of causing the system to show a certain sort and measure of conservation. Therefore the Ashby machines tend to spend a large part of their existence in time in relatively stable states, whereas their instabilities, although they do exist, are so restricted in time as to show very little in a statistical study of the system.

It should be remembered that it is the relatively stable states which interest us in the phenomena of life and behavior rather than the absolutely stable ones. Absolute stability is only to be attained at very large values of the entropy, and is essentially the heat death. However when a system is excluded from this heat death by some of the conditions to which it is subject, it will spend most of its existence in states which, while not states of pure equilibrium, are equilibrium-like. That is, the entropy is not an absolute maximum but is either a relative maximum or at any rate changes very slowly in the neighborhood of these states. It is such equilibrium-like states rather than true equilibria which are associated with life and thought and all of the other organic processes.

Machines with Eyes and Ears?

I think I am thoroughly in the spirit of Dr. Ashby when I say that these equilibrium-like states are in general states in which there is a relatively small transfer of energy between the system itself and its environment, but nevertheless a relatively large coupling of information. The systems of which he is thinking have eyes and ears and thus obtain the wherewithal to adapt themselves to the outer environment. They approach automata in their internal energy balance, but are very far from automata in their external entropy or information balance. Thus the type of equilibrium to which they approach may be an equilibrium in which they are well adjusted to changes in the outer environment and to a certain extent insensitized to such changes. They exist in a state of partial homeostasis.

In his homeostat, Dr. Ashby designs an instrument with this sort of coupling to the external environment, and with a certain degree of randomness in its internal structure. Such a machine can learn to a limited degree: that is, it can adjust itself by its mode of behavior to a stable balance with its environment. Nevertheless, the actual homeostats so far designed in detail by Dr. Ashby, although they have an ability to absorb information from the environment, contain in their own structures a degree of information and a mass of decision relatively large when compared with that which flows in through what we may call their sense organs. In short, these machines can learn but are not in fact wiser than their makers, or indeed nearly so wise. Nevertheless, Dr. Ashby is of the opinion that machines can indeed be made which are wiser than their makers; and in this I fully concur with him. There is no *a priori* restriction of the amount of information which an instrument can observe through its sense organs to that not involving a larger number of decisions than have already been built into its structure. In general the ability of a system to absorb information from outside starts growing rather slowly compared with the amount of built-in information. And it is not until the built-in information has passed a certain point that the capacity of the machine for absorbing further information begins to catch up with what is intrinsic in its structure. But in a certain degree of complexity, the acquired information not only can equal that which has been originally placed in the machine but can vastly exceed it; and from that stage of complexity on the machine begins to participate in some of the important characteristics of a living being.

Complexity—a Necessity

The situation has a curious parallel with the atmoic bomb or the atomic pile, or with the similar situation of a fire in a fireplace. If you try to build your atomic pile or bomb too small, or if you try to light a single solid oak log with a match, you will find that any chemical or atomic reaction which

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you start will die down the moment its stimulus is removed, and will never keep constant or build up. It is only when the fire lighter reaches a certain size or when a certain number of molecules accumulate together in the atomic pile, or when the mass of uranium isotope reaches a certain explosive size that new things begin to happen, and that we see more than fugitive and incomplete processes. Similarly, the really imposing and active phenomena of life and learning only begin after an organism has reached a certain critical degree of complexity, and although this complexity is probably attainable by purely mechanical means of not excessive difficulty, nevertheless it strains such means to their very limit.

It will be seen from this discussion of only some of the items and ideas contained in it, that Dr. Ashby's book gives us an inspiring insight into new vistas of thought. Dr. Ashby, indeed, though he has a highly mathematical imagination, is not in the full sense a trained mathematician and it remains for trained mathematicians to carry out many of the ideas which he has sketched. He does not claim to be a trained mathematician but he is obviously a man of insight and genius, and his book must be read as one of the first fruits in a field deserving of much further cultivation.

Electronic Digital Computers

American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y. 1952, 114 *pages*, $3.50.

THE publication of the papers and discussions presented at the Joint AIEE-IRE Computer Conference, Philadelphia, Pennsylvania, December 10-12, 1951, forms an excellent summary of the proceedings. It brings together into one well-written book the detailed facts about various large and small computing systems as well as operational experience with these systems.

In most cases the proceedings reports extend the detail and information content of the original oral paper, especially as to machine organization and processes.

The fact that some of the sys-

tems have been improved and that much more operational data is now available on these systems, as well as some important new ones not considered in the proceedings, does not detract from the worth of the manuscript. Though not complete in respect to all computers and systems, of the time of the conference, nevertheless it is definitive with respect to most of the systems discussed.

As an indication of the continuing esteem that some computing engineers and mathematicians have for the book, one may cite their use of it in courses on computers as a text and a reference book.

The systems discussed at the conference include machines with magnetic drum storage for main memory, acoustic delay line machines, electronic tube storage, electrostatic tube storage and relay memory. Some operating experience with each type of machine, though not with each system, appears in the papers. There are some misleading remarks in several of these operational discussions. However, we in the computer field have faith that we will eventually live up to the claims! The operational discussions are quite well founded in fact, considering the generalities that one is forced into to discuss this facet of computers.

At the conference, papers by several English authorities were given on two of the English computing systems. Each of the machines discussed sprang from a University, the Ferranti machine from the University of Manchester and the EDSAC from Cambridge.

The Ferranti machine grew out of research on the storage of radar data and was initiated by the Telecommunications Research Establishment at Great Malvern in 1946. The project moved to the University in 1947. EDSAC can trace its history back to the Moore School of Electrical Engineering where Dr. Wilkes took a summer course in computers in 1946.

The ability of each of these machines to grow with the times is true of most of the American systems discussed. Indeed some growth of the systems is indicated in the papers.

American machines that are dis-

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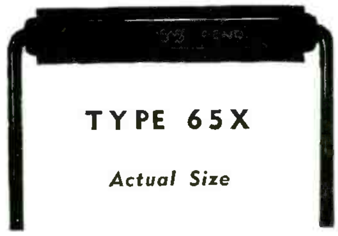

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cussed include the Univac, the Burroughs Laboratory Computer, the IBM-CPC, the ORDVAC, the ERA 1101, the Bell Relay machines, the Mark III, the SEAC and the Whirlwind I.

With the exception of some of the Bell Relay machines these are general-purpose machines. The special-purpose machines such as the digital differential analyzers and algebraic linear equation-solving machines were not discussed at this meeting. One must go elsewhere to learn about them.

In addition to the papers mentioned there are three general papers and one on transistors. One of the general papers, Jay W. Foresters' concluding remarks, "Digital Computers: Present and Future Trends", presents some evaluation of the other papers and some opinions about the future trends. It might be worth while for the reader to read this first before plunging into the details of the other papers.

Mr. C. R. Strang of Douglas Aircraft Co., Inc. discussed their experiences in the use of electronic computers in the past and present, and future expectations. His graphs of their needs in personnel, floor space, power, and cost to man these machines are powerful proof of the fact that these machines are here to stay—and that it will be necessary in the future to make even better ones.—R. C. DOUTHITT, *Computer Research Corp., Hawthorne, Calif.*

Photoconductivity in the Elements

BY T. S. MOSS. *Academic Press Inc., New York, and Butterworths Scientific Publications, London*, 1952, 263 *pages*, $7.00.

PHYSICS, like any other human endeavor, has its fashions. Twenty or thirty years ago, no physics laboratory aspiring to be called modern could afford to be without active research in spectroscopy. Today's "fashions" include nuclear physics first, with solid-state physics a close second.

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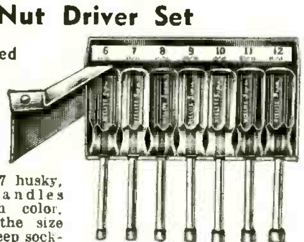

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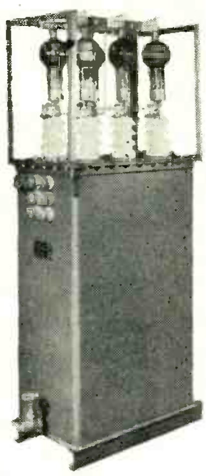

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covery of photoconductivity there have been several periods of intense activity in the field. We could say that the subject has gone through several periods of being "fashionable" and that at present we are in the middle of another revival.

What distinguishes a physical research subject from, let us say, hoop skirts, is that the changes from one revival to another are very profound. In that sense alone are we dealing with a new subject, and a modern presentation, representing new viewpoints and new information, becomes more than necessary. Indeed, the last specialized book partially covering this field is, to this reviewer's knowledge, more than 20 years old, and the number of scientific publications which appeared since then make the earlier book completely obsolete.

Without a doubt the publication of a new book on this subject is very timely and definitely overdue. In that sense the book written by Dr. Moss, an expansion of his doctorate thesis, fills a very acute need. However, there is a slight reservation in the preceding statement because it is this reviewer's wish to see the subject covered a little more thoroughly. Several restrictions present themselves. The first is indicated in the title. It deals with photoconductive elements and excludes all compounds. From the point of view of pure physics, a study of the chemical elements may offer the possibility of sticking to fundamentals and may permit greater simplicity in the treatment. In view, however, of the greater practical importance of photoconductive compounds, we will still have to wait for an authoritative and more embracing treatment of the subject.

A second restriction is the somewhat summary treatment of the theoretical aspects. The book is divided in two parts—Part I: Theory; Part II: Experimental Methods and Results. The theories are discussed for more than one-third of the book. However, this is not a purely theoretical treatment of the subject. There are several short chapters which give the necessary experimental background to theory;

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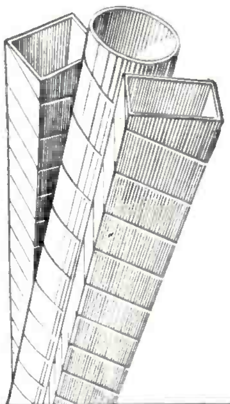

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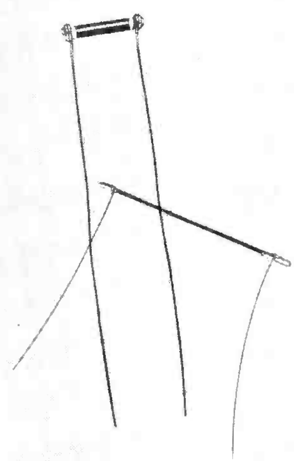

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the result is that the theory is condensed to a degree where extensive study of other books is needed for enjoying the contents of the present one. This review must compliment Dr. Moss on the thoroughness of his list of references.

Many readers will profit greatly from this lucid presentation of a very timely topic, especially from the experimental section. Others will find something lacking. The author very obviously has complete mastery of his subject and succeeded in giving a really fine introduction into the photoconductivity of the elements. Let us hope he will soon follow up with a treatment of the compounds. The publishers and printers have to be commended, too, for an excellent job.—L. MARTON, *National Bureau of Standards.*

Direct Current Machines for Control Systems

ARNOLD TUSTIN, *Electrical Engineering Department, Birmingham University. The Macmillan Co., New York*, 1952, 306 *pages*, $10.

SPECIAL direct-current machines have been developed for use in control systems. With the growing use of such machines it is natural that a special text should be written about them. On the other hand, we see a subject—d-c machines—that was once considered a beginning course for engineers, emerging now as an advanced course.

Topics common to a beginning course on d-c machines, such as static characteristics and winding inductance, are presented. The unique contribution of the book is, however, the extension of these topics to such details as dynamic characteristics and the effect of inductance on time constant. The material is developed as a foundation for machine design and serves also to give the user of such machines an appreciation of the characteristics he can reasonably expect from them. The development of input-output transfer functions and response-vector loci for basic combinations of control generators is especially helpful in analysing the charactertistics to be expected from servos that include rotating power amplifiers.

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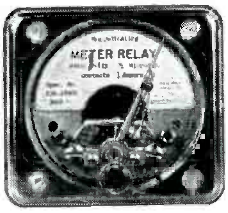

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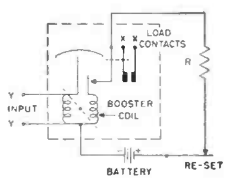

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basic manner, including the Rosenberg generator, the Amplidyne, the Metadyne and the Magnicon. These machines are placed in their environment by introductory and concluding chapters on the basic features of control and feedback. A chapter on torque motors and linear-stroke motors is a new contribution to the literature. A bibliography guides readers to more specialized literature on the subjects treated in the book.

The level of presentation of the book assumes an under-class command of mathematics and a grounding in the basic concepts of electricity. The essential points are clearly made and the explanations presented with the mature command of the language characteristic of many British books and frequently lacking in domestic technical texts.—F. H. ROCKETT, *Airborne Instruments Laboratory, Mineola, New York.*

Theory of Electric Polarisation

BY C. J. F. BOTTCHER. *Elsevier Press, 402 Lovett Blvd., Houston, Texas,* 1952, 492 *pages*, $10.

IT IS EASY, from reading many electricity and magnetism text-books, to get the impression that the well-known Clausius-Mosotti equation

$$\frac{\epsilon-1}{\epsilon+2} = \frac{4\pi}{3}\sum N_i a_i$$

gives a rigorous account of dielectric properties of all substances, for its shortcomings and the many efforts to improve it are seldom mentioned. Actually, the problem is an extremely complicated one which is still far from a satisfactory solution; the dielectric constant of even so simple a substance as a sodium chloride crystal has never been quantitatively explained by physical theory. The problem of accounting for macroscopic dielectric properties of a material in terms of molecular properties is fundamentally one of quantum statistics, and any really correct treatment must take into account quantum effects, such as overlapping of electronic wave functions of adjacent molecules, and statistical factors such as correlations between in-

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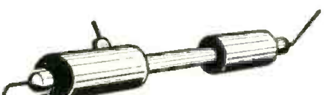

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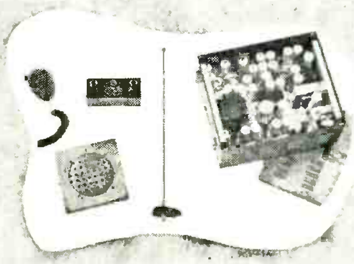

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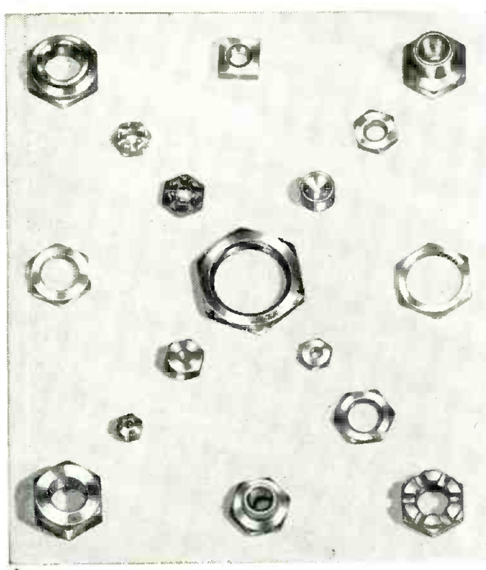

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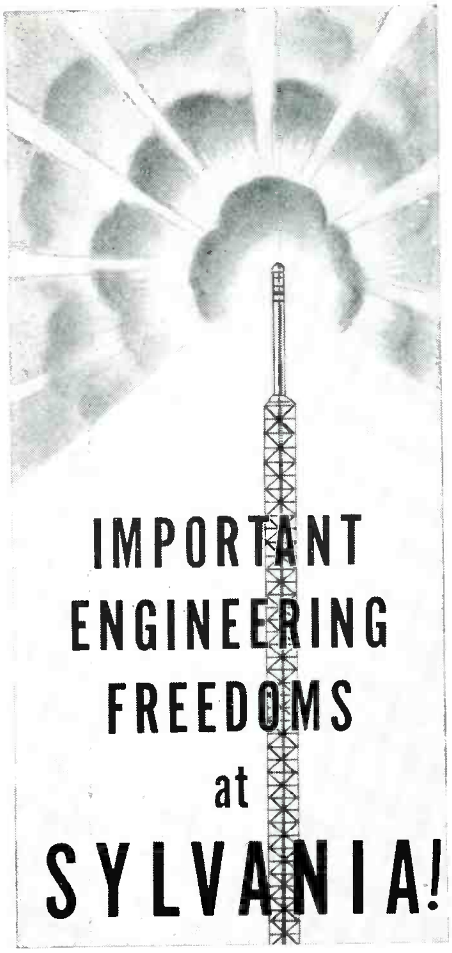
stantaneous orientations of neighboring molecules as they carry out their more or less random thermal motions. However, there is a large body of "classical" literature dealing with a drastically simplified model in which the behavior of an assembly of classical polarizable objects is sought, with or without consideration of some of the statistical factors. This is the work of many investigators, prominent among whom are Onsager, Kirkwood, and Frohlich, and it has not been collected into a coherent and easily digested form until now.

Bottcher's book is truly an introduction to the subject, for roughly the first quarter of the book is devoted to a careful exposition of the electromagnetic theory starting with elementary considerations and leading up to solutions of various boundary-value problems concerned with dipoles and multipoles, and thermodynamic treatments, which are useful for later applications. Most physicists would probably prefer to see this part of the book condensed rather drastically, since it takes so long to get to the real subject, but to a much larger group of readers this feature will be greatly appreciated. It makes the book quite suitable, for example, as a textbook for a course in physical chemistry or as a source of background for an electrical engineer who wishes to understand more about dielectrics than is provided by the tables in handbooks. In this connection the last two chapters, dealing with loss and relaxation in dielectrics and polarization of solids, including ferroelectricity, should be very helpful in giving at least a partial understanding of variation of dielectric properties from zero frequency up through the microwave region.

The middle part of the book is devoted to exposition of the "classical" theoretical work and to the problem, of great interest to chemists, of determination of dipole moments of various molecules from dielectric measurements. If a very general (and therefore not completely accurate) characterization of this theoretical work were to be made, one might say that the basic point of view remains that of Clausius-Mosotti in which the



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notions of internal field and local polarizability are the central things, and that one tries to patch up these concepts by various elaborations intended to take into account more of the actual physical situation. However, few of these attempts lead to any impressive improvement in the agreement between theory and experiment (except that of Onsager, which removes the "$4\pi/3$ catastrophe"), or to an appreciably deeper understanding of physical processes in dielectrics. Rigorously, one would have to adopt from the start a more global point of view and recognize that in condensed phases the internal field and local polarizability are really not precise concepts and it is necessary to think in other terms. The catch is, of course, that the resulting theory is so complicated that little progress has yet been made in it.

These remarks should not convey too great a feeling of pessimism; for all its shortcomings, the existing theory is close enough to the truth to be of great use to scientists in many fields, and it will always have a place in science, because it is so much simpler than any rigorous theory. The less ambitious an undertaking is, the more likely it is to be successful, and it is fortunate that the author, by restricting his attention to the "classical" theory, has succeeded in producing a comprehensive but very readable account of one phase of the theory of dielectrics.—E. T. JAYNES, *Stanford University*

THUMBNAIL REVIEWS

TV Servicing Short-Cuts. By Milton S. Kiver. Howard W. Sams & Co., Inc., Indianapolis, Ind., 1953, 97 pages, \$1.50. This book gives 62 case histories describing unusual troubles in tv receivers and steps taken to correct them. It will give the active serviceman direct answers to a large number of troubles that might be difficult to pin down, and in addition, it provides a series of stimulating mental exercises that should help any serviceman approach his problems—of any type—more intelligently. The 5½ x 8½ inch paper-cover book is a handy size for carrying in a suit-coat pocket for spare-time reading.

Final Approach and Landing. Published by the Technical Secretariat, International Air Transport Association, Montreal, Canada, 80 pages 8½ x 11 inch, paper cover. A condensed

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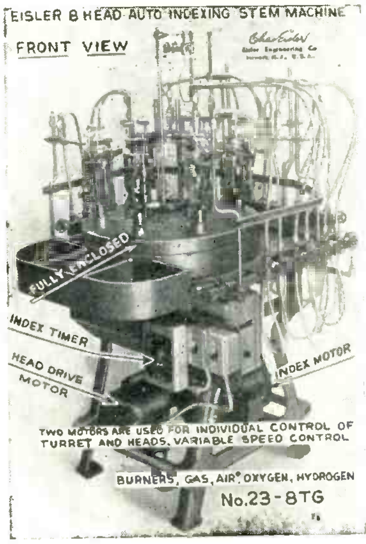

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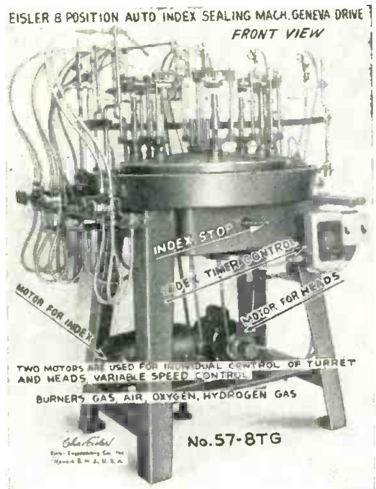

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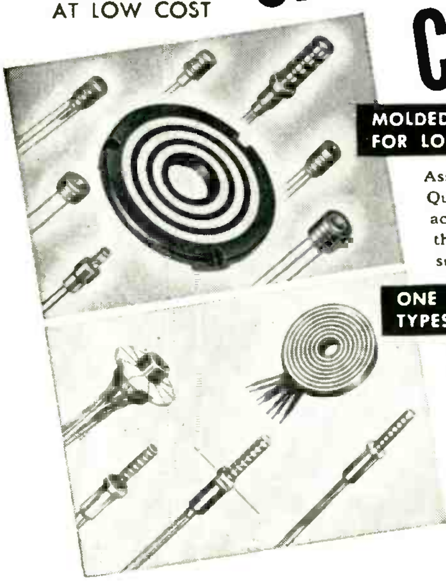

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record of discussions of factors affecting final approach and landing of aircraft at Fifth IATA Technical Conference at Copenhagen in May, 1952. Included are discussions of electronic aids from standjoint of existing equipment and possible future developments. General coverage of pertinent aircraft performance is presented, along with allied factors, such as other instrumentation, visual aids, meteorological requirements, accuracy, reliability and a section describing results of tests of different systems under various conditions.

UHF Converters. Published by Howard W. Sams & Co., Inc., Indianapolis, Ind., 1953, 42 pages, 8½ x 11 inch, paper cover, $1.00. With uhf television spreading across the country, this book promises to be a useful addition to the serviceman's library. Included are detailed descriptions of virtually all commercially-available tuners designed to be attached to vhf sets for receiving the new bands. Complete circuits and excellent detailed photographs give all information necessary to understand operation and maintenance.

Principles of Alternating Current Machinery, 4th Edition. By Ralph R. Lawrence and Henry E. Richards. McGraw-Hill Book Co., 1953, 622 pages, $7.50. A text for senior students, strongly analytical in treatment, dealing with generators, motors, converters and rectifiers. Brought up to date by rather thorough revision.

Consulting Services, 14th Edition. Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41 St., New York, N. Y., 140 pages, 8½ x 11, $1.00, 1953. A listing of over 100 consultants and laboratories working in the field of chemical engineering. A number indicate they are experienced in electronics.

TV Test Instruments. By Milton S. Kiver. Howard W. Sams & Co., Inc. Indianapolis, Ind., 1953, 147 pages, 8½ x 11 inch, paper cover, $3.00. Successful servicing, according to present-day standards, is dependent to a large extent on the equipment available to the serviceman and his ability to use it. This book tells how to use virtually all test instruments usually employed in tv receiver repair. Included are sections on vtvm's, a-m signal generators, sweep signal generators, oscilloscopes, tv and f-m alignment instruments and special instruments. Commercial instruments are used as examples, thus giving the book a highly practical value. The book should also be extremely valuable to a serviceman just getting started in business and faced with the problem of deciding what equipment he should buy.

Pulse Techniques. By Sidney Moskowitz and Joseph Racker. Prentice-Hall, Inc, New York, N. Y., 1953, 300 pages, $6.65. Partial contents: pulse generation, linear pulse amplifiers, pulse measurement, pulse shaping and clamp circuits, design of pulse network, pulse communication systems, and response of linear networks.

BACKTALK

Vibration Isolators

DEAR SIRS:

REFERENCE is made to the excellent article in ELECTRONICS for December 1952, p 126 by R. I. Dickie entitled, "How to Apply Vibration Isolators".

Since I intend to recommend this article for special study to the students in my vibration course, I wonder whether you would consider sending me a complimentary copy of this paper.

Thanking you in advance for any courtesy in this matter, I remain

R. K. BERNHARD
Professor of Engineering Mechanics
Rutgers University
New Brunswick, New Jersey

(Editor's Note: We were quite pleased to find that this article, which represents somewhat of a departure from our usual run of articles, was so well received. More articles on the mechanical and other allied aspects of the electronics industry will be forthcoming in future issues.)

Holes in Horns

DEAR SIRS:

SOME TIME ago I read an article on an experiment in which a signal was bounced off the surface of the moon. The rather plaintive comment was made that the horn antenna did not perform as expected, but was much more "leaky" than anticipated. A photograph of the horn, set up outside the Collins Radio plant, makes the cause rather fantastically obvious, to my mind; the horn walls were constructed of ordinary hexagonal chicken wire.

I have always considered, and correctly I believe, that a perforated sheet reflector should be considered as a series of close-spaced reflectors of dipole-plus length, like a venetian blind, accurately oriented in the plane of antenna polarization. The chicken wire resolves to a series of subdipole-length reflectors strung together with resistors (subdipole length at the frequency used). That this horn would be said to be leaky, and rather ineffective, would seem to be an understatement.

I have repeatedly observed reflectors in use which have a similar aspect, and this use of anything with holes in it as a substitute for a solid reflector seems to be a very common practice, which deserves some comment. A great deal of effort and time is devoted to improving the performance of receivers and transmitters, and then the gains are blithely lost in the antenna system. In the case of the comparatively low-frequency Collins horn, a fence-wire of rectangular, welded design is available which would have been much more suitable for the purpose.

The ultimate aim of minimum weight and wind resistance and maximum reflectivity would be attained with a flat punched sheet, in venetian blind design. The woven-mesh and perforated-plate designs often seen in microwave link and military and civil radar antennas often are quite inferior, particularly the woven mesh (even when properly polarized) because of the lack of a continuous surface current path.

The perforated sheet with round holes in straight lines is a good reflector but contains unnecessary material with increased weight and wind resistance. The perforated-sheet with the holes in a zig-zag pattern (in an attempt to eliminate more material) is bad; this may be regarded as a hexagonal chicken-wire design with gussetted corners, lacking the continuous current path in the plane of polarization.

CHARLES C. LITTELL, JR.
Engineering Associates
Dayton, Ohio

Gunshots

DEAR SIRS:

I WAS very interested to read in the February edition of ELECTRONICS, an article by J. L. Hathaway and R. E. Lafferty entitled "Gunshot Generator for Television Studios" (p 140). I was actively engaged during the last war in designing and developing synthetic sound effects generators for use in the training of the various branches of the Armed Forces.

Referring back to the January 1946 edition of ELECTRONICS you will find that an article was published describing one of these generator produced independently or together, a total of eight battle noises including tanks, aircraft, motor cycles etc.

Development of these effects was not continued after the war, as there did not appear to be sufficient peace time application.

P. D. SHAW
*Aren Radio & Television Ltd.
Guildford, England*

Filter Chokes

DEAR SIRS:

GOING THROUGH the lines of my article on filter chokes (Miniaturization of Airborne Filter Chokes, ELECTRONICS, p 180, Apr. 1953) I was pleased by the perfect editing job you did. Less pleasant for me however was an error I spotted a few minutes later, and which goes back to the manuscript. Under Example 2, the third sentence should naturally read:

"Considering that the specific resistance ζ at 200°C is just about twice the value for copper at room temperature, use 48°C for $10^4\ \zeta/\alpha\xi$. Then $\beta = 100/48 = 2.1$."

The following calculations have to be changed correspondingly. In the part of the text identifying the terms of Eq. 1 on page 180, l_a is the length of the airgap. In Fig. 1, b is constant and on page 183, in Step 4 under subtitle "Use of Calculation Chart", the note bearing the asterisk should read "Based on $\zeta = 1.75 \times 10^{-6}$ ohm-cm."

WALTER E. TANNER
*Bell Aircraft Corp.
Buffalo, New York*

How Many Ohms?

DEAR SIRS:

THE schematic drawing of the amplifier described in the March 1953 issue of ELECTRONICS by Howard T. Sterling and Alan Sobel in their article entitled, "Constant-Current Audio Power Amplifier", p 122, fails to specify the plate coupling resistor values for the first 6AK6 stage.

I think there was another drafting omission also, but not having the issue in front of me I fail to remember what it was. If you have a corrected diagram available you might send me a copy.

ARTHUR J. MAUS
Evanston, Illinois

(Editor's Note: According to the authors of the article mentioned above, the missing values on the plate load resistors should be 39,000 ohms. They suggest that the drafting omission cited by Mr. Maus might be the use of the word *maximum* where it should be *minimum* in the note regarding the feedback phasing capacitors.)

Workmanship

DEAR SIRS:

ON PAGE 129 of the April 1953 issue of ELECTRONICS, the item, "workmanship" under Mr. MacDonald's *Crosstalk* has struck a responsive chord in our organization. It so accurately expresses our own feelings that we are hereby requesting permission to reproduce it in part or in its entirety.

Again, expressing our appreciation for the apt wording and thought of this article we are

R. P. GRANT
Sales Manager
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Lynn, Massachusetts

(Editor's Note: As a convenience to the reader the item mentioned above is reproduced herewith. It is gratifying to know that our thinking corresponds with that of our readers in such instances.

"Modern design plus mass production can provide low-cost electronic equipment capable of giving good service. Much still depends, however, upon personal care during assembly and, particularly, the conscience of inspectors at the end of the line.

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PROFESSIONAL SERVICES

two trips were necessary to buy one good transformer. A microphone fresh from the shipping carton proved intermittent due to soldering flux under riveted lugs.

Maybe we're just unlucky. Or maybe pride in good workmanship has momentarily declined to a point where not even the fanciest test procedures can catch all the bugs.")

Distortion

DEAR SIRS:

WE HAVE NOTED a statement in your very interesting article entitled, "Transistorized Hearing Aids", which appeared in the April 1953 issue of ELECTRONICS (p 154), that we feel should be corrected. This statement is in connection with the distortion characteristics of the Radioear hearing aid manufactured by E. A. Myers and Sons, Inc.

The statement is made that the transistor hearing aid in question had a distortion of "4.4 percent with the output set at one decibel".

With an output of one decibel, no one cares what the distortion is, because this output would (a) be unmeasurable, (b) be below the threshold of audibility for even a normal ear.

The article should have said that with the output sound-pressure level only one decibel *lower* than the maximum obtainable, the distortion has dropped to the relatively small figure of 4.4 percent. As the output level is decreased from this, the distortion continues to drop. Distortion is usually 2 percent or less for the output sound-pressure levels ordinarily used.

Typical values of distortion for two-cell operation as measured on a random-selected Radioear Model 820 are:

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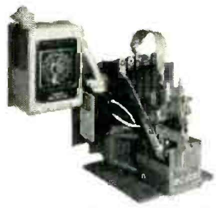

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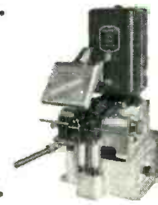

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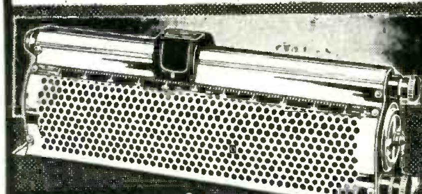

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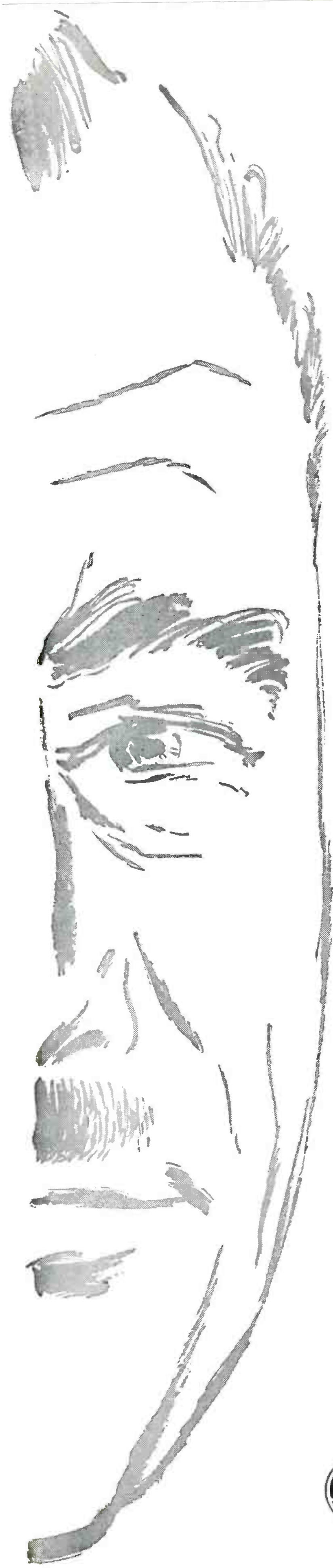
Auction Advertising, page 431—Equipment Wanted, page 436



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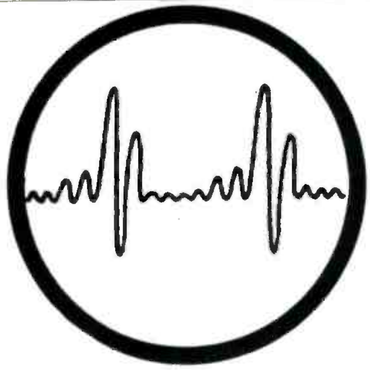

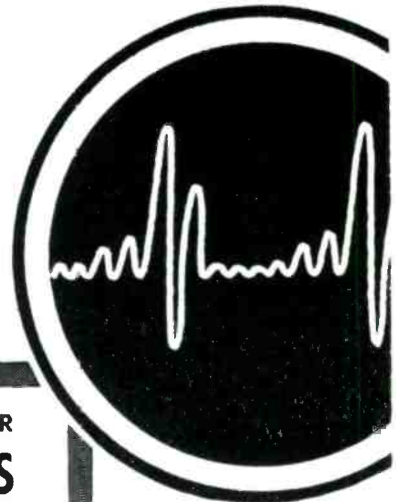

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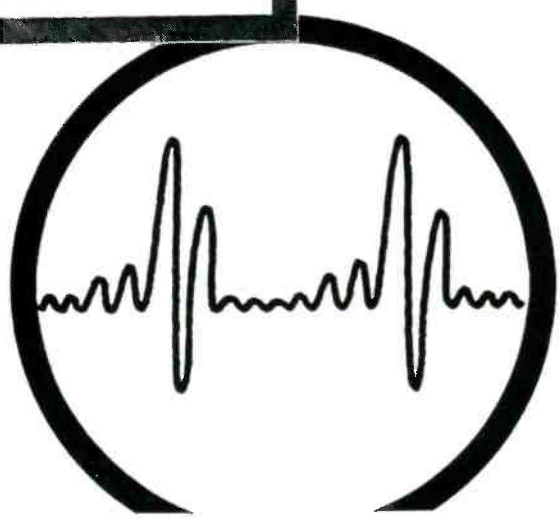

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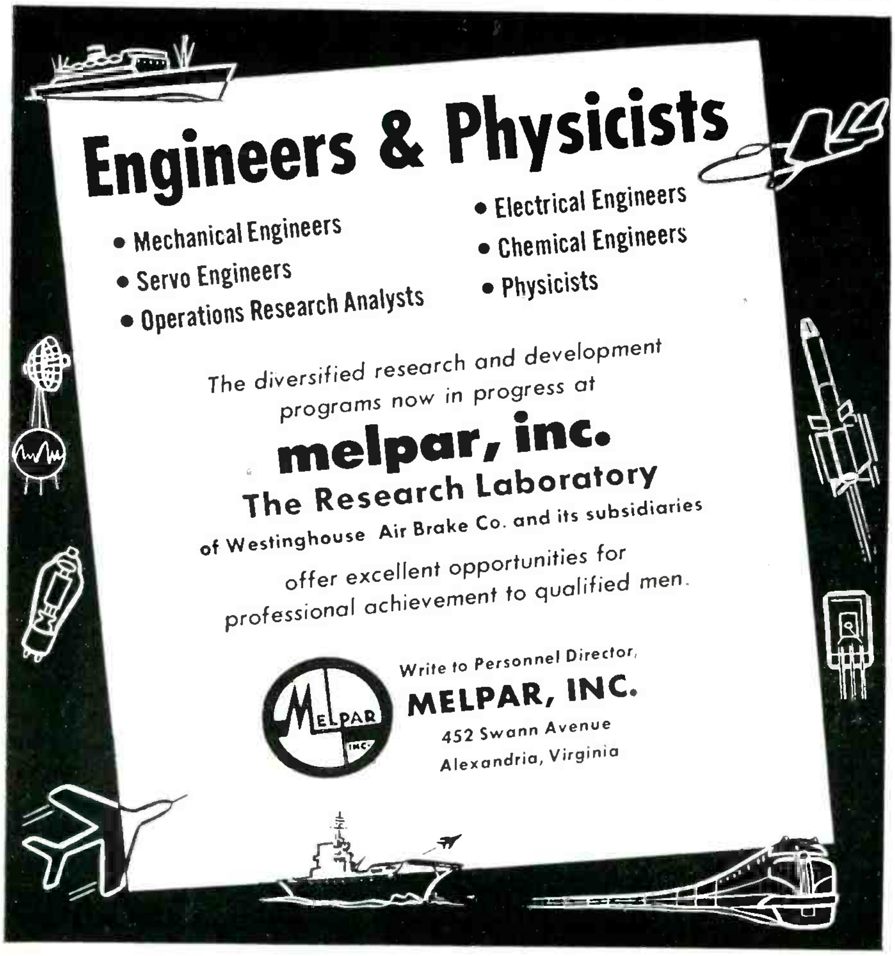

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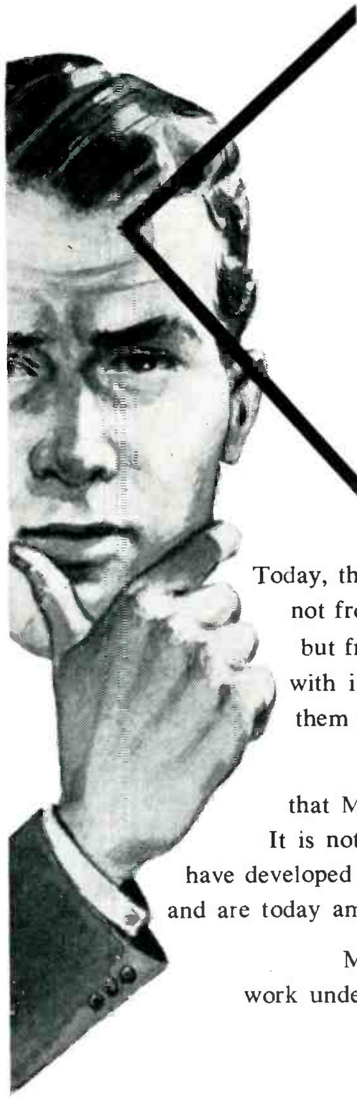
ENGINEERS



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Today, the great ideas that benefit mankind come . . . not from a struggling young genius in a garret . . . but from men who work in an environment rich with incentives, facilities and resources, enabling them to put their ideas into practical application.

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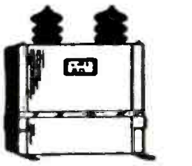

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.02	8,000	9.50
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.1	500	.95
.1	3,000	2.95
.135	7,500	6.95
.2	50,000	67.50
.25	15,000	19.50
.25	20,000	26.50
.25	50,000	72.50
1.	7,500	12.50
1.	15,000	49.50
2.	5,500	12.50
2.	6,000	14.50

Standard Brands

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MODEL SQ. Portable radar set, 10CM. Operates on 90-130 volt, 60 cy., 1 Ph. "A", "G", and "PPI" presentation. Complete with tech manual and full set of operating spare parts.
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MODEL ASG-1 Radar unit consisting of transmitter and converter assembly CPR-43ABC, Antenna Assembly CRP-ACZ, Mounting Base CPR-10ABE, etc.
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Style	MFD.	DCWV	Price
A	.00003	2000	$.75
A	.00005	3000	.75
A	.00009	3000	.75
A	.0001	4500	1.65
C	.0002	1000	.60
A	.0003	2500	.75
B	.00035	2500	.60
A	.0004	2500	.60
B	.0004	3000	.75
A	.00056	5000	3.50
A	.0007	3000	.75
A	.00075	2500	1.75
A	.00075	5000	3.50
A	.0015	5000	3.50
A	.001	4500	1.75
A	.003	3000	1.75
C	.005	2500	1.75
A	.006	2500	1.75
A	.12	500	1.95

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Modulator Units for SO-11 (CUZ-50AGD)
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SO-1 (66AGE) Antenna Reflector Assemblies (RF503)
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With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
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Gov't Cost $1800.00.
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Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals.

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BC-423-B Radio Modulator (Tweeter)
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APR-1 Receiving Sets
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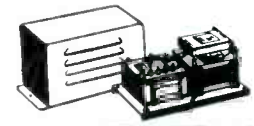
High Reactance Trans. G. E. Type Y-3502A—60 cy. Voltage 1120-135, Ind. H.V. winding 135 hy. Output: Peak 22.8KV. Cat. 8318065G1 .... $39.50

RAYTHEON VOLTAGE REGULATORS

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V. 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6½" H x 8¾" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. **PRICE—NEW** $16.75



400 CYCLE TRANSFORMERS

Auto, .945S-520P KVA. 460/345/200/115. Weight 22 lbs. G. E. Cat. 80G184 .... $4.50
Fil. IN: 0/75/80/85/105/115/125. Out: 5V3A/5V3A/5V3A/5V6A/6.3VO.5A No. 7249010 .... $1.95
Plate. KS9560 800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A Elecstat shld. Wt. 2.3 lbs. $2.95
Plate & Fil. KS9555, Pri: 115V. Sec: 930-0-930 and three 6.3V windings $3.95
Fil. KS9553. Pri: 115V. Sec: 8.2V1.25A /6.35V1.5A Elecstat Shld. Wt. 0.5 lbs. $2.95
Plate & Fil. Pri: 0/80/115V. Sec: #1=1200V DC @ 1.5MA. Sec. #2=400V DC @ 130MA. Fil Secs: 6.4V4.3A/6.35V.8A (Inc. 1500V) 5V2A/5V2A. $4.95
Plate. Thordarson T46889 500 cy. Pri: 105/120. Sec: 2800-0-2800. 7KV Ins. 1.5KVA. $29.50
Misc. types: G. E. #68G665X, #68G666X, #68G667, #68G668X, #80G200, #80G199 .... $2.00

REACTORS

KS9589 Retard. 4HY @ 100MA .. $1.00
#2C2270/R2 For Keyer Unit BC409 $3.75
Multi-Choke 3 hy @ .275A 70 ohms, 17 hy. @ .125A 200 ohms, 17 hy. @ .125A 200 ohms 7⅛ x 6⅝ x 3¾ $6.95

HIGH QUALITY CRYSTAL UNITS

Western Electric — type CR-1A/AR in holders. ½" pin spacing. Ideal for net frequency operation. Available in quantities, 5910-6350-6370-6470-6510-6610-6670-6690-7270-7350-7380-7390-7480-7580-9720. All fundamentals in KC. Good multipliers to higher frequencies. $1.25 each

RADAR ANTENNAS

Type SO-1 (10CM) assembly with reflector, waveguide nozzle, drive motor, etc.
Type SO-3 (3CM.) Surface Search type with reflector, drive motor, etc., but less plumbing. New in original cases.
Type SO-13. (10CM.) Complete assembly with 24" dish, dipole, drive motor, gearing, etc.

1 K.W. MODULATION TRANSFORMER

R.C.A. Broadcast Type. Primary 15,000 ohms. Secondary 5,030 ohms 0.86 KVA audio. Designed for 833 class B modulation to two 833's in final amplifier. Size 11¼ x 9½ x 13. Weight 143 lbs. Type 900777-502. Price, new $97.50

IN21B XTAL DIODE

Sylvania 1N21B, Individually boxed and packed in leaded foil $3.00

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change

ELECTRONICRAFT INC.

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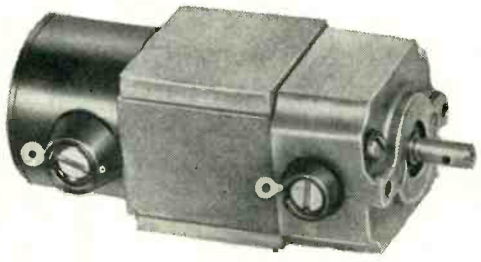
SYNCHROS • AMPLIFIERS • ALNICO MOTORS • SHUNT MOTORS • BLOWERS • RATE GENERATORS • SUB-FRACTIONAL HORSEPOWER AC MOTORS • SELSYN UNITS • TORQUE UNITS • AMPLIDYNES • INVERTERS • ELECTRONIC SERVO SYSTEMS • TACHOMETER GENERATORS • AUTOMATIC PILOT COMPONENTS • DC MOTORS • SINE-COSINE GENERATORS • U. S. NAVY SYNCHROS • AUTOSYNS • SERVO MOTORS • DYNAMOTORS

IMMEDIATE DELIVERY — **Servo-Tek** — **FULLY GUARANTEED**



SA-427

P. M. MOTOR AND RATE GENERATOR

These units are wound with two separate windings on a common skewed lamination stack, with connections brought out to two silver commutators. A husky Alnico field is cast into the motor housing and serves for both the motor and generator. Overall size is approximately 3¼" x 1¾" x 1⅜" with a 3/16" diam. shaft extending 7/16". Six types are available with different winding combinations, including motors for d-c voltages as high as 115 volts and d-c rate signals as high as 9 volts per 1000 rpm. Please state your operating conditions and we will select the type closest to your requirements. SA-427

$39.50 each

SPLIT FIELD D-C SERIES MOTOR

G-E Model 5PS58LA7. 60 volts at 3.4 amp. 1/7 hp at 5000 rpm. 5-¾" long x 3-¼" diam. ¼" shaft extends 1". Ideal for servo applications. SA-513. **$14.50** each

SPLIT FIELD SERIES D-C BRAKE MOTOR

Grayson #25120. 24 volts at 6 amps. 1/10 hp at 7500 rpm. Incorporates internal brake for rapid stopping. 5-7/8" long x 2" diam. 1/4" diam. splined shaft extends 11/16". SA-426 .... **$17.50** each

TEMPERATURE INDICATOR

Edison P109-C127A. -10 to-120 degrees C. 24-28 volts d-c. Wheatstone bridge type of instrument. Used with resistive type sensitive element. Special at .... **$3.75 each**

AIRCRAFT RDF RECEIVER

Bendix Type RA-10DB Input 28 volts d-c. 4 bands, 150 to 1100 KC and 2000 to 10,000 KC. Weight 32.5 lbs. Special at only.... **$39.50** each

GYRO FLUX GATE COMPASS AMPLIFIER

Pioneer #12076-1-A. AN-5753-1A 5 tube amplifier in shock mounted case. Adjustable sensitivity. Operates from either 26 or 115 volts, 400 cycle. Case size 9-1/4" w. x 7-1/2 d. x 6-1/2 h. Without tubes. Special **$49.50** each

SELSYN-SPECIALS

General Electric 2J1F1-2J1G1-2J1F3 115 volt 400 cycle SELSYNS in small size. Will operate from 30 volts 60 cycle. Army Type VII (C-78248) 115 volt, 60 cycle Synchro Generator—Similar to size 5G. Army Type IX (C-78410) 115 volt, 60 cycle. Synchro Repeater — Similar to size 5F. Send for special prices.

1SF NAVY SYNCHRO

115 volts 400 cycle. May be used as transmitter or receiver. Will operate from 30 volts 60 cycle SA-29 **$49.50** each

AIRCRAFT INVERTER

Leland 10486. Input 27.5 volts d-c at 12.5 amp.-8000 rpm. Output 175 VA at 115 volts, 3 phase, 400 cycle **$129.50** each

EAD SYNCHRONOUS MOTOR TYPE J-33

115 volts, 400 cycle, 3 phase. 8000 rpm at 1/200 hp. SA-59 **$16.50** each

D-C SHUNT MOTOR

Western Electric KS-5603-L02. 27 volts d-c. 1/100 hp at 6500 rpm. 4 leads permit reversing SA-233 **$9.75** each

400 CYCLE BLOWER

Westinghouse Type FL. 115 volts, 400 cycle single phase. 17 cfm. at 6700 rpm. includes capacitor. SA-144 **$14.50** each

LEAR D-C SHUNT MOTOR & BLOWER WHEEL

27.5 volts d-c. 4 in.-oz torque at 5400 rpm. Double shaft. SA-352 **$12.50** each

DIEHL D-C SHUNT MOTOR

Type FD52-2. 27.5 volts d-c, 3000 rpm. Used by Sperry as "Follow-up Motor". Sperry #803010. 4 leads. SA-363 .... **$4.75** each

GEARHEAD SHUNT MOTOR

John Oster Type B9-1. 27.5 volts d-c. Motor speed 5600 rpm. Gearhead has dual output shafts upon which cams actuate roller lever arms. Reduction ratios 930:1 and 230:1. SA-335 .... **$8.75** each

1 RPM TIMING MOTOR

115 volt, 60 cycle. Ideal for many timing applications. SA-278 **$2.75** each

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Prices F.O.B. Hawthorne

Telephone: HAwthorne 7-3100

Servo-Tek PRODUCTS CO. INCORPORATED

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Buy TOP Radio-Electronic Values!

SENSITIVE RELAYS

MIDGET TYPE RELAYS

Automatic Electric Type R-45, 6500 ohm Coils. Normally open contacts except as noted.

Stock No.	Contacts	M. A.	Price Each
102152	S.P.S.T.	2.0	$1.25
102249	2.P.S.T.*	4.5	1.50
102264	3.P.S.T.	6.0	2.00

*1 Norm. open-1 Norm. closed.

Same type and style as above, but has 24 V.A.C. coil. Intermittent duty. Will operate on 6 V.D.C. Continuous duty. Contacts: S.P.S.T.-N.O. and S.P.D.T.

Stock No. 102248A — Price Each $1.25

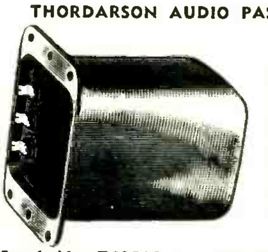
ONAN GAS-DRIVEN GENERATOR 14 V-2500 WATT D.C. $225.00

TCS. GENERATORS

High voltage continuous duty fully enclosed D.C. Generator. Delivers 440 volts at 200 M.A. Motor driven by 3450 RPM motor (not furnished). Made to Navy Specs. for Collins Radio TCS. Transmitters.

Stock No. 6147A — Price Each $15.00

THORDARSON AUDIO PASS FILTER



Band pass 800 to 1200 cycles input 10000 ohms—Output 25000 Ohms Level 10DB

Stock No. T48500 — Price to: $5.50 ea.

.01 MFD.—600 VOLT MICA CONDENSERS

Large quantities available in both CM-35 and CM-40 case sizes.

TOLERANCE	PRICE PER 1000
5%	$150.00
10%	125.00
20%	100.00

350 OHM 22 WATT 5% WIRE. Wound Power Resistor Type RW 21G-351. Meets JAN-R-26A Specs. Flat-wound type complete with mtg. brackets. Brackets allow stacking. 2"L x 1"W x 3/8" thick.

$12.00 per 100

Stock No. 6288A — Price Each $.15

TYPE "J" POTENTIOMETERS

500 Ohm—2 Watt Type J Pot. 3/8" Long Shaft. 1/4" long Bushing. Complete with Knob.

Stock No. A6123 — Price Each 49¢

100 ohm Type 1 with 3/8" bushing and locking nut. Screw-driver slot.

Stock No. 6270A — Price Each $.49

LAB. POTENTIOMETERS

MODEL 260. 6 Watt 20,000 OHM Laboratory, Potentiometer. Resistance tolerance plus or minus 5%. Five finger bronze wiper. Bakelite shaft 3/8" Diam. x 1 1/4" Long.

Stock No. 6277A — Price Each $1.50

MIL—T—27 FILAMENT TRANSFORMER

PRIMARY: 107.5; 112.5; 117.5; 122.5; 215; 225; 235 and 245 Volts 50/60 cycle.
SECONDARY: 6.3 Volts @ 5.3 AMPS and 6.3 Volts @ 3 AMPS. Ceramic bushings with solder lug terminals. Rated for continuous duty under Mil-T-27, Class "A" Grade 1 specs. Hermetically sealed case, 2 3/4" x 3 1/2" x 3 1/8" high.

Stock No. 6284A — Price Each $3.50

MICA CONDENSERS

Type 9 and A2 5000 Volt Test Mica Condensers

Stock No.	Cap. Mfd.	Price Each
6274A	.002	$ .60
6275A	.01	$1.00

SWEEP CAPACITOR

5-10 MMFD. Sweep Generator Capacitor. Has cylindrical silver plated rotor, concentric to silver plated stator plates. Rotor has high speed ball bearings. Completely enclosed in moulded bakelite housing. Ideal for motor driven sweep generators.

Stock No. 6276A — Price Each $2.00

8 MFD—220 V.A.C.

Capacitor. 2" Diam. x 4" high can. Bakelite insulated solder lug terminals.

Stock No. 6278 — Price Each $.80

2 x 4 MFD—600 VOLT

Capacitor made for "TCS" equipment. Mounted in transformer style case with flange mtg. Case 2 1/4" x 2 3/8" x 3" high.

Stock No. 6279A — Price Each $2.00

.25MFD—1000 VOLT

No. 26F467. 3/4" x 1-5/16" x 1 1/2" high can. 2 1/4" mtg. centers.

Stock No. 6282A — Price Each $.30

HEAVY DUTY SWITCH

H&H 4 P. D. O. T. Toggle Switch. 5 AMP. @ 250 Volt. 10 Amp. @ 125 Volt. Single 3/4" hole mount. Ball handle.

Stock No. 6203A — Price Each $1.95

RECTIFIERS

A precision balanced copper oxide double bridge rectifier. Housed in a sealed metal container 1" x 1-3/4" x 1" high. Tapped mtg holes in bottom. Discs have vaporized gold contact surfaces. Made by Bradley Labs. to W. E. spec. D 220005. Nominal input volts 10.5 V.A.C. 5 MA.

Stock No. 6283A — Price Each $1.50

BRADLEY INSTRUMENT RECTIFIER

BRADLEY #CX2E4E-69 Copper Oxide Rectifier, 3 color coded insulated wire leads.

Stock No. 6184A — Price Each 50¢

RECTIFIER POWER UNIT

PP35/ART. Sig. Corps No. 3H 4698-35 input 115 Volts 400-2500 Cycles Note: P/O AN/ART5 to AN/ART11 complete with 2-836 H.V. Rectifiers.

Stock No. 6248A — Price Each $7.50

SPECIAL PURPOSE AND TRANSMITTING TUBES

Tubes listed below are "Jan" types in original boxes and are new. Some in limited quantities. All are standard brands such as RCA, G.E., Nat. Union, Western Electric, Machlet, Etc.

Type	Price Each	Type	Price Each
OB3/VR90	$ .85	826	$ .85
OC3/VR150	.85	836	3.00
1B22	2.00	837	1.00
1B23	7.50	860	4.50
2C22/7193	.25	864	.35
2J36	75.00	955	.25
204A	75.00	956	.35
3B7/1291	.50	10Y	.35
3D6/1299	.50	12GP7	14.95
3B24	5.00	CK1090	1.00
3E29/829B	12.95	1616	.75
3BP1	5.95	1619	.25
316A	1.25	1625	.35
371B	.75	1626	.35
450TL	45.00	1832/532A	5.00
5FP7	5.00	GL-8002R	95.00
705A	2.00	8020	1.25
7188Y	40.00	8025	4.00
724B	3.00	9001	1.50
801	.45	9003	1.25
807	1.75	9006	.30
814	2.75		

SIGNAL CORPS & NAVY TRANSFORMER

Over 200,000 transformers, chokes etc. For Signal Corps and Navy Equipment. Send us your requirements, or ask for our catalog listing, by Signal Corps Numbers. DON'T DELAY!

6.3 VOLT FILAMENT TRANSFORMERS

Primary 115 Volt 60 Cycle 1600 Insulation Three 6.4 Volt Secondaries

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Horizontal Half Shell Mounting. 2 1/4" x 2 13/16" Mounting Centers. 2 13/16" x 3 3/8" Core Size. 1/2" above Chassis. Soder Lug Terminals—All Terminals Marked.

Stock No. 5254A

Price Each $2.65

TERMS:

Open Accounts to rated or Acceptable reference accounts. Others pre-payment of 25% deposit with order, balance C.O.D. Price F.O.B. Chicago and subject to change without notice. Merchandise subject to prior sale.

ORDER TODAY!

Radio Surplus Corp.

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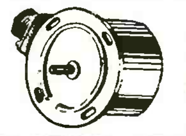
COMMUNICATIONS EQUIPMENT CO.

SAWTOOTH POTENTIOMETER



Continuous rotation, 100 ohm, res. 2 take-off brushes set at 180 deg. to provide saw-tooth output. May be used with milliammeter circuit as 0-360 deg. direction indicator. Brand new, original packing

WE 15038 ..... **$5.75**

SPARES FOR APN-9

Power Trans., Pt. No. 352-7295-2 .... $4.95 each
Counter Trans., T111, T112, T117, Pt. No. 352-7251-2 .... $2.50 each
Counter Trans., T113, T114, T115, T116, T118, T119, T120, Pt. No. 352-7250-2 .... $2.50 each
I. F. Trans: T107-T110 Pt. #352-1554S .... $1.00 each
Resistor: R150, R157, R162 84,000 OHMS .. .50 each
Resistor: R130, 220,000 ohms .... .50 each
Resistor: R159 120,000 ohms .... .50 each
Resistor: R152, R164, 17,000 ohms .... .35 each
Resistor: R142, 4300 ohms .... .35 each

APN-4 COILS

352-1585 .... .49
352-1269 .... .49
352-1549 .... $1.00
352-1550 .... $1.00

EE-89 REPEATER

Extends range of EE-8 field phone up to 20 miles of dry or wet wire operation. Extremely rugged, portable and lightweight. Uses hybrid coils and V. T. Amplifier, with extreme long-life characteristics.
Brand New, Complete With Tube & Tech. Manual, only .... **$12.75 each**

HELMHOLTZ PHASE-SHIFTER

Stator consists of 4 loops oriented at 90 degrees to each other. Total stator inductance is 40 MH. rotor: 10MH. total phase shift 0-360 deg. Designed for range unit of SCR-268 ...... **$3.95 each**

BIRTHER TUBE CLAMPS

926B-16 926C-19 926C-24
926B-15 926C-15 926K-2

PRICE: 18¢ EACH OR $16.50/100

SELENIUM RECTIFIERS—Full-Wave Bridge Types

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.25	$2.10	$3.60	$7.50
2 Amps.	2.20	3.60	6.60	10.50
2½ Amps.	......	......	......	13.00
4 Amps.	3.75		8.75	......
5 Amps.	4.95	7.95	12.95	27.00
6 Amps.	5.50	9.00	14.00	33.00
10 Amps.	6.75	12.00	20.00	40.00
12 Amps.	8.50	16.00	25.50	50.00
20 Amps.	13.25	24.00	36.00	90.00
24 Amps.	16.00	31.00	39.50	98.00
30 Amps.	18.50	36.00	......	......
36 Amps.	25.50	45.00	......	......

DYNAMOTORS

Type	Input Volts	Input Amps.	Output Volts	Output Amps	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DM33A	28	7	540	.250	BC 456
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
ZA0515	12/24	4/2	500	.050	
B-19 pack	12	9.4	275	.110	
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	.5	

INVERTERS

PE-218-H: Input: 25 28 vdc, 92 Amp. Output: 115 v. 350 500 cy 1500 volt-amperes. New $44.50
PE-206 Input: 28 vdc, 38 Amps. Output: 80 v 800-cy. 500 volt-amps. Dim: 13"x5½"x10½". Bew $22.50
LELAND No. 10536: IN: 28 VDC, 12A. OUT: 115V, 115VA, 400 CY 3 PHASE. EXC. COND $70.00

IN STOCK

- APN-3*
- APN-4*
- APN-7
- APN-9*
- APS-2
- APS-3*
- APS-4
- APS-6*
- APS-10*
- APS-15*
- SE
- SG
- SN
- SO
- SQ
- TAJ
- TBK
- BG (iff)

* Major Components and/or Spare Parts

APN-1 TEST GEAR

TS-10/APN

This unit is self contained with all components assembled in a single case with cover and handle. It is used in conjunction with test set TS-16/APN. On the top panel are four outlet receptacles which are terminals of two delay lines. Suitable connectors and indicators are provided. TS-10/APN, which does not require an external power source, provides a highly accurate delay and is used with the altimeter for the following purposes:

(1) Measures power output of the transmitter.
(2) Permits adjustment of the limit lights on low range.
(3) Measures overall sensitivity.
(4) Permits tuning the detector to the transmitter frequency.
(5) Permits delay line calibration of the low range.

Price $32.50

TS-16/APN

This is a portable equipment used in conjunction with TS-10/APN for locating trouble and aligning and calibrating the altimeter. It covers the frequency range from 410 to 470 mc and operates from an input of 27 to 28 volts dc, obtained through a multiconductor cord connected to the altimeter. The unit provides an artificial delay line for high range, a wavemeter, and an audio output of six different frequencies. When used with TS-10/APN it is limited to the high range, although it may be used with less accurate results on the low range. The uses of TS-16/APN with the altimeter are listed below:

(1) Calibrates 500-foot and 3000-foot marks.
(2) Measures the modulator frequency.
(3) Adjusts the transmitter bandwidth.
(4) Permits tuning the detector to the transmitter frequency.

Price $125.00

BAND PASS FILTERS

INPUT IMPEDANCE: 2000 OHMS. OUTPUT: TO GRID. AVAILABLE IN FOLLOWING RANGES:

CHANNEL	Fr.	F1*	F2*
5	1155	830	1620
7	2270	1620	3180
8	3180	2270	4450
9	4450	3180	6230
10	6230	4450	8720

* Fr.: Center Freq. in CPS; F1 and F2 are lower and upper limits (CPS) respectively, at −20 db points.

Price, $4.95 Each

W. E. PRECISION RESISTORS

1% TOL. 1 WATT

D-164886A	2.65 ohms	D-162707CY	2500 ohms
D-164886AA	3.83 ohms	D-171862	279 ohms
D-167026*	13,500/ 10,000 ohms	D-171863	591 ohms
D-162025AT*	1400/135/ 270 ohms	D-164286*	10,000/ 15,000/ 62,000 ohms
D-164285*	40,600/1500 ohms	D-164284*	100,000/ 50,000 ohms
D166860FL	1155 ohms	D-172241*	400/600/700/ 750 ohms

SPOOL-WOUND, NON-INDUCTIVE
* TAPPED AT VALUES SHOWN **85¢ EA.**

24 VOLT TRANSFORMERS

For operating surplus gear, toy trains, gadgets, etc. Operates from 115V, 60 cy., supplies 24 VAC at 1.2 Amp., herm. sealed and cased ...... A Great Buy at Only **$1.49**

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 4.25

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps Input

CTJ5-2-600VCT/.2A, 5V/6A $5.95
CT-15A 550VCT .085A 6.3V/.6A, 6.3V/1.8A 2.85
CT-164 4200V.002A/12KV Test, 5 VCT/3A/12KV Test, 6.3V/0.6A/5400V Test 12.95
CT-341 1050 10 MA,—625V @ 5 MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A 16.95
CR 825 360VCT .340A 6.3VCT/3.6, 6.3VCT/3A 3.95
CT-626 1500V .160A 2.5/12, 30/.100 .... 9.95
CT-071 110V .200A 33/.200, 5V/10, 2.5/10 .... 4.95
CT-367 580VCT .050 A 5VCT/3A 2.25
CT-403 350VCT .026 A 5V/3A 2.75
CT-931 585VCT .086 A 5V/3A, 6.3V/6A 4.25
CT-456 390VCT 30 MA 6.3V/1.3A, 5V/3A 3.45
CT-931 585VCT 86 MA 5V/3A, 6.3V/6A 4.95
CT-442 525VCT 75 MA 5V/2A, 10VCT/2A, 50V/200 MA 3.85
CT-720 550-0-550V/250 MA, 6.3V/1.8A 8.95
CT-43A 600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/1A 6,49
CT7-501 650VCT/200 MA, 6.3V/8A, 6.3V/5A 6.49
CT-444 230-0-230V/.085A, 5V/3A, 6V/2.5A 3.49

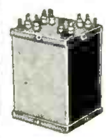
Filament Transformers—115V50-60 cps Input

Item	Rating	Each
FT-674	8.1V/1.5A	$1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79
FT/924	5.25V/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A,	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-38A	6.3/2.5A, 2x2.5V/7A	4.19
FT-A27	2.5V/2.5A, 7V/7A, TAP 2.5V/2.5A, 16 KV TEST	18.95
FT-608	6.3V/3A/750V Test	1.79
FT-873	4.5AV/.5A, 7V/7A	2.19
FT-899	2x5V A 5A, 29KV Test	24.50

Plate Trans.—115V, 60 cps

Item	Rating	Price
PT-699	300/150V.05A, 300/150V/.05A	$2.79
PT-302	120-0-120V/ 350 MA	4.69
PT-108	17,600V/144 MA	120.00
PT-671	62V/3.5A	7.95

H.V. FILAMENT XFMR



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CH-322	.35H/350 MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA 5KV DC Test	4.69
CH-119	8.5H/125 MA	2.79
CH-69-1	Dual; 120H/ 17 MA	2.35
CH-8-35	2/.5H/380 MA/25 Ohms	1.79

STOCK	Description	Price
CH-776	1.28H/130 MA/75 ohms	$2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH43A	10HY/15MA—850 ohms DCR	1.75
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-511	6H/80MA—310 ohms DCR	2.45
CH3-501	2 x .5H/400MA	2.79
CH-188M	5HY 200MA	1.79
CH-488	10HY .030A	1.19
CH-791	Dual 1.75-.125 HY 100 MA	1.27
CH-981	15HY .110A	1.59
CH-22-1	1 HY .100A	1.17
CH-779	.6 HY .490A	1.25
CH-25A	SW .09/.018 HY 3/.3A	8.95
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CH-043	2.2 HY 80 MA	.98
CH-89A	2 x 1.52H @ .167A	1.39
CH-69A	Mult. Choke SECT. 1. Swing 3-12H/.52-.05A SECT. 2. Smooth 5H/.52A SECT. 3. Swing 3.25-18H/.138-014A SECT. 4. Smooth 3.4H/.138A	14.95
CH-445	0.5 HY/200 MA, 32.2 OHMS, 3000V.T.	1.39
CH.170	2X0.5H/380 MA, 25 OHMS	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5KV INS	39.95

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MODEL M1-2 CRYSTAL HEAD: Consists of mosaic of 3 crystals encased in oil-filled disk approx. 4" diam., 1" thick. Entire assembly is attached to 1" mtg. flange. Frequency: 17-27KC. Approx. 50 watts out. Completely watertight $27.50

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AT-68	I-97A	I-245	TS-18	TS-96/TPS-1	TS-194/CPM-4	TS-359A/U
AT-39	I-98A	IE-21A	TS-19	TS-98/AP	TS-195/CPM-4	TS-363/U
AT-48	I-106A	IE-36	TS-23/AP	TS-100/AP	TS-197/CPM-4	TS-375
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BC-439	I-126	LAE-2	TS-32A/TRC-1	TS-111/CP	TS-207	TS-421/U
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BC-923A	I-139A	LZ	TS-39/TSM	TS-131/AP	TS-230B	TS-589/U
BC-936A	I-140A	ME-6/U	TS-45/APM-3	TS-138	TS-232/TPN-2	TS-615/U
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BC-1255/A	I-178	TAA-16WL	TS-61/AP	TS-155	TS-281/TRC-7	TTX-10RH
BC-1277	I-186	TS-1ARR	TS-62/AP	TS-159-TPK	TS-285/GP	
BC-1287A	I-196A	TS-3A/AP	TS-63/AP	TS-164/AR	TS-293	
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Ceramics	Knobs	Switches
Chokes	Potentiometers (sine-cosine)	Transformers
Circuit Breakers	Pulse Xfmrs.	Tubes
Coils		And Others

TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days. All others Remittance with Order. Orders Under $10 Remittance With Order, Plus Approximate Shipping Charges (overage will be returned.)

TELEPHONE TYPE RELAYS

These relays have been standardized so that coils and frames of most manufacturers can be interchanged without affecting adjustments. A wide variety of applicable combinations are thus possible from a comparatively small number of relays.

Listed below are frames and coils from our stock. They may be purchased separately. However, a complete relay consists of coil and frame. In ordering complete relays specify which coil with which frame, i.e.: F101 with K117.

Representative completed relays are also listed with voltage and current ratings. Values are indicative of sensitivity that may be expected from similar combinations.

CLARE, 6500 ohm, 8maDC, 3 makes (3As) R276 .... $ 4.25

5035A7 AUTOMATIC, 1300 ohm, 8maDC, SPST n.o. (1A), #103 .... 1.75

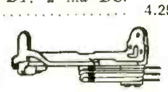
CLARE K101, 6500 ohm, SPDT, 2 ma DC. Fast Action #175 .... 4.25

A18258 BENDIX (Cook 102) 8-12 VDC, Copper Slug, Slow Release, SPDT, 200 ohm, Part of SCR 522, #R365 .... 2.49

R5229A1 AUTOMATIC 6VDC, 3PST n.o. (3As), 75 ohms, Slow Release, #412 .... 2.50

R5021A1 AUTOMATIC 1300 ohm, 20maDC, SPST n.c. (1B), #R413 .... 2.95

FRAMES



(For Cost of Relay Add Price of Frame to Price of Coil)

Stock No.	Contacts	Price each	Stock No.	Contacts	Price each
F101	1A	1.25	F106	1B, 1A	1.50
F102	2A	1.50	F111	1B, 2A	1.75
F103	3A	1.75	F114	1B, 3A	2.00
F104	4A	2.00	F108	1B, 1A, 1C	2.00
F105	8A	2.25	F107	2B, 1A	1.75
F106	1A, 1B	1.50	F112	2B, 2A, 2C	3.00
F107	1A, 2B	1.75	F113	5B, 2A	2.75
F108	1A, 1B, 1C	2.00	F121	5B, 1C	2.75
F109	1A, 1C	1.75	F122	1C	1.50
F110	1A, 2C	2.25	F123	2C	2.00
F111	2A, 1B	1.75	F109	1C, 1A	1.75
F112	2A, 2B, 2C	3.00	F117	1C, 5A	2.75
F113	2A, 5B	2.75	F121	1C, 5B	2.75
F114	3A, 1B	2.00	F110	2C, 1A	2.25
F115	3A, 2C	2.75	F115	2C, 3A	2.75
F117	5A, 1C	2.75	F108	1C, 1A, 1B	2.00
F120	1B	1.25	F112	2C, 2A, 2B	3.00

COILS

(For Cost of Relay Add Price of Coil to Price of Frame)

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K101	0.75	1.25	K109	1000	1.75
K131	5.0	1.25	K136	1200	2.00
K102	12	1.25	K111	1300	1.75
K132	175	1.25	K137	1425	2.25
K103	250	1.25	K138	1500	2.25
K104	450	1.50	K139	1600	2.25
K105	500	1.50	K112	2000	2.25
K133	600	1.50	K140	2300	2.50
K134	700	1.50	K113	3000	2.50
K107	750	1.50	K116	6500	2.75
K135	800	1.75	K118	40,000	3.25
K108	900	1.75			

SLOW-ACTION COILS

SLOW-MAKE			SLOW-RELEASE		
Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K122	33	1.50	K149	3.9	1.50
K146	125/1300	2.50	K123	75	1.50
K125	300	1.75	K124	200	1.50
K147	500/1500	2.50	K150	800	2.00
K148	1300	2.00	K151	1000	2.00
K146	1300/125	2.50	K152	1300	2.25
K147	1500/500	2.50	K127	2500	2.50
K126	2000	2.00			

DUAL COILS

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K141	50/2000	2.25	K145	1000/1000	2.25
K142	125/1300	2.25	K106	1100/500	2.00
K143	200/1000	2.00	K142	1300/125	2.25
K106	500/1100	2.00	K144	1800/500	2.50
K144	500/1800	2.50	K141	2000/50	2.25
K143	1000/200	2.00			

A-C COILS

Stock No.	Voltage	Price each
K119	6VAC	1.75
K121	110VAC	2.60

A = Normally Open; B = Normally Closed; C = Double Throw.

ALLIED TYPE BO & BOY RELAYS

Contacts are silver and have a non-inductive rating of 15 amperes, or 30 amperes for double break (d.b.) at 24V DC and 110V AC. Operate time to make 18.5 milliseconds; release time 8.0 milliseconds.

Contacts*	1.5-3.2VDC, 4 Ohm		6 9VDC, 37 Ohm		12VDC, 70 Ohm		24VDC, 230 Ohm	
	Cat. #	Price	Cat. #	Price	Cat. #	Price	Cat. #	Price
SPST (1A)	R506	2.00	R467	2.00	R476	2.00	R484	2.00
SPST (1A) d.b.	R507	2.25	R468	2.25	R06	2.25	R485	2.25
SPST (1B)	R508	2.00	R469	2.00	R477	2.00	R486	2.00
SPST (1B) d.b.	R509	2.25	R470	2.25	R478	2.25	R487	2.25
1A, 1B	R510	2.50	R492	2.50	R493	2.50	R494	2.50
DPST, 2A	R511	2.75	R499	2.75	R500	2.75	R501	2.75
DPST, 2B	R517	2.75	R518	2.75	R519	2.75	R520	2.75
SPDT (1C)	R512	2.50	R471	2.50	R479	2.50	R488	2.50
SPDT (1C) d.b.	R513	3.00	R472	3.00	R480	3.00	R238	3.00
1C, 1A	R514	3.25	R473	3.25	R481	3.25	R489	3.25
1C, 1B	R515	3.25	R474	3.25	R482	3.25	R490	3.25
DPDT (2C)	R516	3.50	R475	3.50	R483	3.50	R491	3.50

BO9D28; 5.9VDC; 3PDT (3C); 14.2 Ohm; #R225 .... 3.95 ea.

BO9D35; 26VDC; 3PDT (3C); 240 Ohm; #R522 .... 3.95 ea.

* A = SPST normally open; B = SPST normally closed; C = SPDT

BOY TYPE DC RELAYS

CONTACTS*	1.0 V DC Cat. #	1.5 Ohm Price
SPST (1A)	R495	2.00
SPST (1A) d.b.	R496	2.35
DPST (2A)	R497	2.50

Boy 6D42; 8ma; DPDT (2c) 10 AMP; 10,000 Ohm; #498 .... 4.95 ea.

OTHER ALLIED TYPES

AR; 12VDC; SPST (1A); 75 Ohm #R429 .... 1.00 ea.

FID; 3000 Ohm; 8 ma; SPST (1A); #R504 .... 1.50 ea.

AN 13D33; 24VDC; SPST (1A) d.b.; 175 Ohm; 75 amp. continuous duty (Electrical and Mechanical equivalent to CN13D33) #R436 .... 2.95 ea.

ALLIED BJ TYPE RELAYS

Contacts are silver and are rated at 5 amperes, at 24 VDC and 115VAC.

BJ6D36; 24VDC; DPDT; 255 Ohm; #R420 .... 1.75 ea.

BJx42; 12 or 24VDC; SPST (1B) d.b.; 240 Ohm C.T.; #R226 .... 1.50 ea.

BJU (Electrical Latching); 6VDC; 4PDT (4c); 16 Ohm each coil; Dust Cover; 11 pin RMA plug base; #R435 .... 6.95 ea.

BJ6A115; 115VAC; DPDT; #R502 .... 2.95 ea.

BJ5A115; 115VAC; 1C, 1A; #R503 .... 2.50 ea.

AMPERITE THERMOSTATIC DELAY RELAY

NET 2.40 each

Amperite Thermostatic Delay Relays are actuated by a heater . . . can therefore be used on AC, DC, or pulsating current. Being hermetically sealed, Amperite Relays are not affected by altitude, moisture, or other atmospheric conditions. At the present time only SPST is available — normally open or normally closed. Available in voltage ratings of 2.5, 5, 6.3, 12, 26 and 115 volts. Delays in seconds are available as follows: 2, 3, 5, 10, 15, 20, 30, 45, 60, 75, 90 and 120 seconds. Most types from stock. When ordering specify: Voltage—Delay in Seconds—Open or Closed.

HAYDON 5901-2: 220V 60 cyc. Adjustable Reset Timing Relay; SPDT (10 amp); #R466. $7.95

LORD SHOCKMOUNTS

Stock No.	Series	Center Hole	LB	Other Data	Each
SM11	100	1/8"	1	Monel	.12
S12	100	1/8"	2	Steel	.10
SB12	100	Stud	2	Steel Base	.12
S14	100	1/8"	4	Steel	.12
S18	100	3/16"	8	Steel	.15
ST54	150	1/4"	4	Stainless	.20
SM54	150	1/4"	4	Monel	.25
S60	150	1/4"	10	Steel	.20
S83	150	1/4"	33	Steel	.30
S110	200	3/8"	10	Steel	.28
SM120	200	3/8"	20	Monel	.35
SM145	200	3/8"	45	Monel	.45
S279	279	3/8"	250	Steel	1.00
PD53	100PH	1/8"	3	Dural	.20
P54	150PH	1/8"	4	Steel	.25
P56	150PH	1/4"	6	Steel	.20
PS106	200PH	1/4"	6	Steel	.20
PL106*	200PH	1/4"	6	Steel	.25
PT106	200PH	1/4"	6	Stainless	.35
PT120	250PH	3/8"	20	Stainless	.40

*with ground lug

OTHER MOUNTS

ST75 150 Goodyear 1/4" 25 Stainless .25

P100 200PH U.S. Rubber with tapered rubber nozzle 1/2" long Steel .25

S2030 C2030 Barry 1/4" 30 Steel Fr. 1.00

S2335 C2335 Barry 3/8" 35 Steel Fr. 1.00

S912 Lord 2 hole Mtg Centers 1 1/2" 1/4" 12 Steel .15

S908 Lord Slotted 4 hole Mtg Centers 1 1/2" x 2 1/4" 1/4" 8 Stainless .25

S904 Lord 2 Hole Mtg Centers 1 1/2" 1/8" 4 Steel .10

S800 Cylindrical Rubber 1" Dia x 3/4" high two 1/4 — 20 x 1/2" steel screws vulcanized in center, U. S. Rubber .... 15¢

S801 Cylindrical Rubber 1 1/2" x 1 1/2" high with two 5/16 — 18 x 1/2" steel screws vulcanized in center, U. S. Rubber .... 19¢

S803 3/4" Dia. without Mtg Shell Lord 1/8" 2 Steel .10

P101 200PH U.S. Rubber 1/4" #5150C Steel .25

General Description of Series Numbers

100 — 1" Mounting Centers
150 — 1 1/2" Mounting Centers
200 — 2" Mounting Centers
250 — 2 1/2" Mounting Centers
PH — Cup type shock mount

FOR THE BEST IN ELECTRONICS!

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CABLE: TELEMARINE, N. Y.

GROUND, SHIP & AIR COMMUNICATIONS

MARINE

TCS X'mttr-Receivers for Ship or Shore.
TBK HF 500W, 2-20 Mc. Transmitter with MG, Starter, and Spares.
TAJ 500 W. Output, 175-550 Kc with M.G. for AC or DC operation.
TBL 350 W. Output, A1, A3, I.F. & H.F. for AC or DC operation.
APN-4 Loran Eqpt. R-9A/APN-4 Receivers and ID-6A & 6B Indicators, with tubes, crystal, etc. Reconditioned to like-new. **WRITE FOR PRICES.**
GO-9 100/125 W. IF/HF Ship or Aircraft Transmitter, A1 and A2 Emission. All New with Spares.
150-AY Mackay IF Ship X'mttrs.
8707 RMCA Ship Radio Compass.

EXTRA!

PE-104 POWER SUPPLIES for Receiver of SCR-284, NEW, with Spare Vibrator, Export-Packed. Large Quantity Available. *WRITE FOR PRICES.*

MISCELLANEOUS

ATD Aircraft Transmitters. 50 W. A1 & A3. 1.5 to 9.05 MC. NEW.
GP-7 Aircraft Transmitters.
ZB-3 ILAS Eqpt.
SCR-283 Rcvg & X'mttng Eqpt. Complete.
RT-3/ARN-1 Altimeter.
RADIOSONDES AN/AMQ-1A to D. New.
PE-75U Gas Engine Generators. NEW. w/Spares.
T-21/6-R-3-C Sound Ranging Microphones for locating Artillery Fire.
NAA Underwater Beacon Equipment
BD-57-B Switchboards, telephone
YY-2 Tape Reels
HS-23, 33 Headphones
AN-CRT-1A Sonobuoys
DZ-2 DIRECTION-FINDERS, Aircraft or Marine, 15 to 1750 KC in 6 bands, for 24/28 V.D.C. operation. With 34" or 55" Loop Extension Shaft. Complete, NEW eqpt. with Dynamotor, Loop, Extension Shaft and Control, Cables, Instruction Manual, etc., all export packed in 2 cases per set.

SCR-296-A SHORE RADAR

Designed to determine accurately range and azimuth of surface craft and to furnish this information for fire (shore battery) control purposes. It is a fixed radar installation with following Specs:
Range—100,000 yards max., Min. 500 yards.
Accuracy—plus or minus 20 yards (min. range).
Azimuth—360 degrees. **Peak Power** 40 KW.
Indicators—5" Class A scope for Range; 3" for Azimuth.
Frequency—700 MC (43 centimeters).
Operation—120 V. 60 cycles A.C.
Excellent, like new material, complete with all amplidynes, servos, synchros, concentric transmission line and plumbing, tubes, spare parts, etc., in 29 cases per set. **WRITE FOR PRICES**, or further details.

600 W. W. E. AUDIO OR SUPERSONIC POWER AMP.

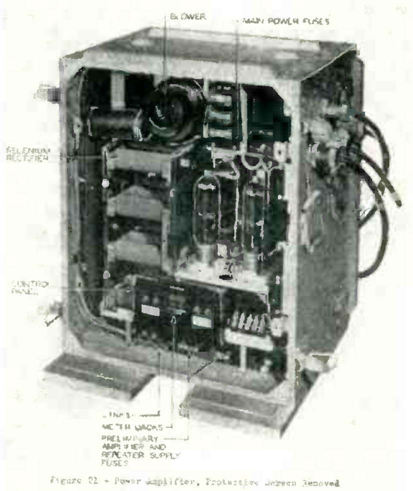

Figure 21 - Power Amplifier, Protective Screen Removed

NEW, Western Electric Audio Power Amplifiers in wooden transportable case, 600 watts max. output, for use as PA amplifier, modulators, or use **as 400 to 1200 cycle power source to test servos, radar, test eqpt., etc., requiring 110 V., 400 to 1200 cycles AC** up to 600 watts. Requires 40 watts max. to drive to full output. Less than 10% total harmonics in output. Input imped. 250/500 ohms; Output imped. 15 to 18 ohms. Uses 4- 805's (supplied) in push-pull parallel. H.V. Power Supply uses selenium rectifiers (no tubes) and motor blower for forced-air cooling. 4-wire (3-phase) 60 cycles AC. Rugged design and construction. Freq. response 200-6000 cycles (amplifier only) substantially linear. **Easily converted to Supersonic Drives & Amplifier for testing, operating magneto-striction units, by changing input & output transformers (20 to 25 KC available AC additional cost).** Dim.: 21" x 24" x 28" overall. NEW, UNUSED eqpt.
PRICE, EACH $135.00
Driver Amplifier, WE, for above, with tubes $175.00
Speaker, 12 units, PM horn type, in 2 sections, shock and blast proof, with 6 lb. ±5 alnico slugs $245.00
20-25KC (Tunable) Input & Output Transformers, for conversion of above, for 600W. Output. **PAIR** $120.00

RECEIVERS

BC-969-T1 Receivers 15 to 150 KC
BC-974-T2 Receivers 100 KC to 20.0 MC
RAK Navy low and Int. Freq. Receivers
RBS Navy low & HF Receivers
BC-224 1.5 to 18.0 MC, similar to BC-348
BC-312, 342 1.5 to 18.0 MC Receivers
BC-1066-A 155-200 MC Receivers

TEST EQUIPMENT

Item	Price Each
TS-143/CPM-1 Synchroscope	$185.00
TS-48AP Echo Box	30.00
BC-1236 Signal Generator, 15-40 & 90-230 MC	250.00
I-138A Signal Generator, 2,700 to 2,920 mc. Output variable to 5 milliwatts. Provision for external 4,100 cps modulation for pulsed RF Output. Operates from 110 V 60 cycles AC. **PRICE**	$350.00
CRV-60028 Frequency Meter, 236 to 256 MC.	100.00
I-148-A Test Set	Write
I-222-A Signal Generator	Write
LU-3 Radar Test Equipment (Freq. Meter & Test Oscillator) 465-475 & 488.5-498.5 MC.	Write
CRO-3A GE 3" Oscilloscope	60.00
160-B RCA 5" Oscilloscope	80.00
804-B General Radio VHF Signal Generator 8 to 330 MC	350.00
814-A General Radio Amplifier	45.00

TRANSMITTERS—RECEIVERS ETC.

TDQ VHF 100-156 MC. 50W. AM X-mttr for 110 V. 50/60 C. AC.
BC-797 VHF 110-126 MC, 50W, AM Output for 110 V. 50/60 C. AC.
SCR-694, Vibrator or Transportable Trans-R'cvng Eqpt., 3.8 to 6.6 MC, 20 Watts CW, 5 Watts voice. **Complete with** all accessories.
SCR-522 VHF. 4-Channel, 100-156 MC Trans-Rcvg. Eqpt. for Plane or Ground Communications.
SCR-511, Walky-Talky, 3-6 MC, Crystal Controlled Trans-Rcvg. with Plug-In Units for Freq. Changing.
96-200A, 2KW Wilcox X'mttr. 125-525 KC, 3 Cabinets: RF Unit, 50-A Modulator, 36-A Rectifier; A1, A2 and A3 **Emission.**
10 KW GE FM RF Amplifiers, Type BF-3-A, 88-108 MC with separate Power Supply. NEW UNITS! Excellent for increasing power of FM & Television stations. **Write for Prices and descriptive data.**
250 & 500 WATT SOUND SYSTEMS for Airports, Shipyards, Amusement Parks, Civilian Defense, Etc. **Write for Prices** and Literature.

SPECIAL!!

PE-218D Inverters, 25-28 V.DC Input; 115 V., 380-500 cycles output at 1500 VA. NEW UNITS. **OUR PRICE, EACH $21.50**

K-RK-ARC-UG-PL-AN

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WORLD'S MOST COMPLETE STOCK

Types in stock: AF, AN, AP, ARC, BN, BNC, C, CLT, CN, CUF, D, DPB, DPD, E, F, FK, FM, FT, FW, GK, HN, IOH, IK, JJ, JK, LC, LF, LK, LN, M, MC, N, NK, P, PJ, PL, PM, PYE, RF, RFK, RGK, RNK, RTC, RWK, S, SF, SK, SKL, SO, U, UG, UHF, WK, XL, ZA.

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MELAMINE BLOCKS

in 1/8"—3/16"—1/4"—5/16"
Thicknesses
4000 pounds
Available at 50¢ per pound

TUBES

250 TH	Boxed	6.00
3 B 29	"	6.00
3 E 29	"	6.00
100 TS	"	2.50
1642	"	.15
10 Y (VT25)	"	.15
1B32/532A	"	.50
3 CP 1	"	.35
211 Spec	"	.35
10 Spec	"	.25
5 BP 1	"	3.50

PLUGS

PLP 170	$2.50
PLQ 169	1.00
PLQ 171	1.00
PLQ 172	1.00
PL 172	1.00
Bias Meters 1-97A	6.50
P 4 Computers	150.00
E 78 Signal Generator	60.00
Antenna AT5/ARR-1	.50
Tuning Units for BC-610 NEW	12.50

WANTED

Factory Close Outs & Terminations

ARC-1 or Components Parts
ARC-3 or Components Parts
ART-13 or Component Parts
BC348 or Component Parts
AN/TRC-1
or Component Parts
SCR 720 Materal all type
SCR 508 Material all type
SCR 608 Materal all type
SCR 609 Material all type
Crystals all types
Test Sets
PE 104 and 98 BD 77
DM 40, 41, 42 and 43
SCR 508 and SCR 608

We buy all types of electronic materials.

We pay cash in advance.

What do you have to sell?

CRYSTALS

25,000 Pieces in FT. 241 Holders
New @ $.10 each

Recorder for underwater sound equipment	$60.00
Transmitter—Aircraft T9/APQ-2, 115v. 400 cy. 26 VDC NEW	$20.00
Radar Transmitter T-26/APT-2, 115V. 400 cy. 200 Watts NEW	$30.00
Corner Radar Reflector NEW	$5.00
R5/ARN-7 Type Certificated	$250.00
TS125 Test Set, complete. NEW	$125.00 ea.
TS10 Test Set, NEW	$20.00 ea.
TS16 Test Set, NEW	$20.00 ea.

CONTACTOR

BC 608 A NEW 7.50

A5 pilot director indicator New		5.50
Spare parts for SCR 595 with Antenna—Plugs, etc.		3.00
MG 149 Filters	New	5.00
Micro Switch WZ7RTC		.20
Vibrators for EE 101 A	New	.75
BC929 Oscilloscopes	New	20.00
Loops LP 21	Lousy	5.00
Loop MN 20 E	New	2.50
Motors PE73	Checked	5.00
DM33	New	2.50
Antennas AN 104	Iron	.75
Antennas AN 104	Copper	2.00
PE 218	Checked	9.50
EE65 Telephone Test Set	New	20.00
Vibrators VB8	New	.35
Vibrators 6V. for Auto Radios	New	.25
MC125 Remote Tuner	New	.50
MC124 Cable	New	1.50
MC215 Cable	New	.60

60,000 Used Headsets on sale 1.00 each

HS 18—HS 30—HS 33—HS 38

Oxygen Gas Masks	New	.25
Control Boxes BC434	New	3.50
Antennas 37-50 MC 72 inch		1.50
Neoprene tubing 5/16" I.D. x 7/64" Wall 80 ft lgths Dehydrator Hose		2.00
RL42 Antenna motors	Lousy	1.50
BC357 Receivers	Used	3.50
Tuning Units TU 10 New		2.00
Telephone A and B line. Station for shipboard use with dial and handset.	New	10.00

SCR 270 RADAR WITH

BC1232A, BC988A, BC 886B, M 337, BD 117A, PE 138
Brand NEW . . . . . $150.00 per Set

BENDIX SALE

TA-2G Transmitters 12V HF	75.00
RA-2 Receivers 12V HF	75.00
MP10E Power Supply for above	30.00
MR44A Shock Mount for RA-2	10.00
MT56B Shock Mount for TA2	10.00

BC 456	New	2.50
BC 455	Used	5.00
BC 453	Used	5.00
Antenna AS 61 Complete New		1.00
Antenna AS 62 Complete New		2.00
TS 245/TRT-1		100.00
TS 125		125.00
BC 966 Complete 1FF with Cables, Mounts—Plugs		35.00
Pilot balloon targets ML 350/AP		.25

ARC-1 SALE

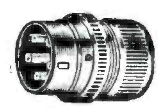
10 Channel Checked Out $850.00
20 Channel Checked Out 1050.00
50 Channel Checked Out 1250.00

Pressurizing Kit—Hand Pump—Dehydrator Cyl, 30 lbs pressure, Gauge and Hose Brand NEW $7.50

MOTORS—DELCO AND DIEHL

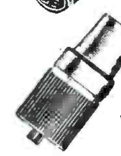
1/40 HP with shaft and flange mtg taken out of new equipment.
115V 60 cy 3450 RPM
50V 50 cy 2850 RPM
$2.50 ea.

PLUGS • CONNECTORS CLAMPS • AMPHENOLS CANNONS • MELAMINE



80% OFF

WE HAVE ALL TYPES WITH CORDS AND CABLES, OR WITHOUT



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WE HAVE OVER 1 MILLION IN STOCK in over 3000 TYPES!!

Get Our Low, Low Prices . . .
WIRE, WRITE, PHONE!!

This is only a partial listing. We have a quantity inventory on our shelves consisting of Coils—Relays—Condensers—Transformers—Radio Receivers and Transmitters—Handsets—Headsets—Microphones etc. etc. All are ready for IMMEDIATE DELIVERY.

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TALLEN CO., INC.

159 CARLTON AVE,. BROOKLYN 5,N.Y. TRiangle 5-8241

MOTORS:

24 VOLT DC 1/10 H P 2800 RPM Reversible Motor. Size: 5-¼" x 3-½". Shaft Size: 1" x ¼". Emerson #186-0412 — Price $5.95

GEAR HEAD for above motor. Ball Bearing Geared Shaft. 10 to 1 reduction..... Price: $5.95

COMBINATION: Motor and Reduction Gear $10.00

24 VAC OPEN FRAME—20 RPM Double Shaft Back Gear Motor with Disengage Clutch. Shaft size: 1-½" x 3/16" .... Price: $6.95

24 VAC OPEN FRAME—3 RPM Back Gear Motor. Shaft size: ⅝" x 3/16" .... Price: $5.95

24 VDC REVERSIBLE—5000 RPM with Magnetic Brake, Flange Mount, Spline Shaft—size: ⅝" x 3/16". Motor: 4" L. x 2-½" Dia. GE Motor only #5BA25AJ32A .... Price: $8.95

24 VDC AIRWAY MOTOR—Model #Z-350. Approx. 5000 RPM. Motor size: 2-½" x 1-⅝". Shaft size: ½" x ¼" .... Price: $4.95

26 VOLT 60 CYCLE—60 RPM Synchronous Cramer Motor #1147. Shaft size: 1" x ⅛" $1.95

110 VDC 1/70 HP. 1550 RPM. Motor size: 4" x 2-½". Shaft size: 1" x 3/16". Redmond #157..$4.95

6 VDC 1/20 HP. 4000 RPM. Motor size: 5" x 3". Shaft size: ¾" x ¼". Redmond #E-56..Price: $4.95

12 VDC 1/30 HP. 4500 RPM. Motor size: 3" x 2-½". Shaft size: 1" x 3/16". Delco #5047520........ $4.95

24 VDC REVERSIBLE

MOTOR—3.7 RPM. 40 lb. Torque Motor Size: 5-⅛" 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 ⅛". Motor Size: 2-½" x 1-½". No. 5069-267 .... $6.95

27VDC—1/10 HP—3500 RPM. Shaft Size: ⅝" x ¼". Motor Size: 4" x 3-½". Air Assoc. No. EE-763 .... $6.95

80 VDC—1/50 HP—3000 RPM. Shaft Size: ⅜" x ¼". Motor Size: 5" x 3". G. E. No. 5 BN38HA10..$8.95

28.5 VDC—1/35 HP—2200 RPM. Shaft Size: 1-⅛" x ¼". Motor Size: 4-½" x 3-¾". Electrolux No. 16876 .... $5.95

DYNAMOTORS

DYNAMOTOR and BLOWER: 9 Volts DC input: output 450 volts 60 MA. 4500 RPM. At 6 Volts DC input: output 260 Volts 65 MA. 3000 RPM...... $4.95

Input	Output	Stock No.	Price
14 V. DC	600 V. 300 MA.	BD-36	$9.95
12 V. DC	220 V. 70 MA.		6.95
12 or 24 V. DC	440 V. 200 MA. & 220 V. 100 MA.	D-104	14.95
14 V. DC	375 V. 150 MA.	DM-375	8.95
14 V. DC	330 V. 135 MA.	DM-330	7.95
14 V. DC	500 V. 500 MA.	PE-59	14.95

ALSO—PE-73; PE-86; DM-53; DM-33; 5055; DM-416; PE-101, etc.

MOTOR—GENERATOR

Navy type CCL-211014. 115 VDC—¾ HP—1750 RPM. Generator 27 VDC, 9.3 Amp. Direct Drive Price: $89.50

BLOWERS

115 Volt 60 cycle BLOWER (pictured), approx. 100 CFM Dis. 2¼" intake; 2" outlet. Quiet running Motor size: 2½"x3¼". NEW — not Gov't surplus. Order No. 1C939 **$8.95**

DUAL BLOWER—Same as RN-520 above, except has blower assembly in each side of motor. Order No. 1C880 .... $13.95

COMPACT TYPE—108 CFM. motor built inside squirrel case. 4-½" Intake: 3-⅝" x 3" Dis. Complete size: 4-¼" W. x 9-⅝" H x 8-⅛" D. Order No. 2C067 .... $14.50

FLANGE TYPE—140 CFM. 3-½" Intake: 2-½" Dis. Complete size: 8-½" W x 7-¼" H x 6-¾" D. Order No. 1C807 .... $13.95

FLANGE TWIN—275 CFM. 4-½" Intake: 3-¼" x 3" Dis. Complete size: 11-¾" W x 9-⅝" H x 8-1/16" D. No. 2C069 .... $21.95

AIRCRAFT CONTROL CABLE—3/32"—7 x 7 Strand. Weatherproofed, Galvanized, Preformed. 920 lb. test. Ideal for Television Guying and many other uses. Prices: 4½¢ per Ft.—1000 Ft. or more at 4¢ per Ft.

ANTENNA EQUIPMENT

MAST BASES—INSULATED:

MP-132 BASE—(As illustrated at left) 1" heavy coil spring, 2" insulator. Overall length: 11-½". Weight: 2-¾ lbs. Price $3.95

MP-S-33 BASE—Insulated type with heavy coil spring and 5" dia. insulator. Requires 2" hole for mounting. Weight: 9 lbs. $5.95

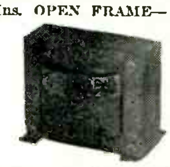
MAST SECTIONS For ABOVE BASES

Tubular steel, copper coated, painted, in 3 ft. sections, screw-in type. MS-53 can be used to make any length with MS-52-51-50-49 for taper. Any section .... 50¢ Eeach

Larger Diameter Section: MS-54........ $1.25
AN-104B Antenna—100-156 MC.—Steel........ 3.95
AN-104B Antenna—100-156 MC.—Copper........ 3.00
AN-117 Whip Steel—6 Ft. Length........ 1.50
AN-109A Whip Steel—5 Ft. w/Base........ 1.50

TELEPHONE WIRE—3 Conductor, copper and steel. 625 feet........ $4.75

TRANSFORMERS—100V. 60 Cycle Pri.



5 VOLT CT-25A—10,000 V. Ins. OPEN FRAME—6" x 5" x 4-½"........ $7.95

Sec. Two 12 V. 4 A. Windings—gives 12 V. 8 A. or 24 V. 4 A........ $5.95
Sec. 24 Volt ½ Amp. $1.50
Sec. 24 Volt 1 Amp $1.95
Sec. 24 Volt 6 Amp $5.95
Sec. 6-24 or 30 Volts 8 Amp........ $5.95

BATTERY CHARGING RESISTOR PANEL

115 VDC—6.67 ohms 30 Amps. Max. Switching High-Low & Off. Charging rate: 6-2 Volt Cells; High 30 A.; Low 15 A.—12.2 Volt Cells: 25.8 High; Low 12.7—15.2 Volt Cells; High 23.7; Low 11.6. Complete with Cable. Panel size: 21" x 22" x 10". Mfg. by Ward Leonard—NEW........ Price: $29.95

SELENIUM RECTIFIER UNITS

HEAVY DUTY—30 VOLT DC OUTPUT:

115/200 V. Three Phase 400 Cycle Input:
TYPE 143 w/Transformer & VR 100 Amp....$69.50
TYPE 3FS15 w/Trans., VR, & Blower—200 Amp. $39.50

ADDRESS DEPT E • All Prices Are F.O.B., Lima, Ohio • 25% Deposit on C.O.D. Orders

FAIR RADIO SALES • 132 SOUTH MAIN ST. LIMA, OHIO

We own and specialize in

Transmitters, Receivers, Communication Accessories and spare parts . . . from Walkie Talkies to Hi Power Transmitters, performance tested.

Inquiries solicited. Prompt quotation.
Export packing facilities on premises

COMMUNICATION DEVICES CO.

2331 Twelfth Avenue New York, 27, N. Y.

Cable—Communidev, N. Y. TWX NY 1-223. *Telephone* ADirondack 4-6174

GRAIN OF WHEAT LAMPS

#322	3 V.	.19 amp
#328	6 V.	.2 amp.

100 for $25.00 10 for $3.00

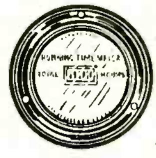
MARKTIME 5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE **$4.90**

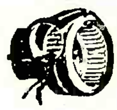
Also available in 15 min., 30 min., 1 hr. at $5.90

10 Seconds to 24 Minutes Timer

A hand wound electric TIMING SWITCH. Pointer moves back to ZERO and shuts off RADIO—TV—Electric Mixer—Photographic Devices—Time Delay etc. Furnished with Calibration Chart and Pointer Knob. Biggest bargain we ever had... **$1.25**

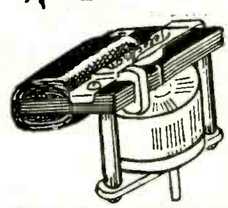


3" Round Elapsed Time Meter **$12.50**
General Electric $15.50
Westinghouse Square $16.00



REDMOND Powerful 5" Blower or Ventilator 115 volts AC 60 cycles 18 watts. For Kitchen — Laboratory. Heat or Cold or Chemicals.... $7.50

Genuine TELECHRON Motors



2 RPM..... $2.90
3 RPM..... 3.90
4 RPM..... 3.90
3.6 RPM... 3.15
1 RPM..... 3.95
60 RPM ... 4.30

1800 RPM SYNCHRONOUS Motor: 115 volts AC, 18 watts 1¼ lbs.: 2"x3"x2".... **$4.50**

Hand Cranked A.C. Generators Removed from Ancient Telephones — 2 bar..$4.50; 3 bar..$5.50; 5 bar..$6.50

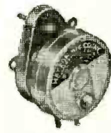
Polarized Bell or Buzzer Works on Magneto or 115 volt A.C. **$1.50**

Complete 2 Station Magneto Ringer Telephones. Incl. Batteries—wire.... **$17.50**

ZENITH Motorized Remote control made for T.V. but ideal for opening doors—windows—Turntables—Gadgets—Tuning Radios. Complete with Transformer 16 ft. cable and reversing button. A few more left........ **$8.95**

NE-16	¼ Watt NEON lamp D.C. Bayonet Base. 10 for.......	$3.00
NE-21	¼ Watt NEON lamp S.C. Bayonet Base. 10 for.......	$2.50
NE-48	¼ Watt NEON lamp D.C. Bayonet Base. 10 for.......	$2.00
NE-30	1 Watt NEON lamp Med. Screw Base. 10 for.......	$2.50
AR-1	2 Watt ARGON lamp Med. Screw Base. 10 for.......	$3.00
NE-40	3 Watt NEON lamp Med. Screw Base. 10 for.......	$3.50
#313	28 volt .2 Amp. Pilot lamp Miniature Bay. Base. 10 for	$2.80
#1820	28 volt .1 Amp. Pilot lamp Miniature Bay. Base. 10 for	$2.00
#1800	2 volt .06 Amp. Pilot lamp Miniature Screw Base. 10 for	$1.00
1¾ volt	Transformer made for #26 tube filament. Will light 30 of the above #1800 lamps...	$1.50
#C1256	6 volt Automobile lamp D.C. but no pins to hold it in socket. 20 for........ $1.00 Special—100 for	$3.50
#1800	1.35 volt .06 Amp. Pilot lamp Miniature Screw Base 10 for	$1.00
#112	1.1 volt Flashlight lamp single pen-lite Battery. 20 for	$1.00

HAYDON SYNCHRONOUS TIMING MOTOR



110 v. 60 cycle 30 RPM... $2.60
110 v. 60 cycle 1/10 RPM.. $2.35
110 v. 60 cycle 1 RPM.... $2.85
220 v. 60 cycle 2 RPM.... $1.65

A Miracle Switch that will not leave you in the Dark. Delayed Action Light Switch **$1.95**

New Sound Powered HAND SET TELEPHONES. 50' Flex. Rubber covered cable FREE. Pair **$19.00**

ALL PRICES F.O.B. N. Y.

EST. 1923 **BLAN** EST. 1923

64 Dey St. New York 7, N. Y.

WIRE-CABLE TUBES PARTS

CORDAGE

CO-122 3 conductor, each #22A WG neoprene jacket 550' lengths
CO-127 single #14 AWG braided and tinned copper braid shield

ARMOR

DRIA-23 DHFA-100

SINGLE CONDUCTOR AWG 10

shielded cable with terminal lug each end 100' and 150' lengths

WIRE

AWG 18 copperweld
AWG 29 tinned copper
Resistance wire AWG 32
AWG 22 with nylon core plastic insulation

TRANSMITTING MICAS

MFD	VDC		MFD	VDC	
.000075	3000	$1.30	.005	3500	$1.70
.0005	3000	1.10	.006	3500	2.20
.0001	3000	1.30	.00075	5000	2.45
.004	3000	1.50	.000375	5000	2.65
.003	3000	1.50	.0003	5000	2.65

TWIN CHART GRAPH RECORDER

Esterline Angus Twin Chart Recorder Model AWT-N Scale; 2.5-0-2.5 MA DC

LINEAR WIRE WOUND POTENTIOMETERS

10 Ohm	25 Watt	$.90	15000 Ohm	25 Watt	$1.70
15	25	.95	20000	25	2.00
20	25	.95	6	50	1.60
25	25	.95	150w/switch	50	2.15
50	25	.95	200w/switch	50	2.15
100	25	.95	10000	50	2.95
200	25	1.20	15	75	2.95
350	25	1.20	.5 Met 1" Shaft	AB "J"	1.15
500	25	1.20	200,000 1/8 SD	AB "J"	1.15
1000	25	1.30	200 1/8 SD	AB "J"	1.15

SPECIALS

80-86 Crystal in Holder $2.50
Balloon with Hydrogen Generator $2.50
300 Feet Aerial Wire $2.00

MICROWAVE TEST EQUIPMENT

10 CM echo box CAV 14ABA-1 of OBU-3, frequency range 2890 MC—3170 MCS Direct reading micrometer head. Ring prediction scale plus 9% to minus 9% Type "N" input. Resonance indicator meter. With accessories, spares and 10 CM directional coupler. Brand New.

TUBES

2C34	5.45	801A	.25	9006	.30
2X2/879	.55	803	3.60	C5B	8.00
3B24	4.95	826	.65	CK 70	4.15
3C24	1.60	864	.25	E1148	.30
7C4/1203A	.70	931A	4.45	HY 615	.20
10Y	.35	955	.30	RK 73	.45
15R	.65	957	.35	5BP4	4.25
30 Spec	.40	CK 1005	.45	5FP7	1.75
39/44	.25	CK 1007	.90	1J6 G	.70
45 Spec	.35	1626	.35	1B3 GT	.80
WE 203A	6.75	1629	.25	3A4	.60
316A	.60	2051	1.10	5U4G	.57
WL 531	4.95	7193	.50	6K6GT	.60
713A	.90	8011	1.50	371B	.75

HI VOLTAGE FILTER CHOKES

.4 HY 4.5 Amp DC 3 ohms 1230 RMS to ground. New.
1 HY 3.2 Amp DC 3.5 ohm GE69G459. New.
1.7-3 HY 2 AMP DC 34,000 VDC GEY346A. New.

NAVY ENTERING TYPE INSULATOR

Porcelain flanged bowl with brass rod, fittings and aluminum shield. Dimensions 4⅜" high, 6-5/16" OD at base. Brand new. $4.50.

10 CM ROTATING ANTENNA

24" Parabola in turret 360° span at 12 RPM DC, motor control and reversing switch New.

TIME DELAY SWITCHES

1 Minute 115 VAC 60 cycle Enc. in Waterproof Metal Case. New $5.25
3 Micro Switches Contact at 40-41-42 Second Time Delay 110 VAC Motor New $4.50
Thermo Switch 50° to 300° F 115 VAC @ 6A 230 VAC @ 5A
Breaks Contact with increase in Temperature. New $1.35

CONTACTORS

DPST 115 VAC 60 cycle 15 Amp De-Ion Line Starter Westinghouse $6.95
DPST 115 VAC "AB" #700 $5.95

RELAYS

12 VDC DPST Allied Control Box 32...$1.25
24 VDC DPTD Allied Control BID36....$1.45
24 VDC 3PDT 8 Amp....$1.50
110 VAC DPST 1 Amp Contacts Struthers Dunn CKA 1970....$3.65
115 VAC DPST Struthers Dunn CXA 2997....$3.65
220 VDC DPDT Struthers Dunn CK.2122.$4.50
230 V 50 cycle DPDT G.E. 12HGA11A2..$4.00

OIL FILLED CONDENSERS

MFD	VDC	Each	Ten	MFD	VDC	Each	Ten
1	600	.85	.80	.5	2000	2.00	1.90
2	600	.95	.95	.25	3000	2.85	2.80
4	600	1.40	1.40	.5	3000	2.95	2.90
5	600	1.65	1.60	.2	5000	4.50	4.25
1-8	600	2.50	2.35	.1	7500	3.95	3.95

METERS

Portable 0-25 Amps AC Weston #433 Brand New $37.50
Switch Board Panel 0-100 Amps DC Weston #269 with 100 Amp Shunt Brand New $24.95

EQUIPMENT

Walkie-Talkie 2.3-4.6 MC
MN-26Y Bendix Compass Receiver
BC-733 Glide Path Receiver
DAB 3—Direction Finder
RDF Receiver Equipment 200-300 KC Fixed Tuned

SWITCHES—BATHTUB—OIL FILLED—MICA CONDENSERS—POTENTIOMETERS. SEND FOR CATALOG

COMET ELECTRONIC SALES CO.
22 Washington St. Tel. BEacon 2-7863 Brighton 35, Mass.

TERMS: Minimum order $5.00 — Mail orders promptly filled—All prices F.O.B. Boston, Mass. Send M.O. or check. Shipping charges sent C.O.D. 25% deposit required with all C.O.D. orders.

WANTED: ARC-1, 3, ART-13, BC-342, 348, APS-10, 15, TS-13, 35, 146, 147, 148, 174, 175, 263 etc. All SCR, BC, AN, TS. ALL TUBES.

RADALAB

1964 Webster Ave., Bronx 57, N. Y.
TEL: CYPRESS 8-4791

TERMS—Minimum order $25.00 all prices FOB New York City. 25% deposit with order, balance COD. Rated firms open account. Prices subject to change without notice.

RADAR

AN/APS-3 3CM search and navigational Radar $1000.00
AN/APS-4 3CM search and navigational Radar $1175.00
AN/APS-10 3CM very light weight search and navigational Radar 5" P.P.I. Complete sets avail.
AN/APS-15 3CM search, bombing, navigational Radar using 5" P.P.I. 3" A scope. Complete sets avail.
AN/APR-1 38-1000MC Receiver.
AN/APR-4 38-4000MC Receiver, 110V 60 Cyc. Input.
AN/APA-17 38-4000MC Automatic Direction Finder for use with APR-1, 4, 5 type receivers.
AN/APR-5 1000-6000MC tunable Receiver, 110V 60 Cyc. Input.
AN/UPN-4 3CM ultra compact long range Radar Beacon.
AN/APT-5 300-1300 MC Trans. 30 Watts output $189.50
AN/ARC-1 100-156 MC Radio Telephone 10 Chan. $850.00
AN/ART-13 Airbourne Trans. Autotune.
BC-348 1.5-18 MC Receiver 28 V D.C. Input.
BC-342 1.5-18 MC Receiver 110V 60 Cyc. Input.
SCR-718C high altitude Airbourne Altimeter. CAA Approved.
SCR-284 portable field Radio Station $350.00
SCR-522 100-156 MC Trans.-rec. 12 and 28V avail. $120.00
SCR-536 Handie Talkies.
SCR-291 Airport Long Range Automatic Direction Finder.
SCR-555 18-65 MC Long Range Direction Finder.

Many other airbourne, ground and marine military equipment available. "WRITE"

TUBES ALL FULLY GUARANTEED

OA2	$.89	832A	9.40
OB2	.95	833A	39.50
1B24	9.75	845	5.40
1P21	29.75	866A	1.40
2C40	9.25	869BX	52.50
2C42	8.50	872A	3.25
2C43	12.95	884	1.80
2C46	8.95	931A	5.25
2D21	1.30	958A	.75
2K25	30.00	959	2.95
2K28	31.50	1603	5.15
3B24	4.75	1624	1.40
3C22	72.50	5516	5.25
3C45	14.95	5643	7.25
3D21A	4.69	5651	2.65
3DP1	3.50	5654	1.95
3DP1/S2	5.95	5670	4.00
3E29	11.75	5672	1.40
4C35	28.75	5676	3.30
5FP7	1.95	5687	3.95
5LP1	14.75	5691	7.65
6C21	19.75	5692	7.65
6J4	5.90	5693	6.50
100TH	8.95	5702	2.95
211	.96	5703	1.89
250TH	16.50	5704	2.40
250TL	16.50	5718	6.50
304TH	7.90	5719	8.65
304TL	7.90	5726	1.69
307A	6.25	5814	2.75
703A	3.95	5876	16.50
705A	1.85	6005	4.35
707A	7.95	8005	6.40
707B	15.95	8020	1.10
715B	9.25	8025	4.75
715C	19.75	9001	1.40
721A	2.80	9003	1.50
723A/B	18.75	FG17	3.50
725A	7.40	FG32	11.75
726A	14.50	FG57	17.50
803	3.75	FG97	22.50
805	4.25	FG105	17.50
807	1.69	FG172	35.00
811	2.95	OA3/VR75	.97
813	10.50	OB3/VR90	.89
814	2.95	OC3/VR105	.95
815	3.75	OD3/VR150	.98
829B	11.75	1N21	.95
832	7.95	1N23	1.75

Complete stock of receiving tubes available

TEST SETS

TS-3/AP S band power, freq. meter $215.00
TS-13/AP 3 CM sig. gen. power meter, freq. meter 110 v. 60 cycle.
TS-14/AP 10 CM sig. gen. power meter, freq. meter. 110v 60 cycle....$650.00
TS-34/AP portable syncroscope....$290.00
TS-35/AP 3 CM sig gen. power meter, freq. meter 110v 60 cycle.
TS-45/AP 3 CM sig. gen. and freq. meter.
TS-61/AP 10 CM echo box.
TS-62/AP 3 CM echo box.
TS-125/AP 10 CM precision power meter.
TS-148/UP 3CM spectrum analyzer.
TS-226/AP 300-1000 MC power meter.
I-100 radio compass test set.
I-208 V.H.F. field radio test set.
BC-221 freq. meter Mod. $175.00
Unmodulated $125.00
IE-19 100-156MC test set.
IE-36 SCR 522 test set....$40.00
TSX-4SE spectrum analyzer.

SPECIAL

K-band 23,000, 24,000 MC RF heads using 2K50 klystrons and 3J21 packaged magnetron and magic TEE AFC mixer very late type. Also K-band complete dual-scanner antenna system. TS-259A/AP K-band sig. gen. power meter, freq. meter also available. WRITE

X and K-band Wave Guide Components

Slotted lines, term., adapt., crys. mounts, etc. in stock. SEND YOUR REQUIREMENTS.

WRITE FOR OUR CATALOGUES

SPECIAL SALE

SPECIAL PURPOSE TUBES

OB3/VR90	.95	5NP1	4.00	715B	6.00
OC3/VR105	.95	C6J	5.75	715C	15.00
OD3/VR150	.85	6AS6 W.E.	2.00	717A	.80
1B22	2.00	6C21 W.L.	18.00	721A	1.75
1B26	2.25	6J4 RCA	6.00	807	1.25
1P23	4.00	7BP7	5.00	814 G.E.	2.25
2A4G	1.20	9GP7	7.50	837	1.20
2C21	.35	10BP4	10.00	860	4.00
2C26	.25	10T1	.75	866A	1.10
2C39A	19.75	10Y	.45	876	.70
2C40	7.25	FG-17/5557	4.00	884	1.50
2C42 G.E.	17.50	24G Eimac	1.75	923	.70
2C46 G.E.	15.00	FG32/5558	5.50	931A RCA	3.95
2C51 W.E.	5.25	RK72	.85	954	.35
2D21W	2.25	100TH		955	.35
2E22	1.75	Eimac	6.75	957	.35
2E24	3.75	VU111	1.00	958A	.55
2E26	2.75	120A W.E.	5.00	1003	.75
2E30	1.65	121A W.E.	2.50	CK-1005	.50
2J22	6.75	F-123A	7.00	CK-1006	3.00
2J26	13.75	F-127A	15.00	CK-1007	.85
2J31	22.50	211/VT4C		1613	.80
2J32	22.50	G.E.	.49	1616	.85
2J33	22.50	231D	2.00	1619	.25
2J34	22.50	250TH	20.00	1622	2.00
2J48	22.50	304TH		1624	1.25
2K22	35.00	Eimac	6.75	1625	.30
2K23	27.50	307A	3.25	1626	.30
2X2/879	.35	309A	5.00	1629	1.00
3AP1	5.00	310A W.E.	5.00	1644	.50
3B24	4.00	311A	6.00	2050	1.25
3B26	3.50	313C	3.00	2051	.90
3BP1	4.00	371B	1.50	5670	3.25
3C24/24G		393A	6.50	5726	1.75
Eimac	1.75	394A	3.00	7193	.40
3C31/C1B	3.00	417A	7.00	8011	.85
3DP1	3.50	471A	2.00	8013A	4.00
3DP1A	5.50	507AX	1.25	8020	1.25
3E29	12.50	559	1.25	9001	1.00
3GP1	3.50	WL-681/686	32.50	9002	.80
5BP1	5.00	705A	1.50	9003	1.25
5C22 Sylv.	40.00	RK-707A	7.00	9004	.25
5CP1	4.00	715A	4.50	9006	.25

CRYSTAL DIODES

1N21	1.00	1N23B	2.75
1N23A	2.50	1N26	6.75

RECEIVING TUBES

1A7GT	.50	6AK5	.65	6SN7GT	.55
1C5GT	.40	6AK6	.90	6V6G, GT	.40
1L4	.50	6AL5	.45	6X5GT	.45
1LC6	.40	6AT6	.40	6Y6G	.60
1LH4	.40	6AV6	.40	7C5	.50
1LN5	.40	6BG6G	1.70	7C6	.50
1R4/1294	.40	6C4	.50	7E5	.50
1R5	.50	6C5	.40	7E6	.50
1S5	.50	6C6	.50	12A6	.50
1T4	.50	6D6	.50	12AT7	.85
3A4	.60	6F6	.60	12AU7	.50
3A5	.75	6H6	.45	12C8	.95
3D6	.40	6J5	.40	12K8	.80
3Q4	.50	6J7	.40	12SF7	.50
3Q5GT	.50	6K5GT	.50	12SH7GT	.50
3S4	.50	6K6GT	.50	12SJ7	.50
5U4G	.40	6K7	.40	25L6GT	.50
5W4	.50	6K8	.75	30	.50
5Z3	.40	6L5G	.60	35	.40
6AB7	.75	6L6	1.25	39/44	.40
6AC5GT	.95	6L6G, GA	.85	50B5	.50
6AC7/1852	.60	6L7	.60	80	.35
6AF6G	.50	6Q7	.50	83V	.95
6AG5	.60	6R7, GT	.50		
6AG7	.95	6SG7	.50		
6AH6	.95	6SL7GT	.65		

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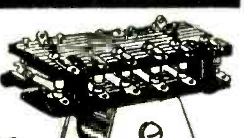

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W/Power supply, multivibrator, standard oscillator and interpolation oscillator.

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Measurements models 80, 75, 65B, 78, 84, (2) federal 605-CS, Boonton 150 A, TS 13 AP, TS 155, I122, ferris microvolters model 10B, 18B and 18C, Hewlett Packard 205-A, S Band Signal Generator, Hickok 199, etc.

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X Band Spectrum Analyzer, X Band and S Band terminations, Sperry Klystron signal source MKSX 12 (3), General radio type 874LB coaxial slotted line, wave guide slotted lines X Band and S Band, X Band frequency power meters, TS 33/AP, TS 36/AP, Lavoie frequency meter model 110S, TGP 6SE pulse generator, measurements 79B pulse generators, 410 R Klystron W/power supply, Hewlett Packard Spectrum Analyzer R.R.L. model 1230, etc.

★ Q METERS

2 Boonton 160A Q meters, Boonton 170A Q meter, Boonton 110 A QX checker.

★ SCOPES

P4 synchroscope, TS100 AP, Reiner model 556, DuMont 248 W/power supply, RCA 160B (2), RCA 155, several panoranic adaptors, RCA 9 inch consolescope, etc.

★ MISCELLANEOUS

Hewlett Packard Wave Analyzer, GR 650A impedance bridge, (3) Clough-Brengle 230A condenser bridge, Lavoie type 0-200 harmonic frequency generator, Hewlett Packard #325 B noise distortion analyzer, TBN-3EV W Bridge, TS 12 VSWR amplifier, ferris 34A VHF Xtal calibrator, Knight frequency standard, Exterline angus recording meters, AN/APR 4 receivers and tuning units; AN/APR 1 receivers and tuning units, T-85/APT-5 transmitters, G-R output power meters, Measurements model 62-AC VTVM, Ballentine AC voltmeter, GR 726-A VTVM, GR reactance meter, Kay megasweep, Measurements model 59 TS 19. Power supplies, miscellaneous waveguide and components, Field intensity meter RCA TMV-75-B, GR 1611 A capacitance test bridge, Measurements 58 field strength meter. Sylvania power supply—3000 volt 2 amp, 417 R Klystron W/power supply, Electrostatic voltmeter 0-10,000 volts, sheet metal brakes, vacuum pumps, plue print developer, oven, desk, filing cabinet, adding machine, typewriter, teletype writer, etc.

INSPECTION: June 15, 1953

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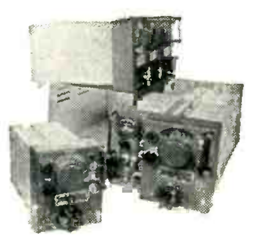

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115/0–115 V POWERSTAT 2 KVA	35.00
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814	2.50
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4–1000	1.50
8–1000	2.50
.5–2000	1.25
1–2000	1.50
2–2000	2.00
4–2000	3.00
1–2500	1.75
2–2500	2.50
4–2500	4.00
1–3000	2.50
2–3000	3.50
2–4000	5.00
3–4000	7.50
1–5000	4.00
2–5000	10.00
1–6000	6.00
2–6000	15.00
3–8000	35.00
1–10 KV	18.00
.1–13 KV	10.00
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.25–20 KV	15.00
.5–25 KV	35.00
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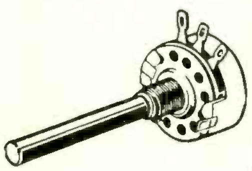

Carbon Potentiometers TYPE JU—RATED AT 2 WATTS Shafts up to 2" long

1 to 5	1.10
6 to 11	1.05
12 to 24	1.00
25 and over	.95

1B22	2.00
1B24	9.50
2C39A	27.00
2C40	12.50
2C43	17.95
2C51	5.75
2D21	1.35
3Q4	.75
3S4	.75
5FP7	3.49
6AJ5	1.35
6AK5	.65
6AK5W	1.79
6AK6	.99
6AL5	.60
6AQ5	.50
6AR6	2.75
6AS7G	4.25
6J6W	3.50
6SG7W	3.75
6SJ7	.75
6V6GT	.75
717A	1.75
725A	5.95
10Y	.35
24G	1.25
100TH	7.95
304TH	6.75
394A	3.75
801A	.35
954	.25
955	.35
956	.35
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5670	5.50
5687	5.25
5702	4.00
5704	2.50
5705	1.50
5726	2.10
5744	3.98
5763	1.50
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5829	2.25
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Type EB—½ WATT
Type GB—1 WATT
Type HB—2 WATTS

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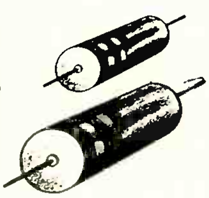

Type	Watt.	Tol.	100 to 499	500 to 999	1000 and over
EB	½	5% 10%	.08 .04	.075 .037	.07 .035
GB	1	5% 10%	.14 .07	.12 .06	.11 .055
HB	2	5% 10%	.18 .09	.16 .08	.16 .08

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Cook Relay #811 telephone type SPDT—7000 ohms 1.95
Cook Relay #796 SPST 200 ohm 1.49
Guardian Magnetic Contactor #NAF-1204-3 28 V. DC 1.95
Hart "Diamond H. Magnetic Relay SPST type B4 24V DC #694R10B 2.95
Butterfly Condensor Type A 76 to 300 MC 4.95
Type B 300 to 1000 MC 4.95
.01 Mfd 8000 V. Mica Cond 4.95
.1 Mfd 7000 V. can type paper 1.95
.002 Mfd. 3000 V Mica Cond .... .69
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2 Mfd. 7500 DCWV oil filled 14.95
1 Mfd. 5000 DCWV oil filled 4.95
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6SN7 to 815 Grids 1.95
815 Class AB2 .... 3.95
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Output Tfr 6F6 to 500 or 250 ohm .... .69
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Swinging Choke 6H 200 MA 2.45
Choke 5.9 H 450 MA 4.95
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8020 New 2.95
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703 A 4.95
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Brush kit for all types of Dynamotors. 25¢ per kit and up.
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ALL TYPES of COILS and PILE-UPS
Send Us Your Specs. for Our Quote

CLARE TYPE C STANDARD SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price.
1)	6500 ohms	1A	4 MA	$2.25 ea.
2)	6500 ohms	1C	2 MA	3.00 ea.
3)	6500 ohms	1B-1C	3.5 MA	2.75 ea.
4)	6500 ohms	2A	4 MA	3.00 ea.
5)	6500 ohms	3A	4 MA	3.00 ea.
6)	6500 ohms	3A-1B	4 MA	3.00 ea.
7)	6500 ohms	5A	5 MA	3.25 ea.

CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Will Close at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
5)	3600 ohms	1C	6 MA	2.00 ea.
6)	4850 ohms	1A	5 MA	2.00 ea.
7)	3300 ohms	(None)	ACTUATOR	1.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE G TELEPHONE RELAYS

1)	1300 ohms	1A-1C	24 or 48V.	$2.50 ea.
2)	400 ohms	1A	12 or 24V.	1.65 ea.

CONTACT SYMBOLS
A=Norm. Open B=Norm. Closed C=S.P.D.T.

G.E. Relays #CR2791-B109P36 Coil—10,000 ohms Contacts 1A, 1B Operates on 8 MA..Price $1.65
Signal Wheelock Relays #KS9665 Coil—2,000 ohms Contacts-1A, 1B, 1C Oper. at 9 Ma Price—$2.75 ea.
Leach Relays Type 1025-SN-BF. Coil—24V. 425 ohms. Contacts—D.P.S.T. Norm. closed. Rated at 10 Amps ....Price—$1.50 ea.
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3) .001 MFD	1200v.	DCW	.35 ea

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Yes here is *positive* proof that advertising in the SEARCHLIGHT SECTION of ELECTRONICS produces results! Following are a few lines from some letters that were sent to us voluntarily:

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"Our two inch ad sold $2,630 worth of equipment in one week"
"Ran a single 4" ad and sold all equipment advertised. Thanks"
"The results were very, very good"

Such enthusiasm proves what we have been saying all along: when you want to sell surplus new or used electronic components and equipment, you can do it best through the

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APR4 with tuning units
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RM 29 with the TS-13 handset
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Complete with attenuator, indicators and 350 ft. of coaxial cable. Originally cost $300.00 . . new condition . . ONLY $14.95
Plugs . . . large quantity available . . . write for prices!

166	**171**	**MC277**	**U10U**
170	**172**	**ART-13-U6U**	

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Shipments FOB warehouse. 20% Deposit on orders. Minimum order $5.00. Illinois residents, add regular sales tax to remittance. ***Prices subject to change without notice.***

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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. Supplied 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.

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-528—Mobile **FM** radio station, operates from 12 or 24 volt dc. Frequency range: 20.0-27.9 mcs.

SCR-628—Same as SCR-528, but with range: 27.0 to 38.9 mcs.

MAG — 10 cm. **PORTABLE LINK RADAR** transmitter receivers, 6-volt operation.

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AN/CPN-8 .... 10 cm.
YJ and YG .... for shipboard use
AN/CPN-6 .... 3 cm.
AN/CPN-8 .... 10 cm.
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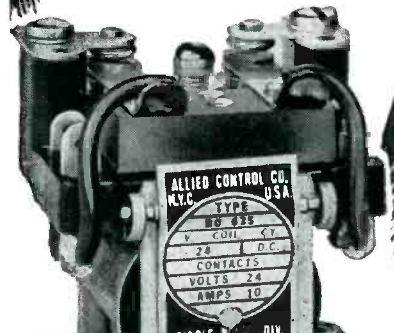

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2C26A	.40
2C34	.60
2C40	10.00
2C51(W.E.)	5.75
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2E25	5.00
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2J26	15.00
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2J31	22.50
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6-4	.50
6-4B	.75
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6SC7	.85
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6SG7W	3.75
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6SJ7Y	.85
6SL7	.75
6SN7	.75
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7AG7	1.75
7C24	95.00
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203Z	4.50
227A	4.50
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310A	5.75
313C	2.75
316A	1.25
327A	4.25
371A	.75
394A	3.00
412A WE	1.25
417A	15.00
446B	3.50
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702A	3.00
704A	.75
707A	7.50
708A	4.50
715-A	4.50
717A	1.25
718CY	35.00
724A	3.75
726C	45.00
728AY-GY	35.00
801A	.35
805	2.00

807	1.25
807W	7.50
826	.75
829B	12.00
835	10.00
836	3.50
837	1.25
843	.35
861	20.00
866A	1.25
872AS	3.00
874	.90
954	.25
955	.35
959	2.25
1616	.85
1625	.35
1626	.35
1630	.85
1632	.70
1633	.70
2050	1.25
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5654	1.50
5656	15.00
5670	4.00
5686	3.75
5687	4.00

5702	3.00
5703	1.50
5726	1.25
5744	1.35
5763	1.50
5787	4.50
5829	1.75
6035	50.00
6095	1.50
6096	1.75
6097	Write
6099	4.00
6100	Write
6101	3.00
6113	Write
7050	Write
8005	6.75
8020	1.25
9001	1.25
9003	1.35
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VU508	1.50
WL481	1.00
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45X674	10.00
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WE ESPECIALLY NEED: APA10, APN9, APR4, APS4, 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, TN18, 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.

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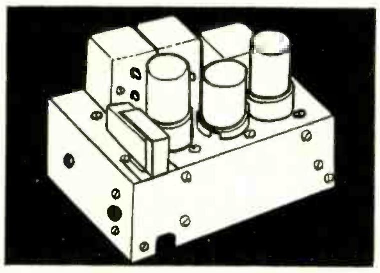

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Also need ART-13 Transmitters and spare parts, plus BC-348 Q and R, BC-788 A, AM, B, C and I-152 A, AM, B, C—plus any other gear you have for sale!

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BD110 Telephone Switchboards, BD100 Telegraph Switchboards, BD 90 Power Boards, EE101 V-F Ringers, BE72 Cabinets, FM19 Frames, RA43, REC30, KS5988, RA87, RA37, RA91 Rectifiers, BD101 Test Boards, SB6 Switchboards. Type CF1A, CF3A, CF2B Carrier Equipments. Any condition and quantity.

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FILAMENT TRANSFORMER—AMERICAN TRANSFORMER CO.—TYPE EFS: Primary: 210/240 volts, 60 cycles. SEcondary: 5 volts & 10 amps. Johnson socket, 123-211—50 watt. Height 12" $14.95

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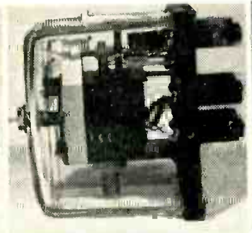
K BAND CAVITY — TKF-7SW: Gear Tuning, calibrated range 23400 — 24500 MCS. Panel mounting $47.50



TIME DELAY RELAY—WESTINGHOUSE: Type TD 115 volts 60 cycles single pole adjustable 0-90 secs. $19.75

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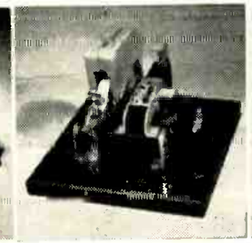

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REDMOND BLOWER MOTOR: Type L 3¼" fin 5¼" length 115 volts 60 cycles 140 CFM 1600 RPM $9.50

HI-PASS FILTER: F-29/SPR-2 for over 1060 MCS. Type "N" connections. $12.50

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STANDARD BRANDS

25 WATTS

Ohms		Price	Ohms		Price
22	Adj.	$.63	2.5K	Adj.	.64
50	Adj.	.63	3.5K	Adj.	.64
75	Adj.	.63	5K	Adj.	.65
150	Adj.	.63	9K	Adj.	.70
150	Adj.	.63	10K	Adj.	.70
200	Adj.	.63	20K	Adj.	.70
1K	Adj.	.63	100K	Adj.	.75
1.5K	Adj.	.64			

50 WATTS

1	Adj.	$.85	5K	Fixed	.59
2	Adj.	.85	8K	Adj.	.89
10	Adj.	.79	10K	Adj.	.89
25	Adj.	.79	15K	Fixed	.70
150	Adj.	.79	20K	Fixed	.70
200	Adj.	.79	25K	Fixed	.78
500	Adj.	.79	25K	Adj.	1.02
750	Adj.	.79	30K	Adj.	1.03
1K	Adj.	.79	33K	Adj.	1.03
1.5K	Adj.	.82	35K	Fixed	.78
2K	Fixed	.59	40K	Fixed	.78
4K	Fixed	.59	40K	Adj.	1.10

100 WATTS

15	Adj.	$1.19	500	Fixed	.81
25	Adj.	1.19	500	Adj.	1.19
50	Fixed	.81	750	Fixed	.81
75	Fixed	.81	5K	Fixed	.87
100	Adj.	1.19	20K	Adj.	1.34
125	Fixed	.81	50K	Fixed	1.12

200 WATTS

5	Fixed	$.81	150	Fixed	.81
10	Fixed	.81	250	Fixed	.81
25	Fixed	.81	1K	Fixed	.81
50	Fixed	.81	1.5K	Fixed	.85
50	Adj.	1.19	2K	Fixed	.85
100	Fixed	.81			

420 WATTS

10	Fixed	$1.99

AUTOSYNS

AY-14
AY-14D
AY-14G

MAGNATRONS:

2J22	$12.60	4J37	230.00
2J26	22.50	4J63	320.00
2J27	22.50	QK-60	100.00
2J31	42.50	QK-61	100.00
2J32	31.00	QK-72	320.00
2J34	42.50	700-A	37.50
2J37	14.50	700-D	37.50
2J49	68.50	706-AY	57.50
2J50	67.50	706-B	57.50
2J54	97.50	706-BY	57.50
2J54-B	147.50	706-CY	57.50
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2J62	63.00	706-EX	57.50
3J30	199.59	714A	12.50
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4J36	250.00	728-EY	250.00

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2K22	$68.00	2K36	398.00
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2K25	33.50	2K44	125.00
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2K29	30.00	723A/B	27.50
2K33	299.00	726-A	13.50
2K33-A	310.00	726-B	54.00
2K34	190.00	726-C	105.00

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1-F	5-SDG	2J5F1	C 78248
1-G	6-G	2J5H1	C 78249
1-SF	6-DG	2J5LA1	C 78386
5-B	7-G	2JD5R1	C 78472
5-CT	2J1E1	C 44968-6	C 81369
5-D	2J1F1	C 56701	K 5950-L2
5-DG	2J1G1	C 69405-2	
5-F	2J1H1	C-69406	

RHEOSTATS
STANDARD BRANDS

25 WATTS

Ohms	Price				
1.3/1.3	.79	175	.95	4K	1.35
15	.95	200	.95	5K	1.35
20	.95	225	.95		
25	.95	300	1.35		
50	.95	500	1.35		
75	.95	1.5K	1.35		
100	.95	2.5K	1.35		
		3K	1.35		
		3.5K	1.35		

50 WATTS

8	1.99
15	1.99
35	1.99
80	1.99
150	1.99
5K/5K	2.99

PULSE NETWORKS

6-A5-1/2-2000-50M	15-E3-1/2-400-50P
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9-E3-.25-2000-50P	15-E4-1-400-50P
9-E3-.5-2000-50P	15-E3-.5-2000-50P
9-E5-2-1000-50P	15-A-1-800-50
10-E3-.5-2000-50P	25-E5-4-120-50P
10-E5-1-400-50P	

PULSE TRANSFORMERS:

UTAH:

9280	9286	9340
9281	9287	9350
9282	9287-D	X 124 T2
9283	9288	X 124 T3
9284	9289	X 143 T3
9285	9318	X 146 T1

RAYTHEON:

UX 7307	UX7361 A	UX 10066
UX7350	UX 8092	U 12920

WESTINGHOUSE:

1P1	132 AW	145 EW2
1P2	132 BW	145 EWP
1P4	132 BW2	166 AW
1P8	132 DW	176 AW
1P13	133 AW	407 CW2
1P26	134 EW	
1P29	145 EW	

GENERAL ELECTRIC:

68G627	68G894	80G59
68G666	68G979	80G625
68G709	80G13	
68G813	80G58	

FREED:

#22647	K 2478	K 35J564-D2
	K 2721A	BX 17-17
K 2449	K 2728	7477707
K 2460	K 2746 A	

4" P.M. SPEAKER:

4-3/16" square speaker frame, mounting centers: 3-3/4" x 3-3/4". Alnico 5 P. M.
Voice coil 3.2 ohms at 400 C.P.S.
Output Transformer:

	PRIMARY	SECONDARY
Res. in ohms at 25°C	275 max.	
Hi-pot test at 60 cycles RMS to core	1300	500
Hi-pot test at 60 cycles RMS between coils	1300	1300
Rated Load		3.2 ohms
Reflected Impedence at 400 cycles	1800 ohms max.	
10 V with rated Secondary Load	3000 ohms max.	
Open Circuit Inductance at 10V. 60 cycles at 40 M.A.D.C.	1.5 ohms max.	
Applied Voltage at 400 cycles	40 V. RMS max.	

Your Cost $1.49

THIS ISN'T EVEN HALF THE STORY

For 'CONDENSERS' see page 466 May Electronics
For 'TUBES' see page 478 April Electronics

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1SF Motor, 115/90V 400~	17.50
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2J1F1 Generator, 115/57.5V 400~	9.50
2J1F3 Generator, 57.5/57.5V 400~	9.50
2J1G1 Control Transformer 57.5/57.5V 400~	9.50
2J1H1 Differential Generator 57.5/57.5V 400~	12.50
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2JD1J1 Motor, 115/90V 400~	15.00
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5SF Motor, 115/90V 400~	32.50
5SG Generator, 115/90V 400~	32.50
5SDG Differential Generator 90/90V 400~	32.50
KS5950 Generator, 115/90V 400~	15.00
KS5950L2 Generator, 115/90V 400~	15.00
2JA39BB2 Motor, G.E., 110/55V 60~	55.00
2J5FB1 Control Transformer 105/55V 60~	60.00
2JD5C2 Motor, 115/105V 60~	60.00
2J5H1 Generator, 115/105V 60~	50.00
2J5HA1 Generator, 115/105V 60~	60.00
2J5A4 Generator, 115/105V 60~	60.00
2J5S1 Differential Generator 90/90V 60~	60.00
2JD5J2 Motor 115/90V 60~	60.00
2J5LA1 Generator 115/105V 60~ (used)	40.00
2J65F1 Generator 110/55V 60~ (used)	35.00
5A Generator, 115 Volts 60 Cycles	22.50
5B Generator, 115 Volts 60 Cycles	22.50
5CT Control Transformer 90/55V 60~	45.00
5HCT Control Transformer 90/55V 60~	77.50
5D Differential Motor, 115/90V 60~	50.00
5DG Differential Generator 90/90V 60~	50.00
5F Motor, 115/90V 60~	45.00
5G Generator, 115/90V 60~	45.00
5M Motor, 115 Volts 60 Cycles	22.50
5N Motor, 115 Volt 60 Cycles	22.50
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7G Generator, 115/90V 60~	79.95
C44968-6 Type II-1, Repeater, 115V 60~	22.50
C56701 Type II-4 Repeater, 115V 60~	22.50
C56776-1 Repeater AC Syn. 115V 60~	22.50
C69406 Diehl FJ84-8 Transmitter 115V 60~	22.50
C69406-1 Type II-2 Repeater, 115V 60~	22.50
C78248 Transmitter AC Syn. 115V 60~	22.50
C78249 Differential AC Syn. 115V 60~	9.50
C78254 Type XII Differential 115V 60~	22.50
C78411 Transmitter AC Syn. 50V 50~	14.50
C78414 Transmitter AC Syn. 115V 60~	49.50
C78359 Diehl 84-4, Receiver 115V 60~	22.50
C78360 Diehl 84-5, Transmitter 115V 60~	22.50
C78386 Type XV Transformer 115V 60~	22.50
C78791 Transmitter AC Syn. 115V 60~	22.50
C79331 Transmitter AC Syn. 115V 80~	22.50
C81369 Type II-8 Repeater, 115V 60~	22.50
PATT-6547 Admiralty Transmitter 115V 60~	17.50
PATT-6548 Admiralty Transmitter 115V 60~	17.50
Admiralty Size 1 Magslip Motor 115V 60~	2.95
Repeater Type X, CAL5328A-1, 115V 60~	32.50
Transmitter Type 130-1, 120/90 VDC	32.50
CA14914-4 Type 851 Bendix Motor 32V 60~	22.50

CHOKES AND REACTORS

S. M. Choke, Raytheon UX8589, rated 25H @ .095A 1780VRMS	$6.50
S. M. Choke, Raytheon UX-9114A, rated 100H @ 1.4A 1780VRMS	2.65
S. M. Choke, Raytheon UX9116, rated .030H @ 2.0A 1780VRMS	4.95
Choke Assy, Raytheon WX5148, rated Dual 1.75H @ .25A, 42Ω res each sec. 1780VRMS	3.50
Choke Assy, Raytheon CRP30509. rated #1: 1.8H @ .384A Sec. #2: 0.7H @ .384A 1780VRMS	3.50
Double Cathode Modulation Reactor, G.E. #7479964, rated 50H @ .025A each side, 58Ω DC res. 15-30, 000cy	27.50

TRANSFORMERS

Write for Quantity Discounts

Raytheon UX8486A, Pri: 115V 400~ Sec: 5V @ 5A 13, 500VRMS	$3.95
Raytheon UX9009B, Pri: 115V 400~ Sec: 5V @ 10A 30KV RMS	14.50
AC-RC Trans. Raytheon UX7358, Pri: 115V 400cy Sec: 6500V @ .005A Test 2XInd	4.25
Filament, Raytheon 292-1202G2, Pri: 115V 400~ Sec: 6.3VCT @ 5A	2.85
G.E. #K54J111, Output, Pri: 990Ω Sec: 3650Ω Pri Ind: 20H @ .01A 10V 60cy	1.95
G.E. #68G449, Pri: 200V Sec: 260/130V 60cy 150W	1.95
G.E. #68G457, Pri: 1/1.5/3.6/8/10V 60cy Sec: 50-50V 150W	1.50
Raytheon Output UX7489. Pri: 3600Ω 70MA, Sec: 720Ω 0MA	1.95
G.E. #68G450, Pri: 500/250V 60cy, Sec: 72.5V .0525KVA	1.95
Stancor Modulation A3871, For use w/6L6 class A1, Pri: 4500Ω Sec: 8500Ω	1.65
W.E. #KS8606, Pri: 115V 60cy, Sec #1: 1080V @ 180MA, Sec #2: 5V @ 4A, Sec #3: 6.3V @ 1A, Sec #4: 2.5V @ 7.5A, All secondaries center tapped	4.50
Moloney Elec. # REL10383, Pri: 115/230V, 50/60 cy; Sec: 21000 Volts @ 200MA, Oil Filled. 16½" W, 16"D, 20-⅛"H exc. of ins	175.00
G.E. Cat. #79G365, Pri: 203.5V; Sec: 6.5VCT @ 250A, 50/60cy. 2.46 KVA, Wt: 130 lbs. 9¼"x7¼"x9-¾"	39.50
G.E. Cat. #7479972. Pri: 230/208V, 50/60cy; Sec: 2450/2320/2210V @ 1.162/1.222/1.29A. 2.85KVA	49.50
G.E. Cat. #7471997. Pri: 215/430V, 50/60cy; Sec: 5VCT @ 30A, 8KV ins	22.50
G.E. Cat. #7475695. Pri: 115V, 50/60 cy; Sec: 3530/3720/3910V 1.31 KVA, 2.5KV ins	47.50

PULSE NETWORKS

Sprague #7.5-E4-16-60-67-P. 7.5KV	$7.95
Sprague #7.5-E-3-3-200-67-P. 7.5KV	$6.75
Sprague #8-E5-1-1000-50P. 8KV	$22.50
Sprague #10-E3-0.5-2000-50P	$29.95
Sprague #15-A-1-400-50P	$27.50
Sprague #15-E4-0.91-400-50P	$19.95
Fast #15-E5-1.33-700-50P2T	$29.50
W.E. #D-163330 Network Assy	$22.50
Raytheon Pulse Trans. Type WX-5137. Pri: 4KV, 1 Mu. Sec., Sec: 16KV 16A	$22.50

HIGH VOLTAGE CAPACITORS

Cat. #	Mfd.	WVDC	Price
18F269	60	3KV	$65.00
QLXP30	120	3KV	87.50
22F985	2	4KV	14.50
PFD40244G	7	4KV	32.50
14F1	4	5KV	32.50
14F2	7	5KV	52.50
19F210	0.1	6KV	37.50
A7548	2x.25	6KV	17.50
TK00020	2	6KV	27.50
1227192	2x.275	7.5KV	27.50
7520	2x1.0	7.5KV	27.50
14F338	4.5	7.5KV	79.50
CC21B	2x0.5	9KV	32.50
10020	0.1	10KV	9.95
Inerteen	1.0	10KV	25.00
26F68	0.1	12KV	9.95
TK120065	.65	12.5KV	19.95
15020	.25	15KV	19.50
14F17	1	15KV	45.00
14F63	1	15KV	45.00
14F18	1.5	15KV	62.50
20020	.25	20KV	27.50
14F64	.25	20KV	27.50
37485	.25	20KV	27.50
26F585	.06	25KV	17.50
XSW200	.25	20KV	27.50
20005	0.5	20KV	45.00
14F22	1.0	20KV	52.50
14F139	.01	22KV	15.50
Inerteen	.5	25KV	57.50
25020	.5	25KV	57.50
14F24	.5	25KV	57.50
14F83	.75	25KV	72.50
Inerteen	1.0	25KV	85.00
A6734	1.0	25KV	85.00
14F112	.001	50KV	24.50
14F98	.025/.025	50KV	37.50
14F127	.025	50KV	37.50
14F126	.2	50KV	59.50
14F97	.25	50KV	70.00

These listings represent only a small portion of our tremendous Electronic inventories. If your requirements are not listed, write and allow us to quote you accordingly. Prices subject to change without notice. Terms: Rated firms net 10 days, Non-rated 25% with order balance COD. FOB Boston. Minimum order $10. Merchandise Fully Guaranteed.

ELECTRO Sales Company Inc. ESCO

50 EASTERN AVE., BOSTON 13, MASS. CAPITOL 7-3456

INDEX SEARCHLIGHT

JUNE, 1953

This index is published as a convenience to the readers. Care is taken to make it accurate but ELECTRONICS assumes no responsibility for errors or omissions.

ADVERTISERS INDEX

TO THE ADVERTISERS

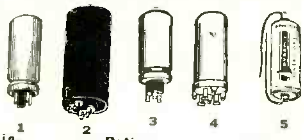
JUNE, 1953

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW 5 oz Designed Portable Equip. Models...98c; 4 for $3
(4) 36V BATTERIES w/Acid............ 3.35
2V 20AH Willard PLUS 2V. Vibrator....... 2.98
2V 20AH Batt. W/Vib. & Acid........... 3.59
6V/6AH Willd NT6/BB214U............... 2.98
6V/6AH Batt. W/Acid................... 3.25
6V/40AH Willard....................... 6.98
6V/40AH Batt. W/Acid.................. 9.25
Acid is shipped in Bottles. R'Exp only

ELECTROLYTIC CONDENSERS



1 2 3 4 5

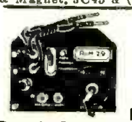
Fig.	Rating	Price
1	2X 20MFD/450VDC	69c; 3 for $1.69
1	3X 15MFD/450VDC	98c; 3 for 2.50
1	3X 20MFD/400VDC	79c; 2 for 1.29
2	80MFD/450VDC	79c; 2 for 1.29
3	25MFD/450VDC	79c; 2 for 1.29
3	45MFD/450VDC	69c; 3 for 1.69
4	2X 20MFD/450 & 25VDC	69c; 3 for 1.69
4	50 mf/350vdc FP	5 for 1.00
2	30-15-10 mf/250vdc	5 for 1.00
4	40-20mf/250-25vdc	6 for 1.00
4	30-2x20mf/450-25vdc	3 for 1.00

WRITE FOR ADDITIONAL LISTINGS

MICROWAVE

Klystron Mts Assy (723AB) & Coupling to 2 Type "N" Co-Ax Fittings. As Shown $9.98; 2 for $18.00
1 Microsecond Delay Line "Millen" $2.95; 4 for $10.00
Microwave Lighthouse Assy —P/O RT39 APG5 & 15. osc and Tr Cavities. Tunes 24-2700 MC. **SPECIAL** $20.00; 2 for $36.00
Variable Attenuator 3CM, Vernier ADJ, RND Choke to Straight Flange 1"x½"............$39.95
X Band Adaptor UG39 to UG40 Choke to Plane Flange Sperry Lab Dsgn.........$1.69; 4 for $6.00
X Band Straight Wave Guide Per/Ft.............$2.
X Band Plumbing, 45° Bend, Choke to Straight Flange 32½" Including Flanges.................$7.49
X Band Straight Plumbing, Choke to Straight Flange 23" Including Flanges....................$5.49
AN/APS10 Modulator Assembly. **New** Mfgrd **G. E.** Design #ML-766 3911-G1. Includes 2J42 & Magnet, 3C45 & (2) 3B24............$225.00

RM29



For Field Phone Use or Remote Control of Transceiver. Simple 2 wire 15 mile Operation. Includes talk listen & ringing Circuits. NEW...........$10.95

RM 53
Remote Control Xmitter or Intercom. Less Relay Plugs & Cable Includes Condensers, Switches, Jacks & Matching XFMR Mike to grid, Line to Grid & Line to Line, in 7½x4½x3¼" Metal Box. NEW.....................$1.25

PULSE TRANSFORMERS

PULSE-XFMR 1000 Pulse Per Sec. 5 Watt. TR1025 P/O LU-3 Test Equipment..........$7.98
7.5 KV Pulse, Pri 4 KV. 50-1000 ohm imped. Permalloy Core. W Eco D-163247...........$12.00
Pulse Blocking Osc. 3 wndgs, 1:1:1 ratio 1 mh wndgs GE H'Sld. HiVins....................$2.98
PULSE SHAPING Xfmr Raytheon UX12819, 1 MU Sec. 2000 CY.............................$5.00
UTAH 9340 P/O CP-5A/APS15...................$5.00
Pulse Transformers to "JAN" MLT27 Specs, Pt 1, 2, 3, 4, 5, 6 each.......................$8.75

TRANSFORMERS

All 115 V 60 Cyc Input TV & CR Pwr Xmfr up to 20" tubes. Hi VOLTS to 20 KV (w/quadrupler ckt.) ALL Tubes. PL & FIL wndgs 300 VDC/275Ma Full-Wave. 6.4V/10.3A, 5.4V/8A, 2.5V/3A Hypersil Core, Oil Impreg. $6.49; Two for...............$12.49
2500V for CRT, 6.3V/.6A, 2.5V/1.75A CSD Kenyon Hvins. 4/BC412 Replmnt.............$7.98
1000VCT/45MA, 795VCT/80MA, 360VCT/55MA 3X5V/3A, 6.3VCT/1A, 6.3VCT/.3A CSD HVINS CAN BE USED 2X RATING RAYTHEON, HIPERSIL CORE..................................$4.98
950VCT/100MA, 5V/2.5A, 5V/5A, 45V/1A, 10V/1.5A WESTERN ELECT.....................$5.49
900V/35MA, 2X2.5V/2A, XCLENT 1800V DBLER TWO 2X2 FIL WNDGS...................$2.25
780VCT/250MA, 5V/6A, 12.6V/5.5A...........$7.95
770VCT/200MA, 5V/6A, 12.6V/5.5A...........$6.95
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS 4-scope....................$3.69
700VCT/120MA, 2X6.3V/3A, 6.3V/1A.........$3.98
680VCT/200MA, 5V/3.5A, 6.3V/4A, 78V/1A $4.39; 3 for $12.
500VCT/60MA, 6.3V/4A, HSLD...............$2.98
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC & 115 & 230 VAC @................$1.49

FILTER CHOKES

12Hy/80ma/3KVins.................. 2.25
10Hy/75ma......................... 1.25
10Hy/125ma/UTC/Csd/H'Sld/1 KVins.... 1.49
50Hy/125ma/Csd/H'Sld.............. 2.89
12Hy/300ma/5KVins................. 4.95
20Hy/300ma or 15Hy/400ma/12KVins Kenyon........ 8.95
13.5Hy/1Amp/17KVins/Raytheon....... 39.95
Dual 2 Hy/300ma USN.........95c; 2 for 1.49
6Hy 175ma 250 Ohm............$1.49; 2 for 2.49
10Hy 100ma Freed................. 1.39

FILAMENT TRANS.

2.5V/2A @ 79c, 2 for $1.49, 10 for......... 56.49
2.5VCT/10A 5KVINS......................... 3.59
5VCT/10A/12KV INSUL G.E................... 8.25
5V/115A CSD KENYON HVINS................. 16.95
7.5VCT/12A CSD KENYON 15 KVINS........... 10.95
12.6VCT/1.25A CSD HMSLD................... 1.49
24V/1.25A CSD @ $1.98 Two for............. 3.49
2X12V/2A or 24V/2A @ $3.89 Two for......... 6.98
6.3V/2A $1.08: Two for..................... 1.98

LINEAR SAWTOOTH DC POTENTIOMETER KS15138

Electric power is supplied through 2 fixed taps 180° apart. 2 rotating taps, and take off brushes are provided for output voltage. Varying position of the brushes, varies the output voltage in accordance with a linear sawtooth wave. Special..............$3.95

WRITE FOR ADDITIONAL INFO

Chrome Vanadium Speed Drills

29 Drills Chrome Vanadium Speed Steel. Top Quality for Machinists or All Purpose Use 1/16 to 1/2 by 64th's. W/"Huot" Drill Index...$9.69
DRILLS, 60 Pcs 1 to 60 C.V. W/Index.......... 7.98
DRILLS, 13 Pcs 1/16" to 1/4" C.V. W/Index 2.69
DRILLS, 12 Pcs 1/16" to 1/2" C.V............ 3.49
1/4" Speed Electric Drill with **Jacobs** Worm-gear Chuck & 60 Pcs Drills & Index......22.00
1/2" Speed Electric Drill with **Jacobs** Worm-gear Chuck & 29 Pcs Drills & Index......39.00

WRITE FOR TOOL CATALOG

"TAB" THAT'S A BUY

HI-FI AUDIO AMPLIFIER

MODEL 1150 HI-FI 10 watt, less than 2 % distortion—response ± 1DB 20 to 20000 CPS. HUM—70DB, separate bass & treble controls. 3 position selector switch, built in equalized preamps for GE Cartridge. Tubes 2-6SL7, 2-6V6GT, 5Y3GT "TAB" SPECIAL.........$29.95
MODEL 1150 & GE S1201D, Hi-Fi amplifier & Speaker SPECIAL.............................$47.00

AUDIO COMPONENTS

GE RPX041 Phono Cart.................. $4.49
GE RPX050 Triple Play Carte........... 6.98
Electrovoice Triple Play.............. 2.69
Pickup Arm & Xtal Hi-Output........... 2.39
PM 12" Hi-Fi **British Speaker**........ 4.98
PM 12" GE S1201D **Speaker**............ 18.69
PM 8" **Blue 8T18-1 Permflux**........... 13.00
PM 10" Hi-Fi Woofer & Separate horn Tweeter. 10 watt 40-20KC............. 19.98
Crystal Mike & Cable................. 2.98
Crystal mike cartridge (Lapel type)..... 1.98

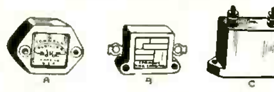
866A KIT AND XFORMER

2 Tubes, Sckts, xmfr 115v 60cyc input, outpt. 2.5vct. 10A/Hvinsul. **SPECIAL**..............$4.98

DIODE PROBE TUBE

Unexcelled for **No-Loss VHF** testing. Ultra sensitive subminiature-envelope. **New,** w/data VR92..........................25c; 5 for $1.

MICA CONDENSERS



A B C

Fig.	MFD	WVDC	PRICE
A	.033	600	69c; 5 for $2.50
A	.03	600	69c; 5 for 2.39
A	.02	600	69c; 5 for 2.25
A	.015	2500	1.75; 2 for 3.00
B	.01	600	56c; 3 for 1.20
B	.01	1000	49c; 3 for 1.25
B	.01	1200	69c; 3 for 1.49
B	.008	600	39c; 3 for 1.00
A	.005	2500	1.19; 3 for 2.95
B	.004	600	49c; 3 for 1.10
B	.002	1200	58c; 3 for 1.25
A	.002	2500	98c; 3 for 2.25
A	.001	1200	55c; 3 for 1.20
C	.00075	5000	2.98; 2 for 5.00
C	.0007	3000	89c; 3 for 2.39
A	.0004	2500	39c; 6 for 1.95
A	.0001	600	25c; 5 for 1.00
C	.0001	3000	89c; 3 for 2.00
C	.0001	5000	1.49; 4 for 5.00
C	.00005	3000	39c; 4 for 1.00

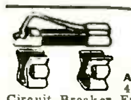
FL-5 FILTER

Range or voice. Filters 1020 cycle audio, excellent for **CW Work**...59c; 2 for $1.00

BANDPASS FILTER

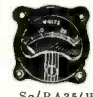
Sharp Cutoff HIQ. Cased & Shielded 60, 90, 150 cyc.................................Each $1.75
UTC 854, 1024, 1250 Cycles
Each $1.50; 2 for $2.50

CIRCUIT BREAKER FUSES



PUSH TO RESET
Amps 5-7-10-15-20 Ea. 27c. 4 for $1.; 25 for $5.; 100 for $18.
Circuit Breaker Fuse W/2 Mounting Clips 39c. 3 for....$1.00; 20 for....$5.98; 100 for....$25. Fuse is 3AG Size. Operates up to 24 Volts; Please State Amps (current) desired.
HEINMANN Magn Bkrs, Amps: 0.22, 3, 7, 9, 12, 15, 20, 30, 35, 40, 80, 180
Each $1.69; 10 for $15.98

METER BUYS



0-5 MA DC Tuning; Aircraft Mtg. "AN" Type 98c; 2 for 1.79
0-30 VDC "AN"...1.49; 2 for 2.49
0-60 ADC "AN" Type Mtg Less Shunt.......2.95; 2 for 5.00
0-15 VAC GE 2½ Rnd 800cy 1.29
0-150 VAC/W stghs/2½ Rnd 3.49
0-150 VAC/25-125cy/3½" Sq/RA35/Wstgh.............................. 5.98
0-1 MADC GE 3½" Rnd Bklt Cst......... 5.39
0-1 MADC Wstghs 3½" Sq RA35........... 6.49
0-50 Microamps Weston 301 3½" Sq.....13.98
0-500 MADC/2½", Rnd Triplett 221T...... 4.98
VU-20 + Weston 301 3" Sq. L. & $41....14.98
0-120 MART 8½ Rnd Weston 301..........$9.95

SELSYNS

2J1H1 GE Selsyns..................2 for $6.98
2J1F3 GE Brand New 115V/400 cy, ea........ 9.75
C78248 Sync. Trans. 115/60 cy $39.95; 2 for 75.00
C78249 Sync. Diff. 115V/60 cy 12.95...2 for 25.00
Sync. Repeater 115/60 cy Type 11-4..2 for 99.00
Bendix Autosyns AY1 & AY5..........2 for 4.95
Bendix AY20 New Orig Crtns................12.98

OTHER TYPES IN STOCK

DYNAMOTORS

INPT 6VDC. Output 200V/100ma, or 12/24V Output 500V/50ma "P" Magnt. As Illustrated.. 6.95
Inpt 28VDC/1.4A Output 250V/60ma......... 3.69
DA3A 28V/10.5A out 300VDC/260ma 150VDC/10ma, 14.5vdc/5amp............. 6.75
PE94 Plate Supp., Uses DA3A (SCR522).... 8.98
PE97 Plate Supp., Less Tubes............. 9.98

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE
Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 line/in. Complete data & tube, ea..$4.98;
SNOOPERSCOPE PWR SUPPLY
1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram **115V/60cy** Oper......$6.98

TUBES

"TAB" TESTED & GUARANTEED

PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	$0.95
OA3/VR75	1.04
OB2	1.37
OB3/VR90	1.09
OC3/VR105	1.15
OD3/VR150	.90
1B3/8016	.81
1B21/471A	2.85
1B22	2.20
1B23	9.90
1B24	9.45
1B26	2.45
1B27	12.75
1B32/532A	3.90
1B35	9.15
1B37	16.98
1B38	29.95
1B41	49.95
1B42	18.00
1B46	1.98
1B53	49.95
1B56	38.50
1B58	175.00
1B60	69.75
1B63	50.00
1B63A	75.00
1P21	33.00
1V2	.70
1X2	.95
1X2A	1.29
2C36	27.00
2C39	21.00
2C39A	29.50
2C40	7.29
2C43	17.75
2C43/464A	9.49
2C44	1.20
2C51	5.49
2D21	1.26
2E31	1.49
2E36	1.49
2E41	1.54
2E43	1.49
2G21	1.49
2J31	27.00
2J31A	79.95
2J32	37.00
2J33	27.00
2J34	27.00
2J36	108.00
2J37	12.70
2J38	11.75
2J39	44.00
2J42	187.00
2J48	24.25
2J49	67.25
2J50	21.25
2J52	249.50
2J55	85.00
2J56	149.00
2J61	49.95
2J62	49.45
2K22	39.45
2K23	39.45
2K25	28.49
2K25/723AB	24.90
2K28	29.00
2K33	259.00
2K35	389.95
2K41	126.00
2K42	145.00
2K48	120.00
2X2	.49
3B22	2.70
3B23/RK22	4.95
3B24	6.97
3B25	4.50
3B26	3.70
3B28	7.90
3C22	89.00
3C23	9.90
3C31/C1B	3.45
3C33	14.98

3C45	12.89
3D6/1299	.69
3D21A	4.98
3D22	13.95
3D23	4.90
3E29	14.95
4C35	22.25
EL5BHD	16.98
5C21/C6J	6.95
5C22	42.05
5C30/C5B	3.95
5D21	19.50
5D23/RK65	36.50
5J29	12.40
5R4GY	1.55
5R4GYW	1.75
5T4	2.49
5U4G	.69
5V4G	1.10
6AG5	.79
6AG7	1.39
6AH5G	1.49
6AH6	1.22
6AJ5	1.40
6AK5	.74
6AK5W	2.98
6AK6	1.05
6AL5	.54
6AL7GT	1.29
6AN5	2.90
6AQ5	.55
6AQ5W	3.98
6AQ6	.81
6AQ7GT	1.29
6AR5	.79
6AR6	2.98
6AS5	.79
6AS6	2.43
6AS7G	4.65
6AT6	.63
6AU5GT	1.10
6AU6	.59
6AV5GT	1.29
6AV6	.49
6AW6	1.89
6B4G	1.23
6BA6	.63
6BA7	1.27
6BC5	.63
6BC7	1.23
6BD5GT	1.65
6BD6	.83
6BE6	.59
6BF5	.98
6BF6	.65
6BF7	2.55
6BG6G	1.39
6BG7	1.98
6BH6	.63
6BJ6	.69
6BK7	2.15
6BL7GT	1.45
6BN6	1.79
6BN7	1.69
6BQ6GT	1.20
6BQ7	1.65
6BY5G	1.59
6C21	29.45
6CB6	.69
6CD6G	1.69
6D4	2.70
6CJ/5C21	6.95
6J4	6.66
6J5GT	.47
6J6	.63
6K4A	6.45
6L6	2.09
6L6G	1.35
6L6GA	1.35
6L6GAY	2.29
6SA7GT	.63
6SC7	.90
6SD7GT	.80

6SF5	.77
6SF7	.73
6SG7	.72
6SH7	.61
6SJ7	.70
6SK7GT	.69
6SL7GT	.69
6SN7GT	.70
6SQ7GT	.63
6SR7	.65
6SS7	.75
6ST7	.98
6V6	1.39
6V6GT	.57
6W4GT	.57
12AK5	1.98
12AK5W	2.98
12AL5	.75
12AT6	.89
12AT7	.81
12AU6	.72
12AU7	.63
12AV6	.49
12AV7	.98
12AW6	1.79
12AX4GT	1.20
12AX7	.79
12AY7	2.79
12AZ7	1.49
12BA6	.59
12BA7	.79
12BD6	1.23
12BE6	.59
12BF6	.85
12BH7	1.29
12BY7	1.35
12BZ7	1.25
12SA7GT	.69
12SC7	.80
12SF5GT	.72
12SF7GT	.49
12SG7	.83
12SH7	.63
12SJ7GT	.59
12SK7	.72
12SL7GT	.65
12SN7GT	.75
12SQ7GT	.63
12SR7	.63
FG17	3.95
19T8	1.09
19V8	1.62
RK20A	8.95
24G/3C24	1.90
25BQ6GT	1.19
25L6GT	.69
25Z5	.79
25Z6GT	.99
FG27A	8.70
28D7	1.95
FG32/5558	13.85
35Z5GT	.59
50L6GT	.69
RK61/XFG1	3.05
80	.69
81	1.69
82	1.19
82V	1.39
83	1.45
83V	1.79
84/6Z4	.99
FG95/5560	24.85
FG98	19.95
100TH	7.83
FG104	37.98
FG105	17.64
117L/M7GT	1.59
117N7GT	2.49
117P7GT	1.39
117Z6GT	1.19
117Z7GT	1.49
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F127A	19.98

VT127A	3.90
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FG172	29.00
250TH	18.97
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304TL	8.90
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446A	1.05
446B	3.89
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450TL	52.00
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CK501X	1.26
CK501AX	2.20
GL502A	1.79
CK502AX	1.49
CK503AX	1.49
CK505AX	1.79
CK506AX	1.49
CK509AX	1.79
CK512AX	1.45
CK522AX	1.29
CK525AX	1.29
CK526AX	1.49
CK528AX	1.49
CK529AX	1.79
GL530	22.00
CK531DX	1.89
531	6.98
CK532DX	1.89
WL532	3.98
CK533AX	1.29
CK534AX	.99
CK536AX	.99
CK537AX	3.04
CK538DX	.98
CK539DX	2.19
CK541DX	1.99
CK543DX	.99
CK544DX	.99
CK546DX	1.99
CK547DX	1.98
CK571AX/5886	2.49
CK573AX/6029	3.49
WL579	10.49
WL579B	12.98
WL652	65.00
WL673	117.00
WL676	39.95
WL686	35.00
703A	4.75
705A	1.98
707A	7.90
707B	13.50
715A	6.00
715B	11.90
715C	24.00
717A	.90
718BY	48.45
718CY	48.45
719A	28.50
721A	2.49
722A/287	2.45
723A	11.95
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724A	3.95
724B	3.45
725A	8.49
726A	21.97
726B	45.00
726C	79.95
801A	.45
803	3.89
805	3.90
807	1.65

808	2.59
809	2.43
810	9.95
811	2.90
812	2.70
813	12.49
814	2.97
815	5.97
816/866Jr.	1.07
826	.95
829	11.49
829B	12.45
832	3.97
832A	9.65
833A	39.45
834	5.95
836	4.75
837	1.45
849	29.45
860	4.90
861	23.95
865	1.29
866A	1.50
872A	3.29
CK1005	.85
CK1027	2.98
CK1028	15.98
5651	2.35
5654	2.79
RK5657	350.00
5663	1.85
5670	5.30
CK5672	1.29
CK5678	1.89
5687	5.49
CK5702	3.49
CK5703	1.29
5812	2.99
5814	3.64
5840	12.34
8020	1.25

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1N21A	$1.55
1N21B	2.89
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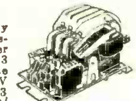
1N22	1.25
1N23	1.35
1N23A	2.20
1N23B	3.49
1N25	4.98
1N26	8.75
1N27	1.55
1N34	.64
1N34A	.90
1N35	1.65
1N38	1.43
1N38A	1.15
1N41	8.95
1N42	16.95
1N43	1.73
1N44	1.24
1N45	1.45
1N46	.69
1N47	4.00
1N48	.55
1N51	.45
1N52	1.39
1N54	.89
1N54A	1.15
1N55	3.10
1N57	.89
1N58	1.19
1N58A	1.15
1N60	.60
1N61	2.07
1N63/K63	2.49
1N64	.69
1N69	.98
1N86	1.15
1N87	1.15
1N88	1.15
K34	1.35

CONTACTOR



G. E. CR2811C22AQ. Heavy Duty Electric Starter, Transmitter or Motor Starter Switch. For Single or 2 or 3 Phase Appl. Rated 1 Phase 3HP/110V, 7½ HP/220V 10 HP/600V. Rated 2 or 3 Phase 7½ HP/110V, 15HP/220 V, 25HP/600V Control Inpt. 220V/1PH/60-Cy. Contacts rated 45 Amp Enclosed, 50 Amp Open. **SPECIAL**..............$19.00; 2 for $36.00

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15 ohm 25W w/knob...........$1.49; 2 for $2.49
20 ohm 50W Model J.......... 1.98; 2 for 3.50
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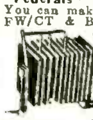
200 ohm 25W Model D......... 1.49; 2 for 2.49
250 ohm 25W................. 1.19; 3 for 2.98
300 Ohm 225W Model P........ 2.98; 2 for 5.00
350, 500, 5000 ohm Slotted shaft, 25 watt.......... 79c; 3 for 2.00

FEDERAL RECTIFIER KIT

"Federals" all purpose selenium rectifier kit. You can make 24 different rectifiers ½ WAVE/FW/CT & Bridge. 8 plates rated 18V/12AMP each. All Hardware & lugs..$19.59



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We specialize in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current Cont.	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1 Amp	$1.35	$2.15	$3.70	$7.50
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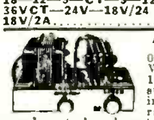
4 Amp	4.25	7.95	12.95	25.25
6 Amp	4.75	9.00	13.50	33.00
10 Amp	6.75	12.75	20.00	40.00
12 Amp	8.50	16.25	25.50	45.00
20 Amp	13.25	25.50	39.00	79.50
24 Amp	16.25	32.50	45.00	90.00

Full Wave Rect & Trans, 115V/60cy inputs,
up to 14VDC at 12 amps....................$23.98
up to 28VDC at 12 amps.................... 31.98
up to 28 VDC at 48 amps...................129.00

RECTIFIER XFMRS
18—12—9—CT—9—12—18V/4 Amp..........$8.75
18—12—9—CT—9—12—18V/12 Amp.........16.75
36VCT—24V—18V/24 Amp.................35.75
18V/2A.....................$1.98; 3 for $5.49

"HO" RAIL PACK



0 to 12VDC/2 AMP Variable DC supply—inpt. 115v/60 cy. Usable LAB supply, filament D.C. platin, battery charging, model railroad includes voltage or speed control and center off reversing sw. Ideal for two "HO" loco's..............$10.95; 2 for $20

BATTERY CHARGER RECTIFIER

10-0-10 Volts (CT) 100 Amp (Fan Cooled). Replace Your Old inefficient Sulphide Rect. with the New Selenium Types. **SPECIAL**..$11.98

BC-442-A

Antenna current indicator & Relay switching includes 750MA "RF" meter, 19.5 millivolt movement, current XFMR, thermocouple & connectors. Complete as shown less vacuum condenser..........................$2.25

Photoflash Capacitors

100MFD 500WVDC..............................$1.98
200MFD 450WVDC.............................. 2.89
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15MFD/330VAC/1500VDC Intermittent... 3.98
25MFD/330VAC/1500VDC Intermittent... 6.49
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"TAB" Sun-Flash Lamps

"TAB" No.	Replaces	W/Sec. Max.	Each
U5W	GE FT105	100	$5.98
U10	GE FT114	100	7.25
No. 1	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
53GT	GE FT 403	500	13.50
VA	SYLV. 4330	200	9.98
23MT	FT 214	250	9.98
22BT	FT 110	200	9.98
353GTQ	FT 503	5000	49.98
V4X4	X400	200	10.98
DX	SPRGFA100	150	9.00

100 WATT SEC PHOTOFLASH KIT

Includes DX Flash Lamp Rated 150 Watt Sec. Flash Lamp Holder & 8" Reflector & Cable Power Transformer & CD Flash Capacitors, (5) 200 Mfd Each W/Output of 100 Watt Sec. All Resistors, Capacitors, Rectifiers & Sockets.$29.98
Extra Flash Lamp Holders W/8" Reflector & Cord $3.98; W/Lamp DX....................$12.98

CU-24/ART 13 LOADING CONDENSERS

Three 25MMF 10,000V condensers P/o ART13 XMTTR. NEW..........$2.49
HI-VOLTAGE Ceramic Condensers, 4 mounted on aluminum plate rated as follows 185-200-280-400 MMF P/o ART13 SIG CORP. #2C6900-47A/11 BRAND NEW................................$1.98

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"WELLER" GUN 115VAC 100 Watt..........$8.69
"WEN" GUN 115VAC 250 Watt 9.49; 3 for 25.50
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PHILIPS "Versa TOOL" 115VAC 250W Including 4 Tips, Special.......................10.83
ESICO IRONS 120 V AC/DC
55 Watt/3/8 Tip/11½ Lng/.38 Lbs................ 1.25
60 Watt/½ Tip/12" Lng/.38 Lbs.................. 1.91
100 Watt/3/8 Tip/12" Lng/.5 Lbs................ 2.55
130 Watt/½ Tip/12" Lng/.75 Lbs................. 3.17
ESICO INDUSTRIAL CONST. USE IRONS 120VAC/DC
Similar to American Beauty type as shown
61A60/60W/1/8 Tip/7" Lng/2.5 oz............... 3.20
#38/Am. Beauty 3138/100W/3/8 Tip.............. 5.29
#58/Am. Beauty 3158/200W/5/8 Tip.............. 6.30
#78/Am. Beauty 3178/300W/7/8 Tip.............. 8.18
#98/Am. Beauty 3198/550W/1⅛ Tip............... 10.08
Esico Temp Regulating Stand.................... 4.20
Kester Solder one Lb. .062 Roll Reg.......... 1.29
With any soldering iron. Special................ 90c

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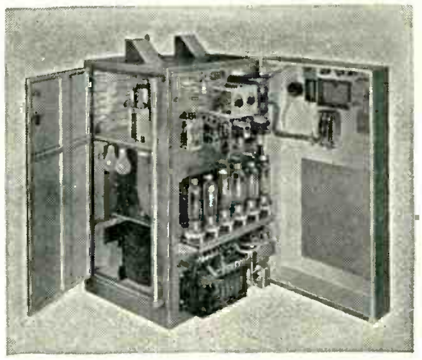
INDEX TO ADVERTISERS

PANELS, LIDS, DOORS MADE RF-TIGHT BY LOW COST METHOD

Electronic Weatherstripping, made of knitted wire mesh compressed to required sizes and shapes, effectively "shields" these openings against RF leakage just as weatherstrips seal doors and windows.

Openings such as these are necessary for operating and servicing the electronic equipment housed in the metal cabinet. Yet these same openings destroy the full shielding efficiency which an "unbroken" metal container would otherwise provide. Careful machining of mating surfaces at these openings is an obvious answer. But such work is expensive, and the initial close fit is often destroyed by repeated openings and closings, by warping of the lid or door and by corrosion of the mating surfaces. Numerous latches, screws, bolts and other fasteners, closely spaced, will help keep these joints RF tight, but they are a time consuming nuisance whenever the cabinet must be opened and closed, and they are also expensive to purchase and install.



"Thermatron built by Radio Receptor Co., Inc."

Metex Electronic strips and gaskets eliminate these objections. Being made of metal, they are conductive; and being knitted they are resilient and conform to normal surface irregularities. They actually "block" the otherwise leaky openings with a gasket of flexible metal, and make the cabinet as effective a conductive shield as if the openings had never been made.

Metex electronic strips and gaskets are easy to install. Not only are they inexpensive, but their use may well save more than their cost by eliminating many operations that would otherwise be necessary. They are available in different shapes, dimensions and resiliencies to meet the varied requirements of specific electronic applications and can be made of metals or alloys selected to meet actual or anticipated corrosive conditions.

A bulletin giving detailed information is available on request from the manufacturer, Metal Textile Corporation, 641 East First Avenue, Roselle, N. J.

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. HILTY, Mgr.

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Shocking News About Super Davohm Resistors

Since Daven originated the first pie-type wire wound resistor more than a generation ago, it has pioneered many innovations in the production of resistors.

Today, *only Daven* uses a stranded lead wire to connect the resistance wire to the solder terminal of the Super Davohm Precision Wire Wound Resistor.

As a result, no matter how much strain, stress, heat or pressure is applied to the solder terminal, no accompanying shock is put upon the fine resistance wire itself, but is absorbed by the heavy lead wire without adversely affecting the resistor in any way.

Therefore, Super Davohm Resistors are substantially more rugged than conventional resistors and are able to withstand unusual vibration, rough treatment and abnormal shocks.

This exclusive Daven feature, plus the many other quality aspects of Super Davohm Precision Wire Wound Resistors, makes Daven the leader in the resistor field.

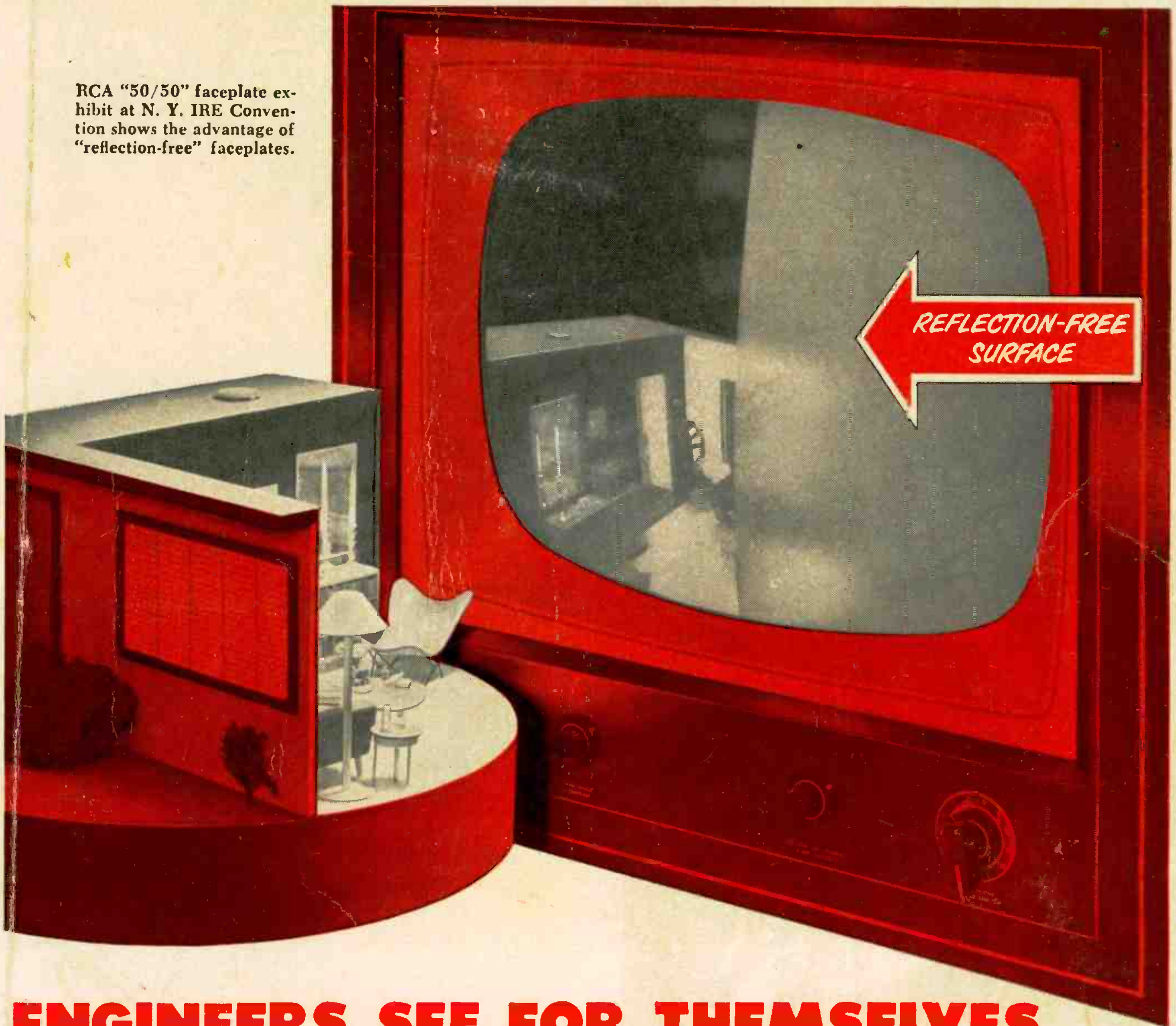
The Super Davohm line includes resistors made in accordance with MIL-R-93A specifications, as well as sub-miniature units to give you the most complete selection of resistors available anywhere. Deliveries can be made to meet your requirements.

Write for assistance with your problems, and ask for a copy of Daven's complete, new brochure on Super Davohm Precision Wire Wound Resistors.

THE **DAVEN** CO.

191 CENTRAL AVENUE, NEWARK 4, N. J.

RCA "50/50" faceplate exhibit at N. Y. IRE Convention shows the advantage of "reflection-free" faceplates.



ENGINEERS SEE FOR THEMSELVES

...how room reflections vanish!

Remember this? It's the "reflection-free" demonstration that thousands saw at the RCA exhibit during the IRE Convention in New York. The right half of the kinescope faceplate was lightly frosted to "kill" room reflections, but the left half of the faceplate was left untreated. The miniature room provided the source of reflections as it moved back and forth in front of the faceplate.

This photograph shows conclusively how the "reflection-free" surface eliminates the annoyance of room reflections.

If you are using the "reflection-free" feature to fullest advantage, YOU know what this potent sales aid can do for your TV line. For it goes almost without saying; you get greatest boost in sales power—with RCA metal-shell kinescopes. *High-quality frosted faceplates offer the combined advantages of reflection suppression with fine picture detail.*

For technical data or design help, write RCA Commercial Engineering, Section 42FR, Harrison, N. J. Or just call your nearest RCA Field Office:

(EAST) Humboldt 5-3900, 415 S. 5th St., Harrison, N. J.
(MIDWEST) Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill.
(WEST) Madison 9-3671, 420 S. San Pedro St., Los Angeles, Cal.

RCA Metal-Shell Kinescopes

RCA-21AP4 (magnetic-focus type)

RCA-21MP4 (electrostatic-focus type)

All RCA Metal-Shell Kinescopes feature "reflection-free" faceplates which suppress annoying room reflections.

RADIO CORPORATION of AMERICA

ELECTRON TUBES — **HARRISON, N. J.**