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Model Speeds Antenna Design For New Communications Ship

electronics

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MODEL SPEEDS ANTENNA DESIGN—All-brass 1/48-scale model of USS Mount McKinley is irradiated at scaled frequencies while rotating on model range at Navy Electronics Laboratory in San Diego, Cal. to find optimum positions for the many antennas (see p 162) COVER

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Range: 1 mv to 100 mv
100 mv to 1 v
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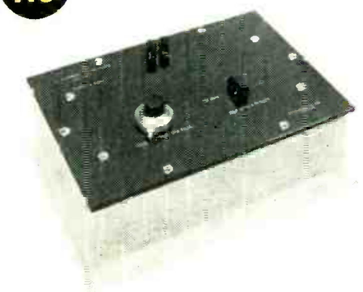
Accuracy: ±0.25%

Input: 115 VAC ±10%, 1ϕ, 60~

Output loading: 1 megohm or higher. However not damaged by short circuit.

We solicit inquiries for AC standards of other voltage and current ratings.

AC



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DC

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TYPE D-650-A

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

FEATURES

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

Frequency accuracy: ±0.2% or ±0.5c/s.

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

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

Harmonic content: 1% at 1W output.

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

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

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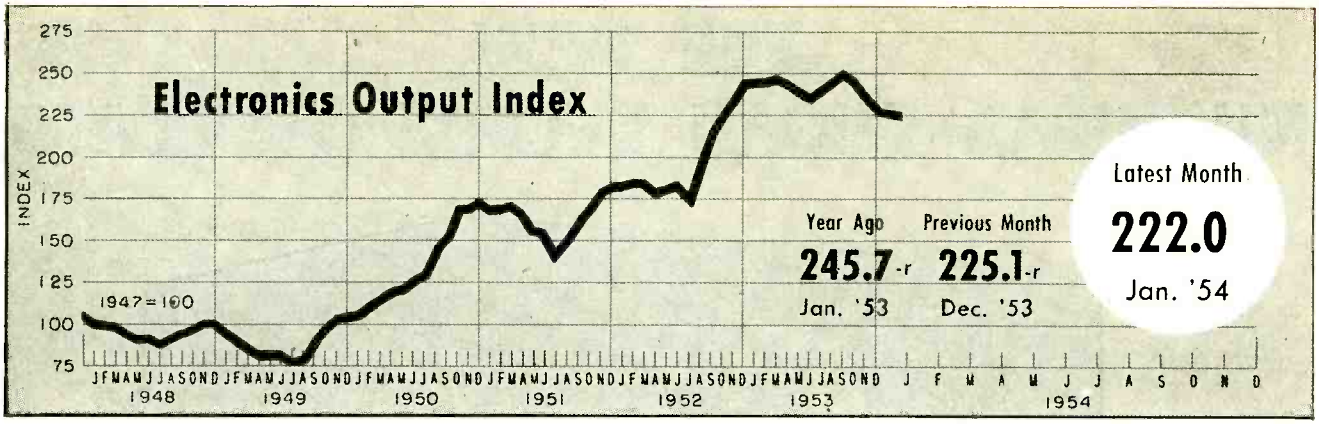


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago Jan. '53	Previous Month Dec. '53	Latest Month Jan. '54
Television sets	719,234	449,787	420,571
Home sets	361,921	514,428	271,036
Clock Radios	189,592	117,672	159,932
Portable sets	93,962	103,931	46,571
Auto sets	447,667	365,084	394,442

RECEIVER SALES

(Source: RETMA)	Jan. '53	Dec. '53	Jan. '54
Television sets, units	640,073	774,856	731,917
Radio sets (except auto)	414,726	1,456,008	306,407

RECEIVING TUBE SALES

(Source: RETMA)	Jan. '53	Dec. '53	Jan. '54
Receiv. tubes, total units	37,343,081	23,404,026	22,133,347
Receiv. tubes, value	$25,688,914	$17,832,387	$16,412,505
Pic. tubes to mfrs., units	988,316-r	644,287-r	557,681
Picture tubes, value	$23,892,982-r	$14,801,856-r	$12,173,923

SEMICONDUCTOR SALES

(Source: RETMA)	Dec. '52	Nov. '53	Dec. '53
Germanium Diodes	1,568,334	733,029	689,409

INDUSTRIAL TUBE SALES

	Quarterly Figures		
(Source: NEMA)	Year Ago 3rd '52	Previous Quarter 2nd '53	Latest Quarter 3rd '53
Vacuum (non-receiving)	10,582,110	10,320,720-r	9,434,082
Gas or vapor	2,951,067	3,303,631-r	4,145,018
Phototubes	566,234	706,055-r	510,686
Magnetrons and velocity modulation tubes	8,491,301	10,523,247-r	9,822,600
Gaps and T/R boxes	1,698,259	1,683,637-r	1,554,000

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago Jan. '53	Previous Month Dec. '53	Latest Month Jan. '54
Sets in Use—total	21,234,100	26,973,000	27,666,000

BROADCAST STATIONS

Source: (FCC)	Feb. '53	Jan. '54	Feb. '54
TV Stations on Air	147	369	379
TV Stns CPs—not on air	221	197	198
TV Stns—Applications	815	134	99
AM Stations on Air	2,409	2,524	2,529
AM Stns CPs—not on air	131	120	128
AM Stns—Applications	252	165	154
FM Stations on Air	611	555	554
FM Stns CPs—not on air	20	19	19
FM Stns—Applications	8	4	3

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Jan. '53	Dec. '53	Jan. '54
Aeronautical	35,323	42,455	42,314
Marine	38,631	43,703	43,918
Police, fire, etc.	12,234	14,663	14,865
Industrial	15,761	19,797	20,053
Land Transportation	5,531	6,470	6,556
Amateur	117,106	115,518	116,369
Citizens Radio	1,892	5,439	5,492
Disaster	90	254	256
Experimental	507	506	525
Common carrier	1,037	1,430	1,479

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Nov. '52	Oct. '53	Nov. '53
Prod. workers, comm. equip.	398.0	407.6	395.2
Av. wkly. earnings, comm.	$65.99	$66.97	$67.43
Av. wkly. earnings, radio	$63.71	$65.84	$66.40
Av. wkly. hours, comm.	41.5	40.1 -r	39.9
Av. wkly. hours, radio	40.1	39.9 -r	40.0

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Feb. '53	Jan. '54	Feb. '54
Radio—TV & Electronics	304.5	273.4	281.7
Radio Broadcasters	285.1	274.3	284.8

p—provisional; r—revised

FIGURES OF THE YEAR

		TOTALS FOR THE FIRST MONTH		
	1953 Total	1953	1954	Percent Change
Television set production	7,214,787	719,234	420,571	—41.5
Radio set production	13,368,556	1,093,142	871,981	—20.2
Television set sales	6,375,279	640,073	731,917	+14.3
Radio set sales (except auto)	7,064,485	414,726	306,407	—26.1
Receiving tube sales	437,091,555	37,343,081	22,133,347	—40.3
Cathode-ray tube sales	7,582,835	988,316	557,681	—43.6

INDUSTRY REPORT

New York Subways Go Electronic

FASTEST subway train operation in the U. S. will result from an all-electronic traffic control system to be installed on the Flushing line of New York's IRT. The $9,028,995 job will be handled by Union Switch who have a similar system in Stockholm, Sweden.

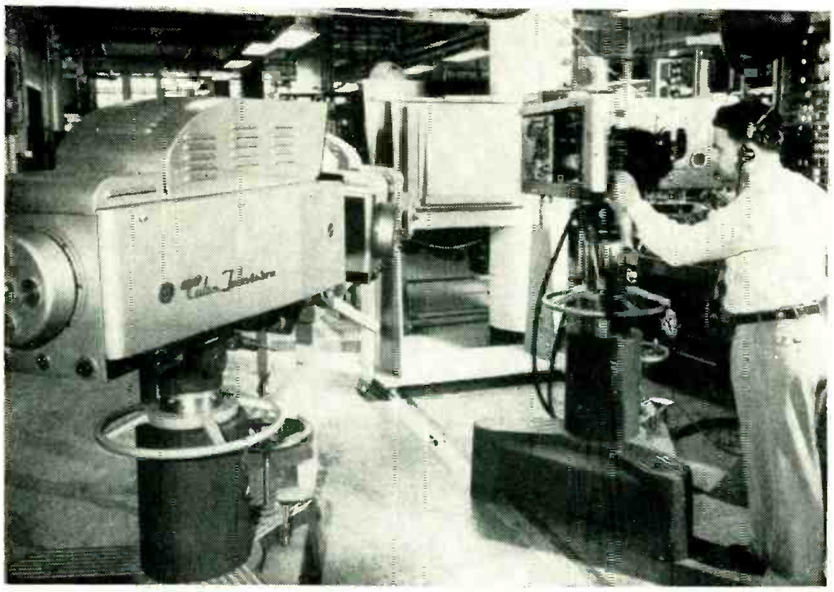
▶ **What It Does**—Features of the traffic-control system include train identification that will identify an approaching train, operate switches automatically and indicate to passengers on the platform the classification of the train.

▶ **How It Works**—Each train will be equipped with an inert coil tuned to a specific frequency. Each frequency represents a train classification. At points along the right-of-way at which the identification is to be made there will be a bridge, tuned to each of the identifying frequencies. As the train goes by, the coil unbalances its corresponding bridge.

▶ **Speed**—When the new traffic control system is completed, the ten-mile Flushing Line will be operated from two control points instead of ten. Eventually, the whole line will be controlled from one point.

The new signal system will also allow the operation of 37 11-car trains an hour over the line against a maximum of 30 9-car trains at present. These two improvements should produce a 25¾% increase in passenger-carrying capacity per train.

Stations along the line are being extended to accommodate 11-car trains. At present they only take trains of nine cars.



INITIAL shipments of commercial color cameras are made by RCA as . . .

Manufacturers Boost Color Output

RCA, GE and DuMont expand production plans to prepare tv broadcasters for color

IN MARCH the pace of production activity for color tv station equipment increased when both RCA and GE announced deliveries of color camera equipment.

RCA has made delivery of several commercial color tv cameras and associated equipment to NBC and CBS. Production and shipment of the cameras will continue on a regular schedule against orders already received. These include orders from WKY, Oklahoma City; WBAP, Fort Worth; WBEN, Buffalo; WTMJ, Milwaukee; WCCO, Minneapolis; KTLA, Los Angeles; NBC and from CBS which recently increased its order to cover 12 complete studio camera chains and associated equipment.

Each color camera chain includes the camera, an aperture compensator, rack-mounted control amplifier, shading generator, remote control panel, gamma corrector and master monitor and auxiliary switching unit.

▶ **Coders**—General Electric, which signed a patent license agreement for the right to manufacture and sell color apparatus developed by CBS, including the single-tube field-sequential color tv camera and the Chromacoder, also began deliveries in March. First camera went to CBS which has ordered four of the units.

The company also announced plans to modify existing black-and-white cameras for use with the

Chromacoder. Although none for individual stations have as yet been converted, it is estimated that the cost for converting one camera, including the coder, is about $46,000. Because one coder unit can handle any number of field-sequential cameras, a second camera could be converted and added for about $6,000 additional. Four cameras converted and coder come to about $64,000.

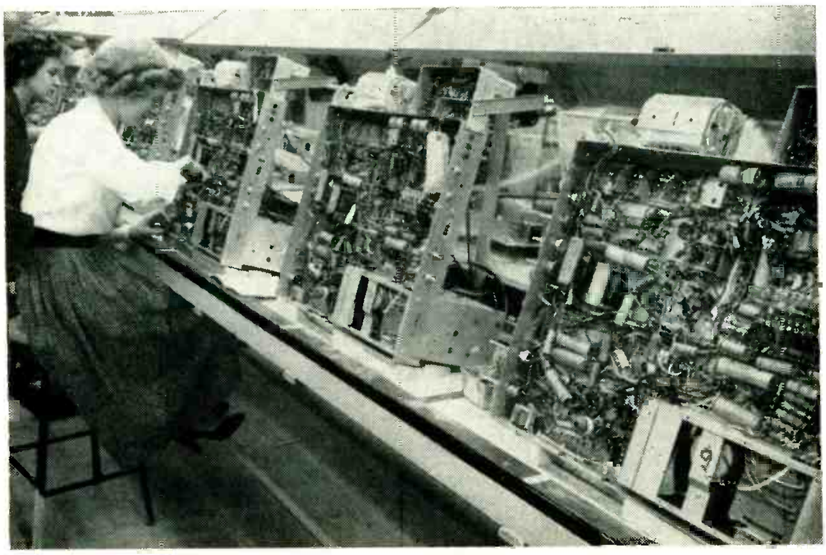
Three-tube color cameras cost $66,000 each.

▶ **Scanner**—DuMont, which shipped its first Colorvision slide scanner in December to CBS, announced that it has delivered approximately 10 scanners to equipment manufacturers as a video source for test purposes since that time.

The firm has no immediate plans for production of color cameras but is concentrating on film equipment. Introduction of 16-mm color equipment is planned for the NARTB meeting this year. Production plans for 35-mm equipment are underway.

It has been estimated that by the end of 1954 at least 180 stations of all networks will be able to broadcast color tv.

CBS-type color tv camera built by GE uses field-sequential disk. Chromacoder converts signal to NTSC color.



ASSEMBLY-LINE methods are used at Westinghouse as . . .

Production Begins on Color Sets

Westinghouse and RCA are now producing color sets on regular production basis

DURING March, two major tv receiver manufacturers, Westinghouse and RCA, announced commercial production of color tv receivers on an assembly line basis.

Westinghouse receivers are now being offered for immediate home delivery at 36 retail stores in New York City and 14 in northern New Jersey.

Suggested retail price of the set is $1,295. The firm plans to market the sets in other major cities in the near future.

▶ **Tubes**—RCA's first commercial models of color tv receivers went into production in March, three months ahead of schedule at its Bloomington, Indiana plant. A tentative list price of $1,000 has been set for the 15-inch open-face console model. The RCA production model has 36 tubes including picture tube.

The company also announced that the production of RCA tricolor picture tubes had reached a going rate of 2,000 a month, within a period of two months following FCC's approval of NTSC color.

Engineers Develop New Transistor Uses

Include audio and computer fields; new production processes appear

NEW USES for transistors include speech amplifiers built into hand microphones as well as terminal equipment and repeater amplifiers for rural carrier telephone systems. Circuits demonstrated recently indicate forthcoming application in electronic computers. Meanwhile development continues of transistors resistant to heat and moisture.

▶ **Hand Mike**—A junction transistor preamplifier built into a $95 dynamic hand microphone has been announced. Use of the preamplifier achieves an overall output comparable to a carbon microphone but the unit is more directive and avoids hissing and frying sounds. The existing microphone bias powers the preamplifier without additional connection.

▶ **Carrier Telephone**—In Americus, Ga., AT&T has installed a rural carrier system that uses 300 transistors. The system covers 26½ miles and includes three terminal units and several repeater amplifiers. Use of transistors reduces the equipment size to 1/10

(Continued on page 8)

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and requires only 1/20 the power of an electron tube system.

▶ **Computers**—An eight-stage decimal counter using junction transistors was demonstrated at a West Coast computer show and the introduction of a completely transistorized electronic computer may take place later this year.

▶ **Stabilized Germanium**—Change of transistor characteristics caused by aging or effects of surface moisture can be avoided by using germanium stabilized by heat treatment in a bath of molten potassium cyanide. In announcing this development, Sylvania also called attention to a germanium-silicon alloy, which will permit effective transistor action up to about 350 F.

DEMAND is for more accurate fee collections as

Electronics Moves In On Toll Roads

Pennsylvania Turnpike orders new toll collection equipment; other roads may follow

EXTENT to which electronic equipment can be utilized on turnpikes is emphasized by plans to equip all terminals and interchanges on the 360-mile Pennsylvania Turnpike with electronic toll equipment in the fall of next year. The Ohio Turnpike, now under completion, plans to install similar equipment. With about 2,000 miles of toll highways completed or authorized in the U. S. and at least that many more miles planned, the nation's toll roads represent a sizeable potential market for specialized electronic equipment.

▶ **Phototubes**—Recently developed by IBM, the new toll collection and audit system to be used on the Penn Pike is a combination of phototubes, specially designed weighing platforms and toll recorders that make possible greater operating efficiency, increased revenue protection and more equitable vehicle classification.

▶ **How It Works**—When a vehicle pulls up to the toll booth the operator depresses a key on the toll recorder, shown above, corresponding to the number of axles he has counted. If his count disagrees with that made by the phototubes, the toll recorder will lock. The operator may correct his error by depressing the proper axle key.

Axles are weighed separately as they pass over the weighing platform. Load cells and electronic storage units retain these weights and when the fare card is processed, the weight class is automatically punched into it.

▶ **Recheck**—At the exit interchange, equipment automatically reweighs the vehicle, comparing the weight class punched by the entrance recorder with the weight class determined by the exit classifier. It also reads the number of axles and the time.

The toll equipment will compute all revenue, compile traffic density data, total charges by account number and quickly audit collectors' daily work reports.

Electronic Management Rated Excellent

Management Institute cites firms in electronics field for management excellence in 1953

TWENTY companies in the industry are among the 348 companies in the U.S. and Canada that have been found eligible for the designation "excellently managed", by the American Institute of Management.

In all, the methods of 4,000 leading companies were evaluated by the Institute. Firms in the electronics field so designated are: AT&T, Burroughs, CBS, GE, IBM, McGraw Electric, Minneapolis Honeywell, Minnesota Mining, Motorola, NCR, Otis Elevator, Philco, RCA Sperry, Sprague, Square D, Sylvania, Thompson Products, Westinghouse and Zenith.

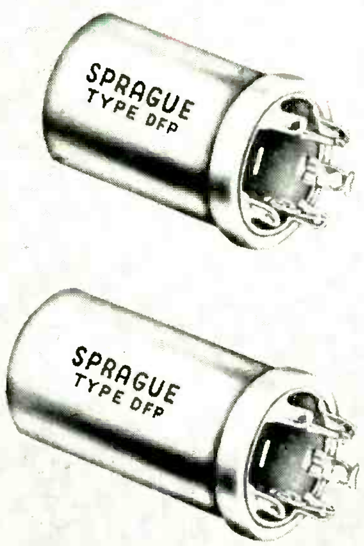
▶ **Ratings**—When auditing a management, the Institute uses a point system for rating 10 key factors. Each factor has an optimum and

(Continued on page 10)

DEPENDABILITY

is why Sprague Type DFP Twist-Loks* are the *preferred*

ELECTROLYTIC CAPACITORS



Leading television set makers rely on Sprague as their major source for electrolytic capacitors.

Stability under maximum operating conditions plus outstandingly l-o-n-g service life are the engineering reasons for this preference.

From the business standpoint, it makes good sense to deal with a supplier whose quality of product is uniformly excellent and who has the largest production facilities in the industry.

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minimum within which a company must come to be certified as excellently managed. The following table lists the ten factors with the minimum and maximum ratings:

Factors	Max	Min
Economic Function	400	300
Corp. Structure	500	375
Health of Earnings Growth	600	450
Fairness To Stockholders	700	525
Research and Development	700	525
Directorate Analysis	900	675
Fiscal Policies	1,100	975
Production Efficiency	1,300	975
Sales Vigor	1,400	1,050
Executive Evaluation	2,400	1,800

▶ **Executive Evaluation**—According to AIM this factor is most important. Some questions for evaluating this factor are: What executive personnel changes have occurred in recent years and why?

What program is followed in training promising executives? Have training programs been established on the top management level? How do executive salaries compare with the industry?

Progress Payments Clarified By Defense

FIRMS whose main business involves government orders can breathe more easily; advance payments on Defense Department contracts have been reinstated.

Contractors may now receive progress payments to cover up to 90 percent of direct labor and material costs or up to 75 percent of total costs of work done under undelivered portions of government contracts. This statement of policy by the Defense Department clears up the state of confusion which led to a stoppage of all progress payments in January 1954.

The confusion began during the Korean war. At that time, progress payments were made overly liberal; some contractors openly discussed profits already made on undelivered items. Consequently, the Defense Department asked for an investigation of progress payment policies. This was interpreted by department officials as drastic curtailment and in January, 1954, complete stoppage of progress payments was ordered.

Industry Wants Excise Tax Changes

RETMA presses for excise tax relief for monochrome sets, full exemption for color tv

DRIVE to persuade the Senate Finance Committee to revise the excise tax reduction formula approved by the House of Representatives and substitute a proportionate cut in all excise taxes and exemption for color tv is being made by the Radio Electronics Television Manufacturers Association.

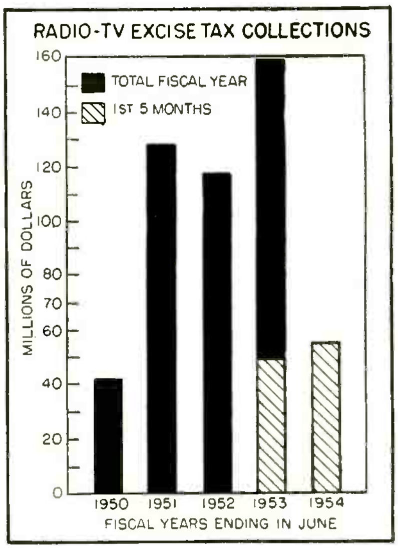
The House proposal as it now stands would place a ceiling of 10 percent on all excise taxes except those on liquor and tobacco. The present 10 percent excise tax on all tv sets would remain unchanged.

▶ **Take**—Excise taxes collected from the electronics industry in fiscal 1953 total $159.3 million, the highest take from the industry on record. Collections for the first five months of fiscal 1954, which began last June, are above the 1953 amount.

The U. S. collects manufacturer's excise taxes on 20 categories of products. Radio and tv sets and parts excise totals rank sixth on the list, led only by gasoline and products of the automotive industry.

▶ **Reduction**—According to RETMA, the electronics industry agrees with the basic objective of the House bill to increase consumer purchasing power and stimulate production through excise tax reductions but believes it can be better achieved by broadening the base of products which will benefit from the tax cut. The House bill, the association says, will reduce the excise levy on many luxury products while a proportionate tax reduction would stimulate the production of many manufactured products.

By removing the 10-percent tax on color sets, Congress will follow the traditional policy of withholding taxes on new products and will bring about an immediate reduction in the price of color receivers,



RETMA points out. It estimates that if a proportionate tax reduction is followed, the present 10-percent excise tax on tv sets would be cut to 8 percent.

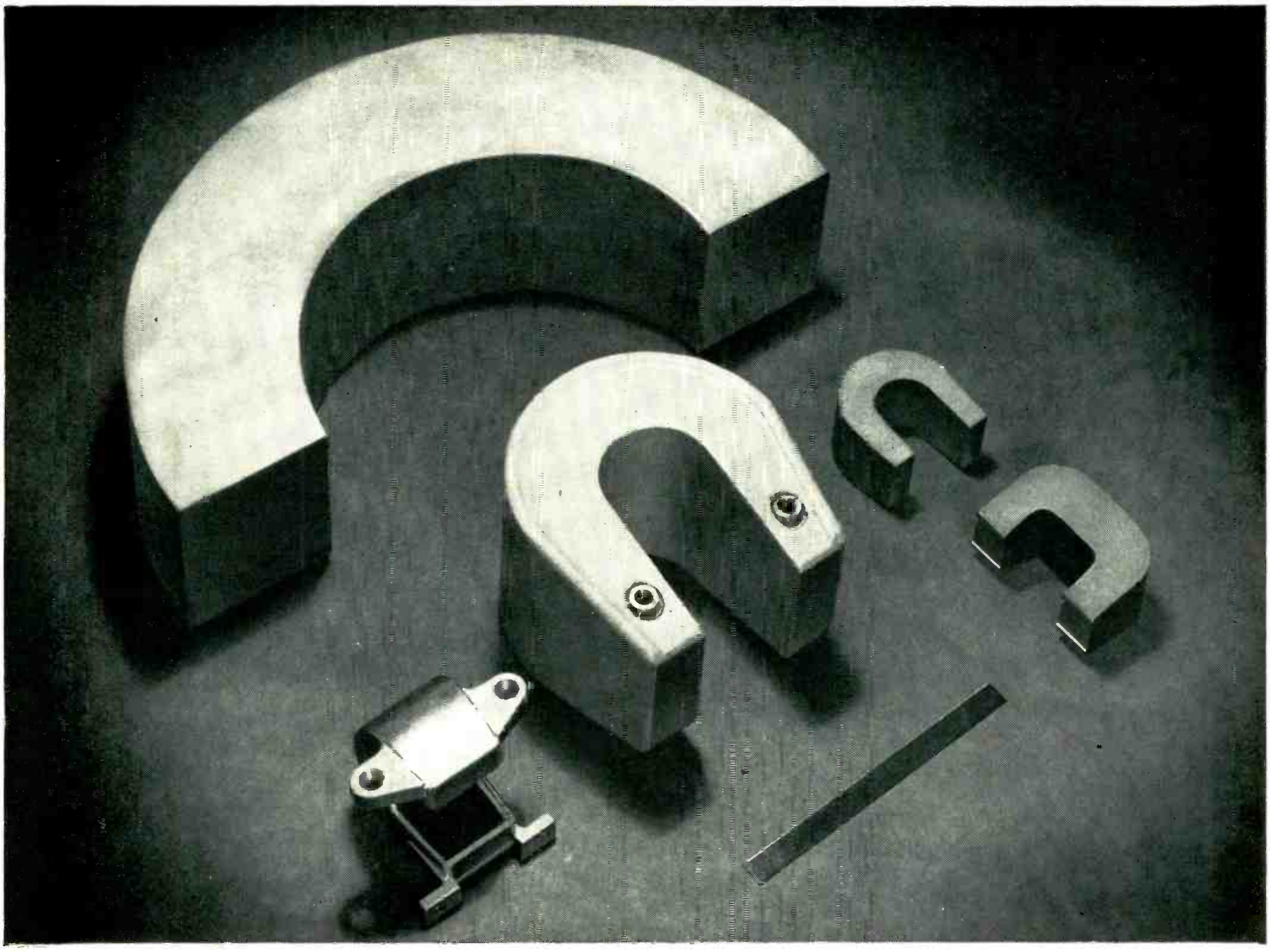
Packaging Electronics Is Big Business

Bigger tubes and sets have affected packaging expense; color may increase it

COST of the average picture tube carton is only about 60 cents. But multiply it by the number of picture tubes that were produced in 1953 and it can be seen that packaging in the electronics industry is big business indeed. Approximately $4 million was spent for picture tube boxes alone last year. Add to this the cost of cartons for complete tv and radio sets, receiving and industrial tube packaging and that for military equipment and the total cost of packaging for the industry in 1953 was a top expense item.

▶ **Tubes**—Cost is one main reason why set makers were quick to ship black and white tv tubes already installed in receivers when it was

(Continued on page 12)



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found that it could be done safely. Then tube makers were able to use larger cartons for factory use in which six picture tubes could be shipped. Only tubes for replacement sales needed individual cartons.

But color tv may bring back the practice of shipping picture tubes and sets in separate cartons to the final customer. A few companies have indicated that they plan to ship color sets that way, at least initially. Westinghouse, however, is shipping color sets with tubes already installed.

▶ **Savings**—More companies are employing packaging experts to concentrate exclusively on the operation. One electronics firm set up a packaging department to coordinate its entire packaging program and made savings of some $1 million a year.

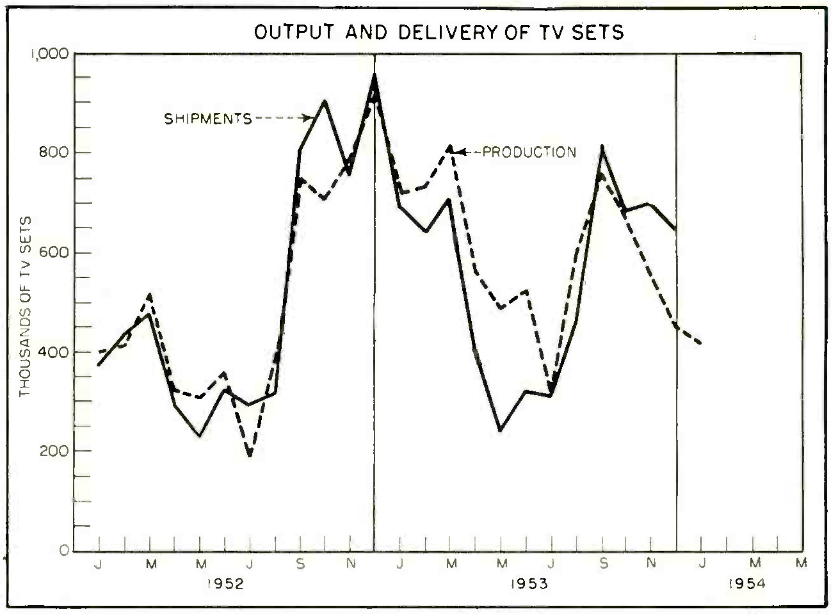
Another company, Federal Mfg., found that its military packaging costs reached $1 million in 1953. This year it decided to become a package manufacturer in an effort to convert the expense into a profitable business.

Elevator Sales Go Up

LEADING manufacturers of elevators estimate that between 60 and 65 percent of all passenger elevators sales made in the past five years have been of the automatic type that uses electron tubes. Nearly 80 percent of all passenger elevator orders currently on the industry's books are reported to be of the automatic type and the percentage is seen increasing.

▶ **Tubes**—Total annual production of passenger elevators is roughly about 4,000 banks a year, according to one estimate. In some fully automatic elevators as many as 80 tubes are used per bank or shaft. In other types which are not traffic controlled, from 8 to 10 tubes may be utilized.

▶ **Market**—Tubes are moving into old elevators too. Companies which specialize in converting elevators to automatic operation do an increasing number of changeovers each year.



TV Shipments Surpass Output

Set production in relation to deliveries indicate status of the industry's pipelines

CHANGES in tv receiver distribution channels are indicated by the varying gap between set production and shipments to dealers. As is shown in the chart, monthly deliveries to dealers have dropped less since September, 1953 than have monthly production tallies.

In December, the widest gap in two years indicated that over 200,000 more sets were shipped to dealers by manufacturers and distributors than were produced during the month. Set manufacturers and distributors were evidently loaded with inventory even before the drop in retail sales occured last year.

▶ **Concern**—The tv production cutbacks that were made during the final months of 1953 caused concern both in and outside the industry. But according to R. C. Sprague, chairman of the board of RETMA, the important fact that retail sales of sets were at virtually peak levels in 1953 has often been overlooked in the attention many people have given to output cutbacks which became necessary late in the fall to prevent further accumulation of inventories.

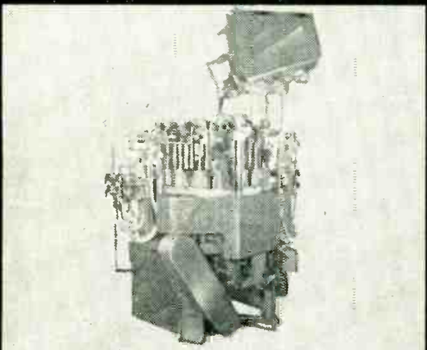
Sprague reminds that stocks of tv sets on hand at the beginning of last year were somewhat low in relation to normal demand and to the number of retail outlets; it was not until July or August that this condition was corrected. However, the drop in retail sales beginning in September was so sudden that there was overproduction for several months, with the result that November and December output had to be cut back fairly sharply, to bring total stocks down to the level of 1.9 million at the end of the year. Although this represents a substantial increase from 1.2 million a year earlier, it is not far out of line with a normal level of 1.6 to 1.8 million sets.

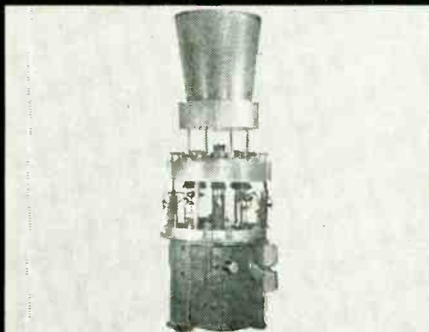
▶ **Where**—At the end of 1953, over 28.5 million tv sets had been shipped to dealers in the U. S., Hawaii and Alaska since 1946. Over 62 percent of the receiver shipments were concentrated in only eight states, all of which received over 1.25 million during the eight-year period. Leading this list was New York which received set shipments totaling 4.1 million units during the period.

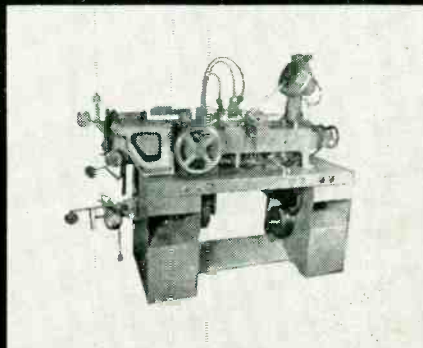
The other states where tv set shipments to dealer totaled over a

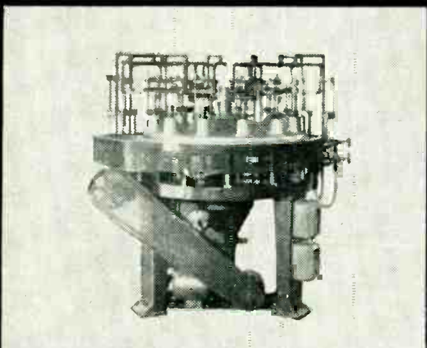
(Continued on page 14)

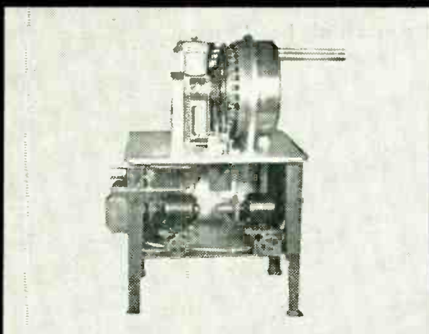
6 wonders of the age?

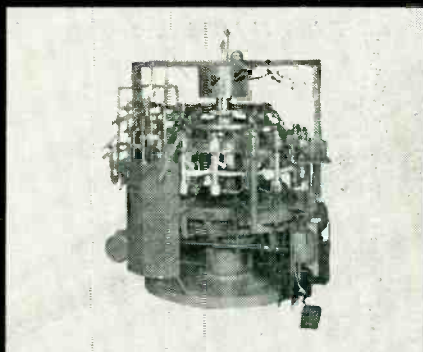

BULB MAKING MACHINE


GLASS TUBING CUTTING MACHINE
VERTICAL TYPE


LEAD WIRE WELDING MACHINE


BUTTON STEM MACHINE


GLASS TUBING CUTTING MACHINE
HORIZONTAL TYPE


AUTOMATIC EXHAUST MACHINE

Built into the automatic machinery shown on this page is knowledge of every phase of electronic tube production...

Kahle's "6 Wonders" are engineered to mass-manufacture Sub Miniature Tubes so that the burden of "knowing how" to make the product falls upon the machinery itself instead of the manufacturer. Forty-six years of intimate contact with the design and construction of custom machinery together with a long history of pioneering successes in electronics and allied industries, produce the "know-how" in such combinations of machines as the models depicted above. Kahle executives have vast experience in the actual manufacturing of the end products which such machinery produces. This cumulative knowledge is built into the machinery to solve bottlenecks and gives a smooth uninterrupted flow of the finished products.

"Built-in know how" is what makes Kahle's name the password in the electronics and glass industries where production difficulties can be overcome with custom machinery.

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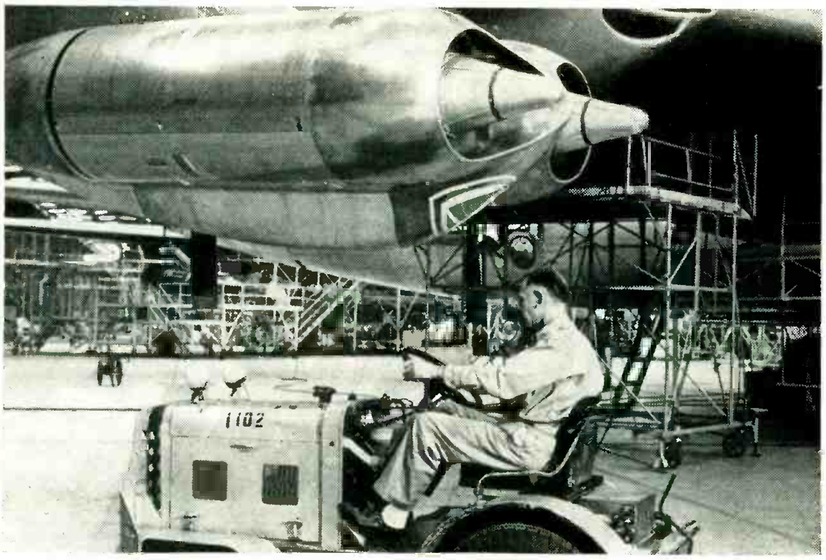
million units during the eight-year period were Pennsylvania, 2,647,-072; California, 2,611,984; Ohio, 2,236,969; Illinois, 2,048,620; New Jersey, 1,462,698; Michigan, 1,386,-542 and Massachusetts, 1,257, 588.

A total of 28.4 million sets went to dealers in the U. S. but 45,308 sets were shipped to Hawaii while 2,330 sets went to Alaska in '53.



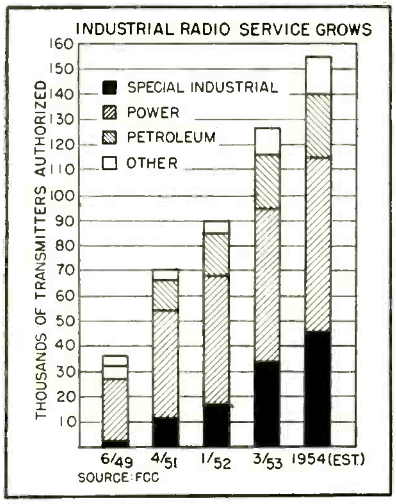
AIRCRAFT PLANTS use two-way radio for materials handling as . . .

Industrial Radio Surges Upward

Special and low-powered industrial transmitters are gaining the lead

FACTORIES have become one of the most important markets in the industrial field for manufacturers of mobile radio equipment.

As indicated in the chart, the number of special and low-power industrial transmitters authorized by the FCC for use mainly in plant areas has grown faster than all other services in the industrial classification. Manufacturing plants now rank second to utility companies as the industries number one market in this field.



There were 30,324 transmitters authorized in the special industrial field, as of March 1, 1953, comprised of 27,800 mobile station transmitters and 2,524 fixed transmitters. This represented an increase of 14,701 over the 15,615 transmitters authorized as of Jan. 1, 1952.

Authorizations for low-power industrial transmitters, all of which were mobile, increased during the period from 2,305 to 4,821. Both classifications nearly doubled their activity over the previous year's total. Extension of past rates of growth indicates that in 1954 special and low-power industrial authorizations may reach 40,000 and 6,000 respectively. Total transmitter authorizations in this classification may go as high as 150,000.

▶ **Per Acre**—Airframe manufacturers have found two-way radio useful in increasing the efficiency of materials-handling vehicles. They point out that the average airframe manufacturer uses more than 100 specialized vehicles for feeding assembly lines.

A Douglas aircraft plant which spreads over 110 acres, used 110 vehicles. North American, with a factory covering 230 acres, uses 195 vehicles. There are about 30 airframe manufacturers in business in the U. S., indicating the size of this market.

▶ **Future**—Total two-way radio sales in 1954 are estimated to approach $40 million. The sales for Civil Defense, the leading market for such equipment in 1953, are expected to hold up this year.

That electronic manufacturers are aware of this growing business is underlined by the recent entry of DuMont into the field. The company has formed a mobile communications department to develop, manufacture and market mobile radio equipment. There are now more than 20 mobile and portable receiver and 35 mobile and portable transmitter manufacturers.

Specialized Computer Applications Increase

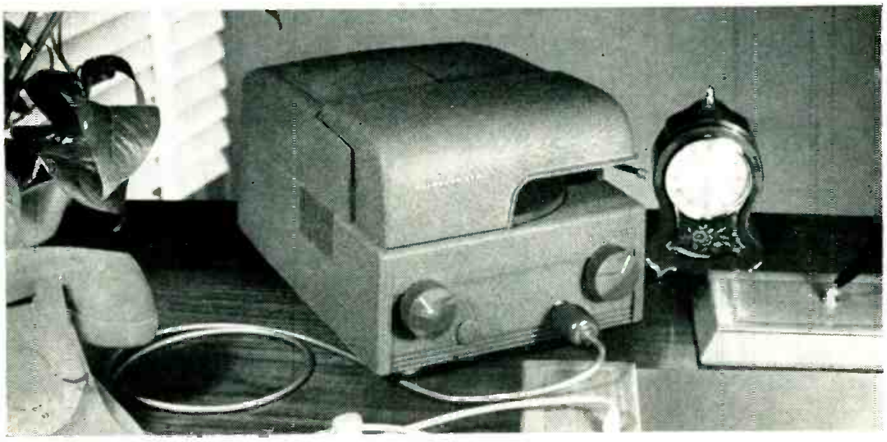
Modified input systems enhance computer utility; new design trends appear

ELECTRONIC computing equipment has been installed to calculate and record tolls on the Pennsylvania Turnpike. A computer has also been installed by the Census Bureau to read information recorded on census data sheets. Both are specialized computers rather than general-purpose machines.

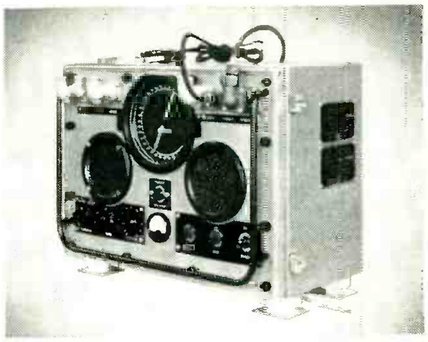
An automatic tone transmitter that can feed data into a large computer by telephone lines is under study by the Air Force and a West Coast aircraft manufacturer. The transmitter may allow a computer to be operated from several points.

(Continued on page 16)

SHOCK – VIBRATION – NOISE
ISOLATION NOTES



DICTATING MACHINE FLOATS ON BARRYMOUNTS — For noiseless operation, smooth, faultless playback, and the ultimate in protection against vibration and shock, Soundscriber Corp. chooses Barrymounts to support their new transcription unit. One more instance of how Barrymounts protect the performance of precision instruments. *Ask for data on Type 372 Barrymounts.*



COAST GUARD DIRECTION FINDER GUARDED BY BARRYMOUNTS — Where reliability of performance is really vital, sensitive electronic equipment *must* be protected from shock and vibration. Raytheon Manufacturing Company says: "We find that the high quality and effectiveness of these mountings help us assure the famed reliability and excellence of our own products." *Ask for data on Type C-2000 Barrymounts.*

ALL-METL BARRYMOUNTS PROTECT AIRCRAFT RADIO COMPASS — For safe, assured, brilliant operation, at extremely high altitudes and over a wide range of temperatures, Lear uses Barry ALL-METL vibration isolators to support the sensitive components of their "Executive" radio compass. They say: "We have chosen the Barry product because we feel it is a superior product from the standpoint of providing greater trouble-free life". *Ask for data on Type M-44 Barrymounts.*

INDUSTRIAL MACHINERY MOBILIZED BY BARRYMOUNTS — For example: a production line of eight punch presses was shut down, moved 200 feet across the plant, and was producing parts again *in a total elapsed time of 23 minutes.* No lagging, no shimming, and no walking of the machines in operation — because they were mounted on the new Leveling Barrymounts. This is *machine-tool mobility* — a new idea to make new profits for YOU. *Ask for "LOOK — NO LAGGING!"*

The wide range of Barry products and the experience of Barry engineers can help you solve shock, vibration, and noise problems in any area of military or industrial activity. Call our nearby sales representative or write directly to us.

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Other computer design trends include use of transistors, improved tape handling and design of low-cost machines.

Logistic Research Inc. is a new name in the computer business. The West Coast firm backed by Axel Wenner-Gren, Electrolux Corp. head, has sold one compter to the Navy.

▶ **Census**—Designed by the National Bureau of Standards, the Census Bureau's machine is called FOSDIC—Film Optical Sensing Device for Input to Computers. The machine uses a phototube and cathode-ray tube to sense positioned marks on census data sheets and convert the information to electrical impulses. Input to the machine is from microfilm copies of data sheets while output is on magnetic tape that can be fed directly to a computer.

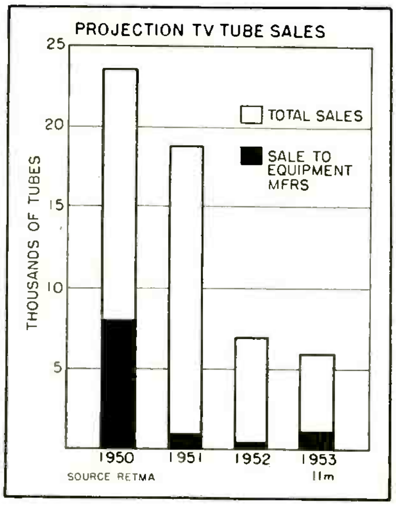
▶ **Remote Input**—Transmission of accounting data over telephone wires at 1,000 characters a minute is accomplished automatically by an IBM unit that senses holes in punched cards and converts the information to tone impulses. A West Coast plane maker is using a tone transceiver to tie one of its labs to the computing center.

Key to computer potential business is Douglas Aircraft experience. Five years ago the company devoted only 500 sq ft to its computing center. Today, 12,000 sq ft are occupied.

▶ **New Firm**—The Logistic Research computer is called ALWAC. The computer can be sold for $48,000 and is designed for the small plant—under 500 employees.

The company is also at work on a magnetic drum that eliminates friction between reading head and magnetic surface. It claims the so-called air-floating drum will store more than 2,000,000 decimal digits.

▶ **Design Trends**—Two computer circuit designs introduced by IBM at a West Coast computer show are a decimal counter using eight junction transistors and an array of ferrite memory cores hooked up to do the work of a rotating drum. Next step—a completely tubeless computer without moving parts.



Projection Television Is Down But Not Out

Home set production is virtually non-existent but there is some activity

DECLINE of projection tv is indicated in total factory sales of projection tv tubes, shown in the chart. Although renewal sales have held volume up somewhat, the sales drop has been sharp. Last year's volume for the first 11 months was only 25 percent as large as that in 1950.

Despite the black picture that these statistics indicate, there is a bright spot in projection tv trends. During the first 11 months of last year, nearly 1,000 projection tv tubes were sold to equipment manufacturers, almost double the total amount sold to this market during all of 1951 and 1952. Some of these tubes went into theater tv equipment but indications are that most of them are being used by tv set manufacturers for research and development purposes.

▶ **Color**—One major set manufacturer, in discussing the future of color tv, predicted that it would speed up the development of projection tv and indicated that the firm is continuing its activities in the projection field. Other manufacturers agree that there seems to be a place for projection in the color picture and say that they are continuing to experiment with it. However, some companies feel that projection is still passé.

Financial Roundup

FINAL profit tallys for 1953 announced by companies in the electronics field show, on the whole, that 1953 was a banner year. Continued activity of some electronic manufacturers in security transactions indicates that further expansion is planned for this year.

The following firms made profit reports in the past month:

Company	Net Profit 12 months 1953	1952
AT&T	$421,485.570	$358,493,204
Emerson 3m—1954	449,231	899,516
12m—1953	2,988,432	2.262,556
General Electric	165.727,889	151,719,905
Magnavox 6 m	1.702,000	1,546,000
Minnesota Mining	17,977.771	16.089,995
Motorola	7,076.335	7,012.700
Philco	13,068,000	11,491,000
	*5,283,000	
RCA	35,022,000	32,325,000
Stewart Warner	4,081,000	4,234,000
Stromberg-Carlson	1,667,308	1,240,746
Sylvania	9,536,181	6,960,625
Western Electric	52.604.613	47,081,705
Westinghouse	74,322,000	68,581,000

*Proceeds from sale of WPTZ to Westinghouse

▶ **Securities**—Audio Devices filed with SEC covering 10,000 shares of common stock, (par 10 cents) to be offered at market ($3.75) for the account of the selling stockholder.

Magnetics filed with SEC covering 250,000 shares of common stock to be offered at par ($1 per share). Proceeds will be used to pay part of the cost of plant and equipment facilities.

Stromberg-Carlson registered with SEC covering 72,025 shares of convertible preferred stock (cumulative-$50 par) to be offered to common stock holders at a rate of 1 preferred for 7 common. Proceeds will be used to repay $1.1 million of notes payable to banks. The balance will go into general corporate funds.

Westinghouse registered two statements with SEC. One covered 483,190 shares of $12.50 par common stock to be offered under the firm's restricted stock option plan to certain officers and other executives of the company. The other covered 200,000 shares of the $12.50 stock to be offered under an employees stock plan to employees of Westinghouse and six specified divisions.

Plastic Wire & Cable offered its

(Continued on page 18)

0.1% ACCURACY from 30 c to 100 kc

The Type 1610-A Capacitance Measuring Assembly

consists of five well-integrated G-R instruments for the accurate measurement of capacitance and dissipation factor. *Two or three-terminal measurements are possible.*

In addition to its usefulness in electrical development and testing, the Capacitance Measuring Assembly finds wide application in the dielectrics laboratory and chemical research organization. The close relationship between capacitance and dissipation factor and the physical and chemical composition of a substance make this precision apparatus very useful for investigations in countless basic research problems.

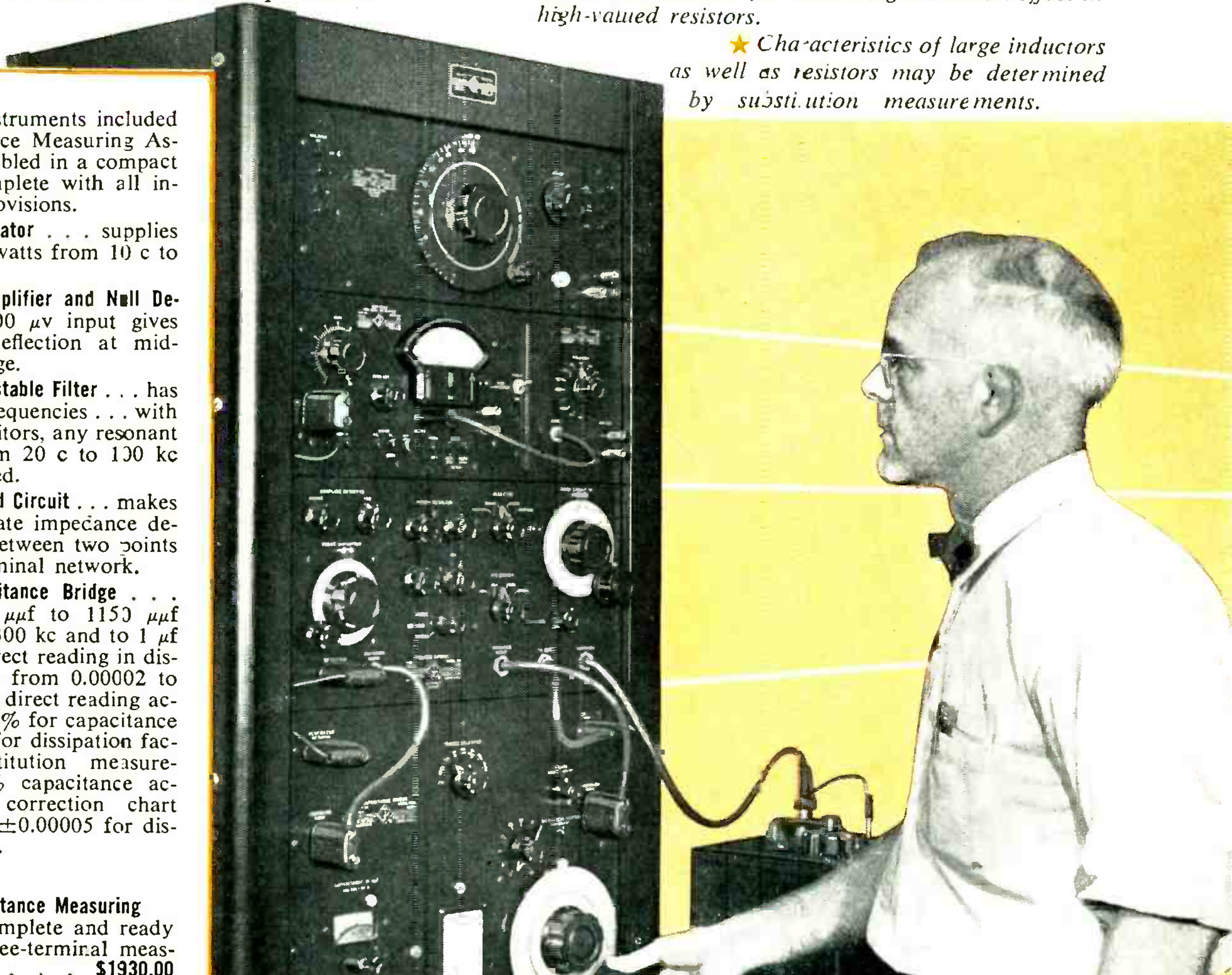
★ *This assembly is widely used in conjunction with the G-R Sample Holder to study dielectric properties of plastics and other insulating materials such as steatite, teflon, polystyrene, mica and others.*

★ *Effects of interfacial polarization at low audio frequencies and dipole polarization in polymers may be investigated.*

★ *Characteristics and effects of surface water films may also be studied.*

★ *The Capacitance Measuring Assembly offers one of the best methods for measuring the Boella effect in high-valued resistors.*

★ *Characteristics of large inductors as well as resistors may be determined by substitution measurements.*



The five G-R instruments included in the Capacitance Measuring Assembly are assembled in a compact cabinet-rack complete with all interconnection provisions.

Type 1302-A Oscillator . . . supplies up to 80-milliwatts from 10 c to 100 kc.

Type 1231-BRA Amplifier and Null Detector . . . 100 μv input gives 10% meter deflection at mid-frequency range.

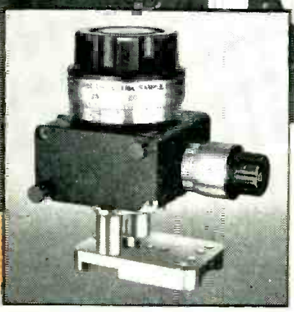
Type 1231-P5 Adjustable Filter . . . has eleven fixed frequencies . . . with external capacitors, any resonant frequency from 20 c to 100 kc can be obtained.

Type 716-P4R Guard Circuit . . . makes possible accurate impedance determinations between two points of a three-terminal network.

Type 716-C Capacitance Bridge . . . measures 0.1 $\mu\mu$f to 1150 $\mu\mu$f from 30 c to 300 kc and to 1 μf at 1 kc . . . direct reading in dissipation factor from 0.00002 to 0.56 . . . basic direct reading accuracy is ±0.2% for capacitance and ±0.0005 for dissipation factor; in substitution measurements, ±0.1% capacitance accuracy with correction chart supplied, and ±0.00005 for dissipation factor.

Type 1610-A Capacitance Measuring Assembly . . Complete and ready for two or three-terminal measurements **$1930.00**

Type 1610-A2 Capacitance Measuring Assembly . . . Without Guard Circuit, for two terminal measurements only . . . **$1635.00**



The unique Type 1690-A Dielectric Sample Holder is an accessory unit readily attached to the bridge unknown terminals. It permits precise determinations of dielectric constant and dissipation factor of practically any solid dielectric-material.

The sample holder's 2-inch diameter electrodes are ground to optical flatness and are micrometer driven for highest accuracy. The instrument is rugged, completely shielded and useful to 100 Mc and higher.

Additional Price $435.00

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Top Navigation Group Organizes For Action

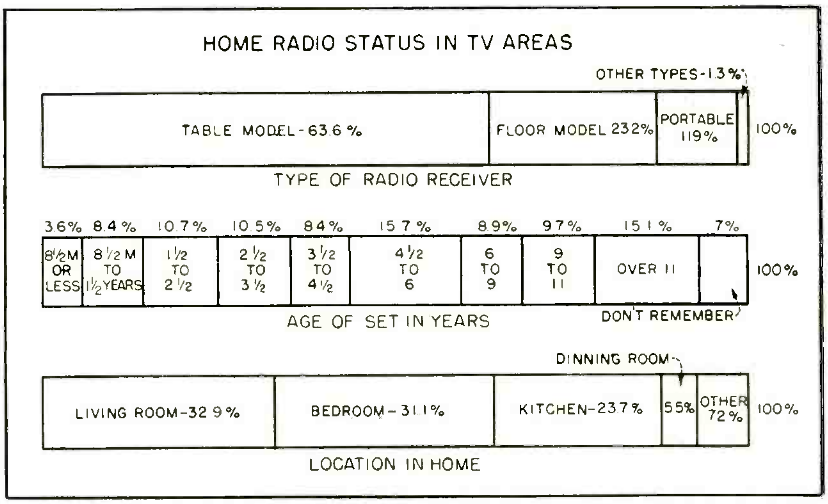
Army, Navy, Air Force and Commerce to be represented on new board

AIR NAVIGATION Development Board (ANDB) will henceforth comprise persons at a high policy level from Army, Navy, Air Force and Department of Commerce. Chairman of ANDB may be selected from outside the government. The reorganized agency's charter makes it responsible for procurement, installation and operation of navigation and traffic control aids as well as research and development of new aids.

▶ **Greasing the Wheels**—Project funds for the Board's program will come from the participating departments, rather than solely from Commerce, as in the past. Responsibility and authority are now shared equally by the Departments of Defense and Commerce.

First major evaluation job will be on TACAN, a short-distance navigation system being pushed by the military. TACAN provides a pilot with the same type of continuous bearing and distance navigational information now available from the vhf omnirange and may later be useful in commercial flights.

▶ **Personnel**—Chairman of ANDB is Donald A. Quarles, assistant Secretary of Defense for research and development. Other members are Robert B. Murray, under-Secretary of Commerce for transportation; James N. Davis, special assistant for research and development for Secretary of the Army; James H. Smith, Jr., assistant Secretary of the Navy for air and Trevor Gardner, special assistant for research and development for the Secretary of the Air Force.



STATUS and characteristics of radio are shown as . . .

Stations Rate Radio In TV Areas

Survey of the radio picture shows that sets are more than holding their own

SET MANUFACTURERS who might have misgivings about the future of radio in tv areas can find valuable and reassuring market information on the subject in a survey made by Politz Research for 11 broadcasters.

As shown in the chart, the type of receiver owned by people in tv areas is predominantly the table model. However, floor models are still popular. The living room is still the radio room in most homes and bedrooms rank second. Age breakdown of receivers in tv areas shows that over 55 percent are more than 4.5 years old.

▶ **Sales**—The survey also indicates the importance of radio replacement sales as against second set sales in tv areas: 47.3 percent of all home receivers purchased in tv areas were bought as additional sets; 35.5 percent were bought as replacements because the previous set was no longer used, and 17.2 percent were purchased as the first set.

Over 26 percent of the people who were without operating home receivers had none because the set needed repairs or batteries; 16.2 percent had none because they couldn't afford it; 15.3 percent said they watched tv instead and 12.8 percent reported that they had no use for it or didn't care for radio. A variety of reasons comprised the remaining percentage.

▶ **Expectations** — People were asked whether they expected to buy a radio receiver within the next few months. The survey, made early in 1953, showed that over 4 percent would, as an additional radio and 1.3 percent expected to, as a replacement. Total of 86.5 percent of all people surveyed did not expect to buy a set soon and 7.8 percent didn't know.

Crackdown Ordered on Illegal Diathermy

SHORT-WAVE medical diathermy machines have long been disruptive to radio communications (ELECTRONICS, p 19, Feb. 1936). More recently, they have caused interference to aircraft, police and television broadcast services.

Methods for reducing or eliminating danger and annoyance to other users of the radio spectrum are known. They include crystal

(Continued on page 20)

CHECK RAYTHEON for PENCIL TUBES

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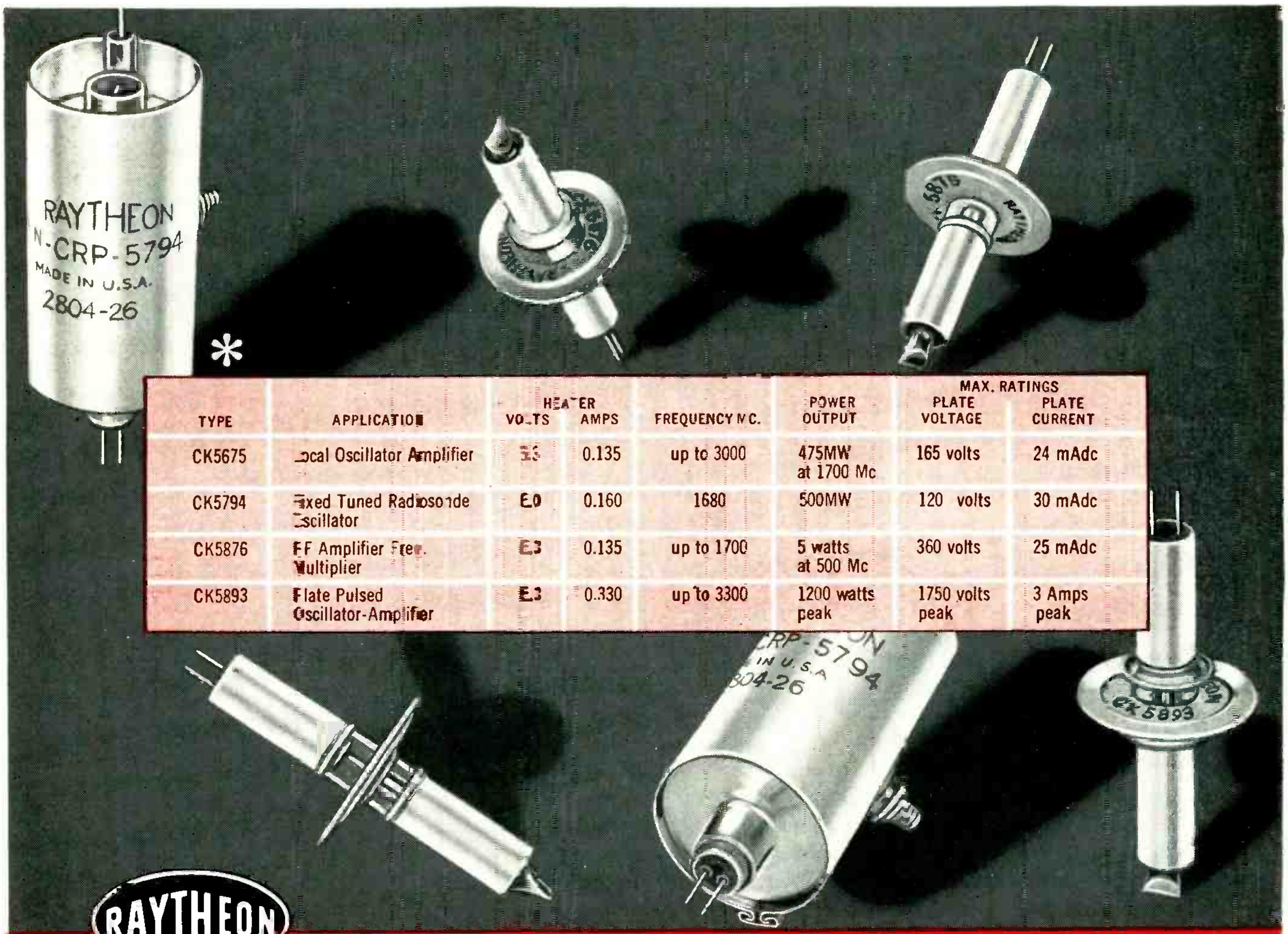
Look at the chart. Radiosonde, low Mu, high Mu — whatever characteristics you're looking for in a Pencil Tube may be found in Raytheon's line.

And every one meets RAYTHEON standards of Quality and Reliability

Raytheon is the pioneer and leader in the development and manufacture of special purpose tubes. Raytheon production, testing and inspection techniques, worked out over sixteen years of making millions of tubes, offer the soundest possible reason for specifying Raytheon Pencil Tubes.



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TYPE	APPLICATION	HEATER VOLTS	HEATER AMPS	FREQUENCY MC.	POWER OUTPUT	MAX. RATINGS PLATE VOLTAGE	MAX. RATINGS PLATE CURRENT
CK5675	Local Oscillator Amplifier	6.3	0.135	up to 3000	475MW at 1700 Mc	165 volts	24 mAdc
CK5794	Fixed Tuned Radiosonde Oscillator	6.0	0.160	1680	500MW	120 volts	30 mAdc
CK5876	RF Amplifier Freq. Multiplier	6.3	0.135	up to 1700	5 watts at 500 Mc	360 volts	25 mAdc
CK5893	Plate Pulsed Oscillator-Amplifier	6.3	0.330	up to 3300	1200 watts peak	1750 volts peak	3 Amps peak

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control to keep emanations within a definite assigned band and shielding.

▶ **Ignorance No Excuse** — Until July 1947, the radio law had inadequate teeth to bite the offender. Since then, Part 18 of the Federal Communications Commission's rules have declared illegal all medical diathermy equipment that is not type approved, certified or licensed. Penalties are prescribed for offenders.

But since doctors and athletic directors may not even know of the existence of such a regulatory body as FCC, the Commission has been understandingly lenient. Now it proposes to blow the whistle. In a sobering report, FCC cites just one instance in which inspectors tracked down an illegal machine in Miami, Fla.

Directional bearings were taken at primary monitoring stations in Kingsville, Texas; Grand Island, Neb.; Allegan, Mich.; Laurel, Md.; and Powder Springs, Ga. Signals were also traced by the secondary monitoring station in Muskogee, Okla. The illegal radiation was picked up in Oregon, Washington and California.

From now on, the Commission warns, it will issue cease-and-desist orders, seek injunctions or institute criminal proceedings.

Electronics Firms Study '54

As final reports on 1953 business are made, manufacturers reassess prospects for this year

CURRENT feeling of top management in the electronics industry about business prospects in 1954 is revealed in statements made by the presidents of seven leading companies as 1953 annual reports were announced.

▶ **Companies** — Emerson's president Benjamin Abrams pointed out that although its sales in 1954 are expected to exceed 1953's, the firm may not be so fortunate insofar as profits are concerned. During 1954, prices will have to be maintained at the lowest possible levels to maintain the interest of potential purchasers of black-and-white receivers. This, of necessity, he said, must have an effect on profits.

President Ralph J. Cordiner of GE expressed the belief that the year will bring a more favorable earnings climate than the last several years even though sales for his company are expected to decrease somewhat from the 1953 peak. Defense business is expected to make up a lower percentage of the total business volume in 1954.

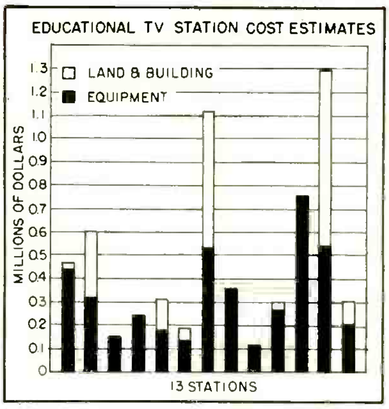
Magnavox president Frank Freimann holds an optimistic view for continuing good business during the final six months of the firm's fiscal year ending in June, 1954. He expressed the opinion that industry tv sales are likely to drop to a level somewhat lower than that achieved during the first six months.

Minnesota Mining top executives are hopeful that 1954 will be at least as good as the year just ended.

President Paul V. Galvin of Motorola forecast sales of 100,000 color tv sets in 1954 by the industry.

Sylvania officials expect competition will be increasingly intensive in the months ahead. However, they feel the company is better equipped and more effectively manned than at any previous time in its history.

Westinghouse president Gwilym Price expects a continued high rate of operation in 1954. He said the company's earnings will be effected by it's ability to maintain profit margins in the face of increased competition and that with this in mind reduction in costs and expenses had been stressed for the past year and will continue to be. Even if the level of general business activity for 1954 is moderately lower than in 1953 as has been predicted, the firm is planning for and aiming toward larger billings and profits in the coming year.



Educators Examine Television Costs

WITH 30 educational tv stations expected on the air by the end of 1954, and prospects of more on the way, universities are scrutinizing the dollars and cents side of beginning operations.

The investments required, shown in the chart, are estimates made by 13 prospective operators. Costs vary widely because in many cases land and buildings are already on hand. Equipment costs, which include expenses such as labor, also vary because in some cases items such as towers are also on hand.

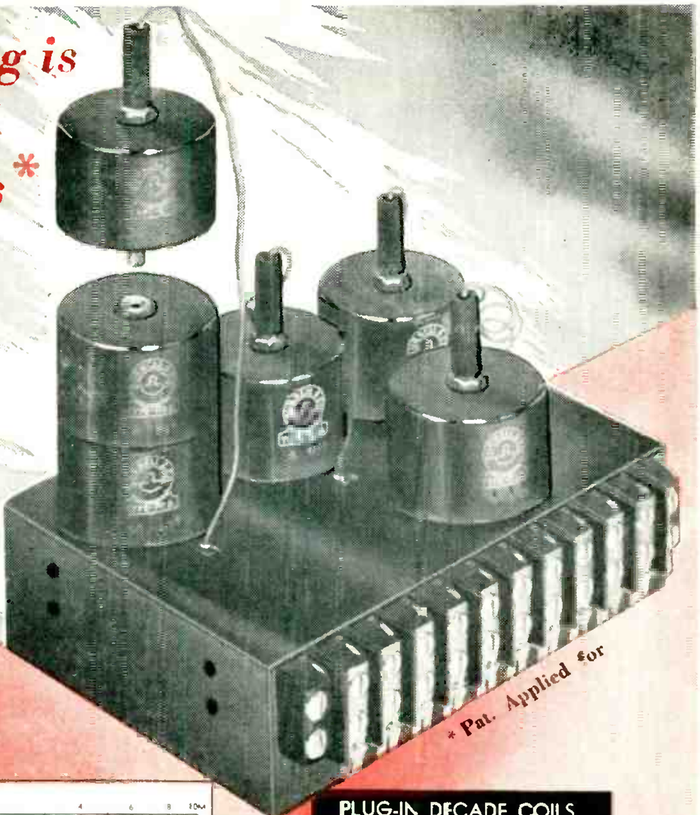
According to FCC Commissioner Doerfer, construction costs can range from $100,000 to $600,000. If a start is made from nothing, however, and a high-quality station is aimed for, the cost of construction and equipment can run at least $500,000.

▶ **Operations**—Since educational stations will be nonprofit, operating cost is also important. Some estimates indicated that $150,000 to $200,000 a year will cover all of the reasonably chargeable costs. The University of Houston which has had a station in operation the longest, is now facing the problem of station operating expenses for its second year. Some observers foresee financial troubles ahead for educational tv because of the drain these costs will put on school budgets.

▶ **Industry Help**—Educators are receiving help from private industry in defraying costs. Emerson an-

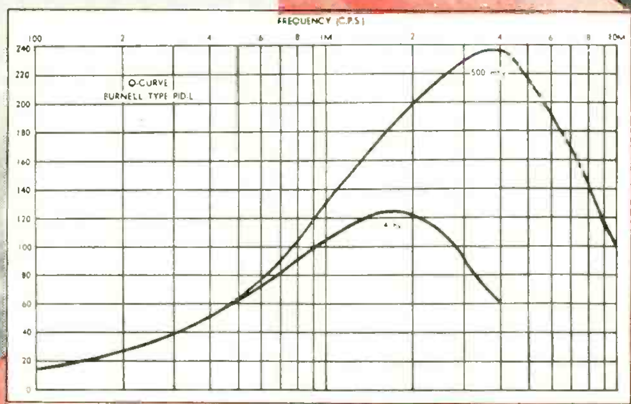
(Continued on page 22)

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



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

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



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

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

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

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

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

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

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

OTHER RECENT *Burnell* ACHIEVEMENTS IN TOROIDS AND FILTER NETWORKS

SIDE BAND FILTERS

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

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

MINIATURE TELEMETERING FILTERS

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

SUB MINIATURE TOROIDS

Toroids for intermediate frequencies of 100KC to 1 megacycle. A wide variety of coils ranging in size from 5/8 inch provides high Q in the frequency range between audio and RF.

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

Literature for all the above available on request

Write for new and enlarged 16 page catalog 102A

Exclusive Manufacturers of Communications Network Components

Burnell & Company
YONKERS 2, NEW YORK
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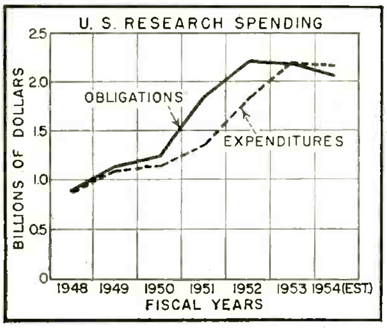
nounced recently that $90,000 of its $100,000 educational tv grant is still available. KUHT-TV is the only station so far to receive a $10,000 grant from the fund. KTHE-TV in Los Angeles is operating under a STA and will be eligible for a $10,000 award from the firm upon issuance of a permanent license.

The University of North Carolina has received help from two firms in the form of $50,000 in materials and labor on its tower, buildings and studio. Numerous private tv stations have donated use of their facilities for educational use.



U.S. Research Funds Seen Declining In '54

BUDGET estimates compiled by the National Science Foundation indicate, as is shown in the chart, that federal obligations and expenditures for scientific research and development will drop in fiscal year 1954 from those of previous years.

Research and development obligations for fiscal 1954 are estimated at $2,074 million compared to $2,187 million for 1953. Expenditures are estimated at $2,187 million for 1954 compared to $2,205 million in fiscal 1953.

With a decline in obligations for 1954 expected, a further decrease in expenditures in fiscal 1955 may result since the lag between obligations and expenditures has averaged about 9 months over the past several years. These estimates, which were revised, are still tentative since several agencies plan further revisions in their programs.

▶ **Defense**—Department of Defense estimates constitute the largest portion of the totals for both obligations and expenditures. Present figures indicate that in fiscal 1954 the department may obligate $1,556 million, including a carry-over of $142 million from previous years. Expenditures in 1954 by Defense are estimated at $1,636 million.

Tungsten Supplies Up; Prices Drop

Government and domestic sources keep the electronics industry well supplied

USERS of tungsten have had no trouble maintaining plentiful supplies of the metal for commercial products as well as government orders, despite the loss of China as a main source for the ore. Tungsten wire makers say that supply exceeds demand and new lower prices were announced by some suppliers.

Near-panic conditions prevail in the tungsten ore market. Good foreign tungsten ore is available as low as $18 per short ton but even this pre-Korean price attracts no customers. Rumors that Russia had a surplus to sell added to the confusion. Now the U. S. no longer regulates internal or domestic use although exports are still controlled.

▶ **Use**—Total U.S. annual consumption of tungsten in 1949 was 5,210 short tons. Then, in 1950, after the Korean War had begun, it increased to 6,932. Consumption in current years has remained in that area.

The electronics industry is by no means the largest consumer of tungsten. One tungsten wire manufacturer estimates that the entire industry accounts for no more than 5 percent of the total used each year. Biggest users in the electronics field are transmitting and industrial tube manufacturers and relay makers. The metal is also used in equipment for aluminizing tv picture tubes. Less than one penny's worth of tungsten is used in the average tube, a price that includes all labor and processing costs from ore to finished metal.

▶ **Sources**—The present ample supplies of tungsten in the U. S. are due largely to effective stockpiling encouragement of domestic ore production and the handling of Korean sources of supply. The U. S. controls over 60 percent of the tungsten mines in Korea. Korea became the number one source of the metal after the war began and China, which had been first, dropped to ninth place. Twenty other nations and home producers have contributed to the U. S. tungsten stockpile.

Manufacturers Review Equipment Leasing

RECENT announcement by Emerson that it plans initially to lease color tv receivers to the public on a monthly fee basis has been responsible for some study of past and present equipment leasing arrangements.

▶ **Tubes**—Some time ago General Electric announced it would lease its high-power klystron tubes for uhf transmission to broadcasters. Since then over 30 leasing arrangements have been made. At a leasing fee of about $2.50 per hour, stations can get three tubes, two for use and one spare. The fee also covers service on the tubes. The plan has worked well and it is now planned to sell the klystrons outright.

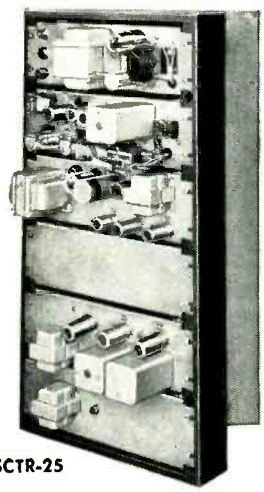
One of the early Univac computers, the installation at GE's Appliance Park, was leased by GE from Remington Rand for two years with an option to buy. With computer cost still high, leasing may continue for some time to come.

▶ **Sets**—Television sets have been rented before too. In 1948 during

(Continued on page 24)

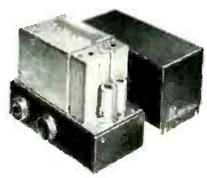
Improve Your Communications Service With Hammarlund Selective Calling

ADD PRIVACY • SPEED • QUIETNESS • CONVENIENCE



SCTR-25

FOR FIXED STATIONS

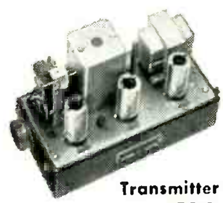


Decoder Unit
SCM-30T

Coding Unit
SCPB-30

FOR INDIVIDUAL MOBILE UNITS

Receiver Unit
FRC-1



Transmitter Unit
FTC-1

FOR FLEET CONTROL

Speeded operations, better manpower utilization, and elimination of confusion is achieved through the selective channeling of voice communications.

Hammarlund has available a wide range of tone-dialing and push-button operated systems for contacting fixed stations, individual mobile units, or fleets.

With the SCTR-25 fixed station equipment, for example, it is possible by means of coded audio frequency tone signals activated by a simple dialing operation, to selectively ring any single station on a system with as many as 126 stations. This is particularly advantageous when there are a large number of individual telephones connected to the same speech transmission channel, such as with a long microwave radio relay network. The bell at each station operates only when that station is called.

Efficiency is increased for 2-way radio equipped individual or fleet mobile units when Hammarlund Selective Calling equipment is added, since confusion caused by today's overcrowded radio spectrum and skip-distance signals are eliminated. Each receiver is activated only when it is called.

For detailed information on Hammarlund Selective Calling systems, write to The Hammarlund Manufacturing Co., Inc., 460 West 34th St., New York 1, N. Y. Ask for Bulletin 57.

HAMMARLUND

SINCE 1910

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the political conventions, companies were formed for the sole purpose of renting sets.

Conelrad Plan Extended to Aviation Services

METHODS for denying navigational aid by radio stations while at the same time providing broadcast service have already been tested (ELECTRONICS, p 5, Nov. 1953). Having successfully disposed of this phase in a hypothetical defense against enemy aircraft, the Federal Communications Commission now proposes rules for the aviation services.

▶ **Alerting**—Open to change until March 29, FCC's proposal would require all stations to maintain radio silence. Stations in communication with a CAA Air Route Traffic Control Center (ARTCC) can receive the alert by this channel. Other stations must provide a connection to a CAA circuit; keep a broadcast set (a-m, f-m or tv) continuously tuned in; monitor another station in contact with ARTCC or find some other method that will be approved by CAA.

Many stations in the aviation services will remain on the air, at least intermittently, for traffic control, Civil Defense or other approved activity.

MEETINGS

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

APRIL 6–8: Radio Component Show, Great Hall, Grosvenor House, Park Lane, London, Eng.

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

APRIL 12–14: International Symposium on Information Net-Works, IRE, ONR, AAF, Signal Corps sponsorship, Engineering Societies Bldg., New York, N. Y.

APRIL 12–14: Eighth Annual Frequency Control Symposium, Signal Corps, Berkeley-Cartaret Hotel, Asbury Park, N. J.

APRIL 12–17: Symposium On Electronics And Television, National Museum Of Science And Technology, Milan, Italy.

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

APRIL 21–23, 1954: AIEE Conference On Feedback Control, Claridge Hotel, Atlantic City, N. J.

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

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

MAY 3–6: Spring Technical Meeting sponsored by URSI and IRE, National Bureau of Standards Bldg., Washington, D. C.

MAY 3–14: The British Industries Fair, London and Birmingham, England.

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

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

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

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

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

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

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

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

JULY 16–18: High Vacuum Symposium, Committee On Vacuum Techniques, Berkeley Carteret Hotel, Asbury Park, N. J.

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

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

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

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

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

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

SEPT. 16–18: Joint Electron Tube Engineering Council, General Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

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

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

OCT. 4–6: National Electronics Conference, Hotel Sherman, Chicago.

OCT. 18–20: Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

Industry Shorts

▶ **Regulation** for licensees of low-power industrial radio services (in-plant communications) is proposed by FCC which would prohibit further use for dispatching vehicles on public highways or streets.

▶ **Curtailment** of 15-inch color tube production at GE was made because of indications that the future trend is going to be toward the larger sizes of color tubes.

▶ **Colombia** has signed contract with Du Mont and Siemens & Halske for the installation of the first tv station in Bogota, scheduled to open in June.

▶ **Over** half of the nation's tv owners (56 percent) have had their sets two or more years, according to RETMA.

▶ **Whirlwind** computer at MIT was used by five Du Pont scientists to operate, on paper, a chemical reactor in a company plant hundreds of miles away. Study resulted in a 25 percent increase in the reactor's production rate.

▶ **Sheraton Hotels** have entered the closed-circuit tv business and now offer business groups and associations a network of more than 28 hotels. An average cost per city using hotel closed circuits is $1,200.

SEVEN YEARS IN SERVICE

This Electronic Calculating Machine Is A Giant of Precision

◆ Mathematical robot with nearly 18,000 vacuum tubes does in hours what mechanical devices would require years to complete; built for war purposes, it has potentialities of interest to designers and engineers.

. . . and the large transformers were all furnished by

NOTHELFER

NOTHELFER 3 Phase Plate
Rectifying Transformer
240/125 at 12½ KVA
125
All transformers designed
for 40° rise.

THE Electronic Numeral Integrator and Computor shown above, designed and constructed in 1946 for the Ordnance Department, U. S. Army, at the Moore School of Electrical Engineering, University of Pennsylvania, is said to be the first all-electronic general purpose computor ever developed.

The design of the TRANSFORMERS among much other complex and expensive equipment, was limited by many unknown factors. However, this 3 Phase Plate Rectifying Transformer is representative of a typical installation by NOTHELFER, whose skill and experience has been instrumental in helping to solve many a difficult winding job.

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COMING IN SHARP AND CLEAR

...OVER LEAD-IN COVERED WITH "BAKELITE" POLYETHYLENE

BAKELITE Polyethylene wire covering compounds provide constant impedance, low line loss and great resistance to weather. Where these outstanding materials are specified, you see *all* the picture the antenna picks up!

BAKELITE Polyethylene compounds have superior electrical and mechanical properties that permit smaller diameters in wire and cable—for easier handling, and for weight and space savings. They hold their toughness and pliability at -70 deg. C. . . . resist deformation in temperatures as high as 90 deg. C. BAKELITE Polyethylene is light, glossy-smooth—for easier pulling and stripping. It won't festoon. It resists oil, grease, alkalies, most strong acids, abrasion, moisture and mildew. A service life of several decades is indicated by tests with the black compound.

Learn how BAKELITE Polyethylene can help you in your wire and cable problems. Complete technical data on request to Dept. UB-79. Ask for Kabelitems No. 48.

FOR LINE WIRE, SIGNAL SYSTEMS AND SERVICE DROP—wet or dry—the power factor of BAKELITE Polyethylene (black compound) is only 0.004 at 25 deg. C.; dielectric constant is 2.5. Electrical properties of BAKELITE Polyethylene Resin stay constant through a frequency range of 60 cycles to 50 megacycles. Temperatures in the vicinity of 90 deg. C. have little effect on electrical properties. Volume resistivity is so high it can be measured only by very sensitive instruments. Voltage breakdown resistance is excellent, even after long-term water immersion.

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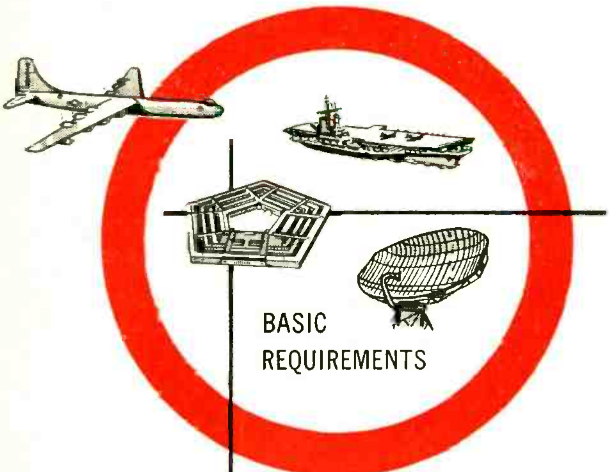
Polyethylene
WIRE COVERING

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

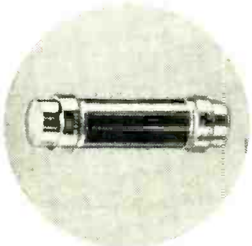
Automatic testing and recording permits accurate evaluation of greater numbers of resistors

ONLY IRC MAKES SO MANY JAN AND



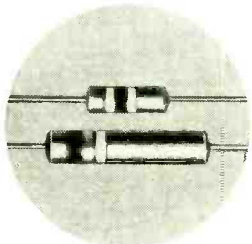
JAN and MIL Specifications are basic guideposts for electronic advancement, whether used as engineering reference points or as procurement standards. IRC's dual emphasis on mass production and frequent, accurate performance testing assures you of the highest performance standards at the lowest possible cost.

56 different IRC resistors is today's figure—all equivalent to JAN or MIL specifications. And all are standard units, available on excellent delivery cycle! If you manufacture end-equipment for the armed forces and must meet these specifications, or if you apply them as standards to your own requirements, depend on IRC for everything you need. For, manufacturing the widest line of resistors in the industry—127 different types in all—IRC is logically your best source of JAN and MIL type units.



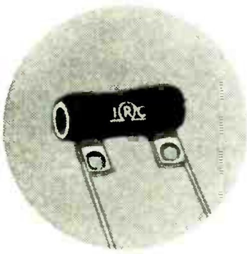
JAN-R-29 *specification*

For all requirements of JAN-R-29 Specification, Amendment 4, IRC sealed precision Voltmeter Multipliers function efficiently even when exposed to the most severe humidity. Used with 1-milliampere DC instruments, they enable voltage measurements to be made up to 6000 volts. Send for Bulletin.



JAN-R-184 *specification*

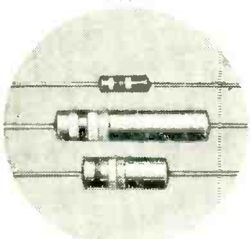
Unusually stable and inexpensive, IRC BW Wire Wounds meet JAN-R-184 Specification, Amendment 5, at ½ and 1 watt. Resistance element is uniformly and tightly wound on insulated core. Molded housing provides full insulation. Widely used in meters, analyzers, high stability attenuators, low-power ignition circuits, etc. Send for Bulletin.



MIL-R-26B *specification*

For high power dissipation, IRC Power Wire Wounds meet every commercial requirement of MIL-R-26B Specification, Characteristic G. Tubular, flat, fixed, adjustable, inductive, non-inductive, lead, lug and ferrule types provide resistors for virtually any circuit. From 5 to 225 watts. Send for Bulletin.

MIL TYPE RESISTORS



MIL-R-11A *specification*

IRC Advanced BT Resistors meet and beat MIL-R-11A Specification, Amendment 2. Filament-type resistance element and other exclusive features afford extremely low operating temperature and superior power dissipation in a compact, light, fully insulated unit. Available at ¼, ½ and 1 watt to MIL specification and 2 watts to commercial specification. Send for Bulletin.

NEW *product*

HERMETIC *sealing terminal*

Overcomes limitations of other types of hermetic sealing terminals.

Molded KEL-F* body—chemically inert to organic solvents, acids, oils, fumes.

Rugged construction—tough and resilient; withstands constant vibration.

Type HS-1 Feed-Thru Terminals, provide assured hermetic sealing for electrical and electronic components. Exclusive IRC molding Technique bonds Kel-F* to metal in a superior seal. Designed to the sealing requirements of MIL-T-27. Send coupon for full data

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

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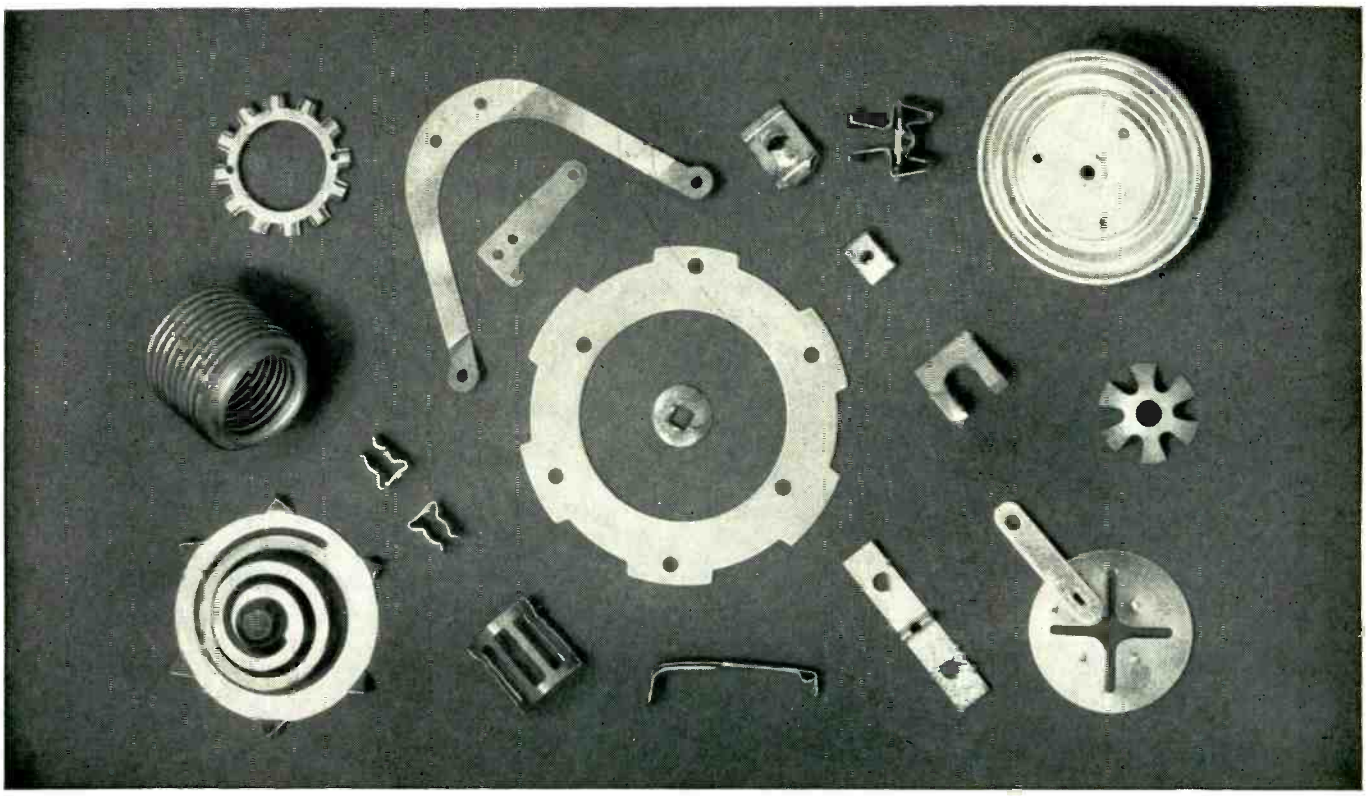

Reliability is built into many types of electrical and mechanical spring parts with Bridgeport Phosphor Bronze.

Product improvement through . . .

What do you look for in a spring material?

1. Resilience.
2. High fatigue resistance to withstand millions of flexing cycles.
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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Welded Terminals

Proved by Years of Service

NOW AVAILABLE IN ALL

OHMITE®

WIRE-WOUND RESISTORS

Provide a Perfect, Permanent Connection between Resistance Wire and Terminal

WELDED RESISTANCE WIRE

All Ohmite resistors now have the resistance wire welded to the terminals instead of soldered or brazed. This provides a resistor with superior characteristics.

WELDED TERMINAL LUG

Another Ohmite resistor feature is the welded terminal band. The band is permanently held together around the resistor tube by means of welding, providing a strong, permanent fastening.

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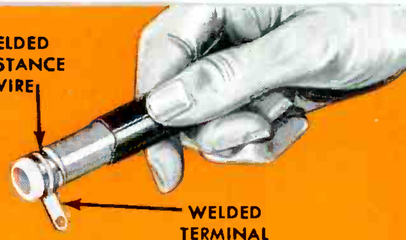
Now in All Sizes . . .

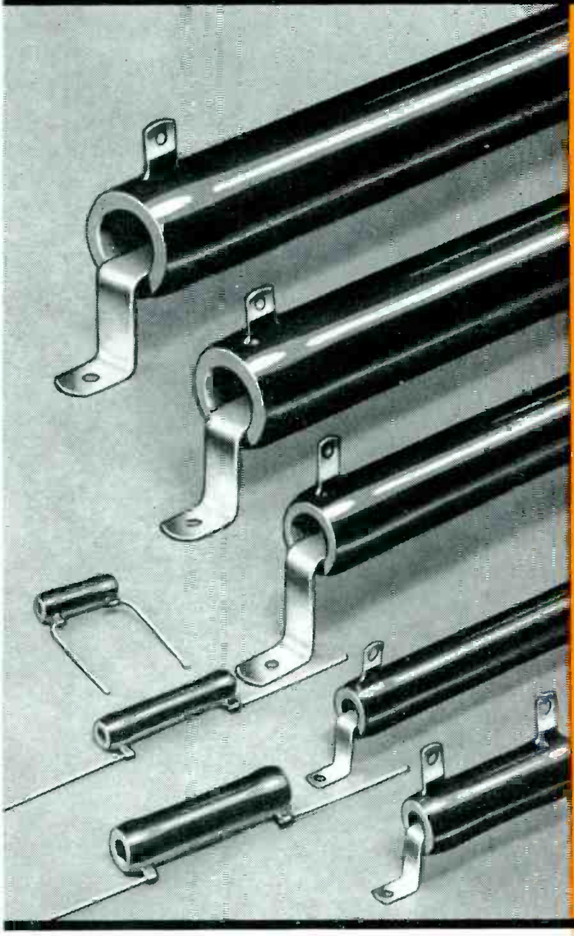
Welded Terminals

ON

OHMITE®

RESISTORS





PATENTED OHMITE PROCESS ASSURES PERFECT WELDS

Ohmite has perfected and patented a new welding technique, and has developed a method of testing every weld between the resistance wire and terminal. Thus, with every Ohmite resistor, you are assured of permanent terminal connections, unaffected by vibration or high temperatures.

PERFECT ELECTRICAL CONNECTIONS

The fusion of the metal in the resistance wire and terminal lug provides a perfect and permanently stable electrical connection. This is extremely important in eliminating noise in audio circuits or instability in other highly sensitive circuits.

HIGH-STRENGTH ALLOY TERMINALS

The terminals on Ohmite resistors are made of a special high-strength alloy, which has a coefficient of expansion that is properly related to that of the enamel, ceramic core, and wire. This keeps the terminal firmly anchored, and prevents cracking of the enamel.

The resistance wire is welded practically flush with the terminal, so there is no projection extending from the surface. Hence, the connection and terminal are as well covered and protected by the vitreous-enamel coating as the winding itself.

PROVED IN TEN YEARS OF SERVICE

Ohmite developed welded terminals more than ten years ago. Since that time, this construction has been gradually extended to cover the entire Ohmite line. Millions of these welded resistors have proved their reliability in the toughest kind of service.

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

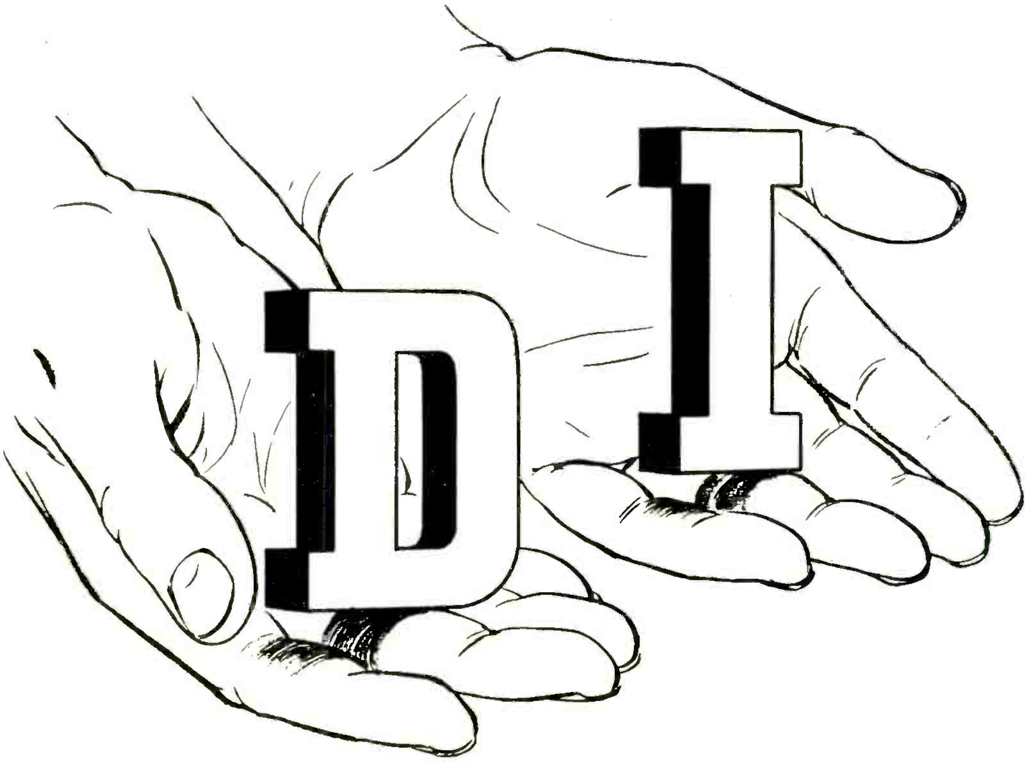
Plus THESE OTHER OHMITE FEATURES

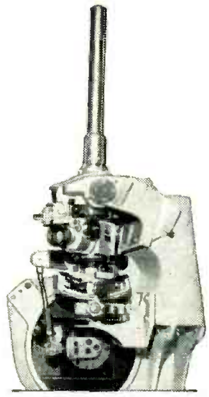
Ohmite resistors provide other important advantages, too—a superior vitreous-enamel covering, which holds the winding rigidly in place, preventing "hot spots," and protecting the winding from moisture and fumes; strong ceramic core that is unaffected by cold, heat, fumes, or high humidity; and hot tinned terminal lugs for ease in soldering. For unfailing dependability, specify Ohmite resistors.

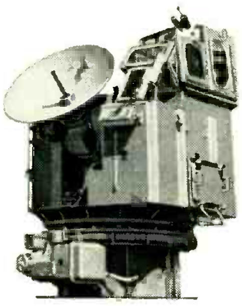
OHMITE MANUFACTURING CO.
3610 Howard Street, Skokie, Illinois (Suburb of Chicago)

Be Right with **OHMITE®**

RHEOSTATS • RESISTORS • TAP SWITCHES







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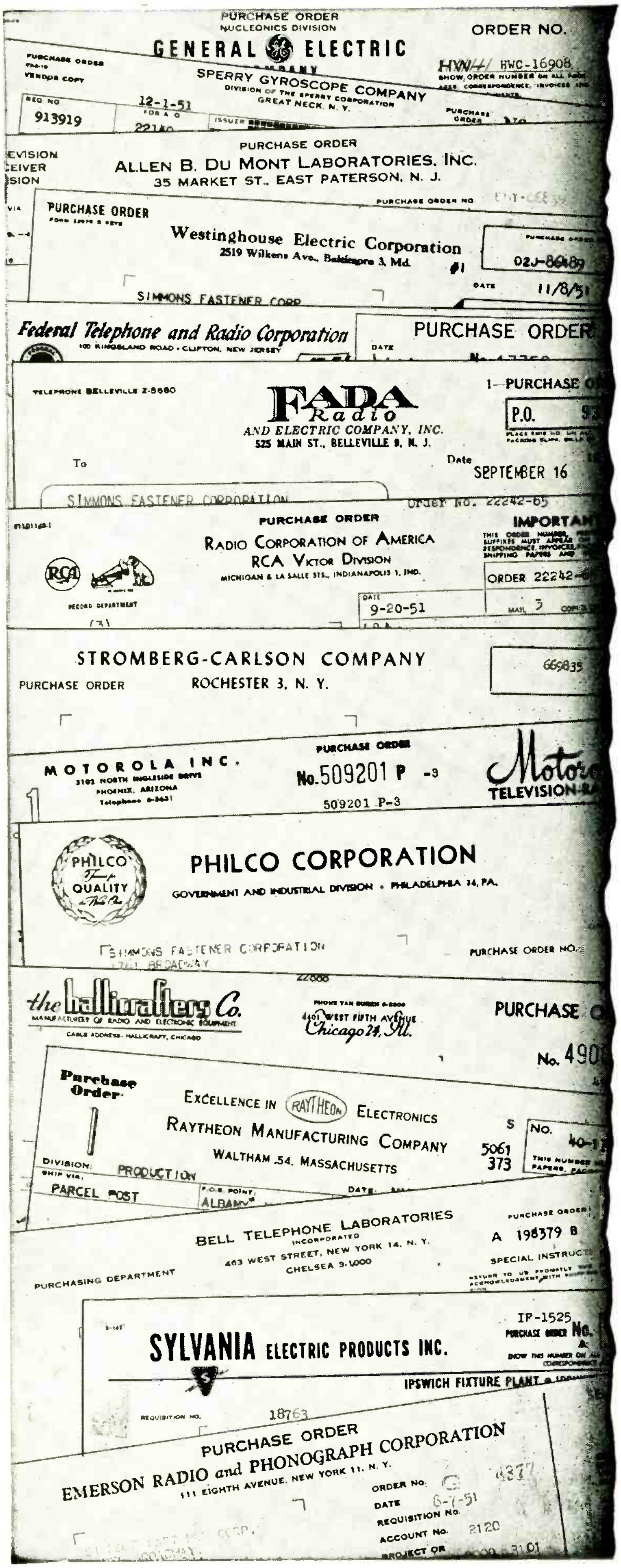

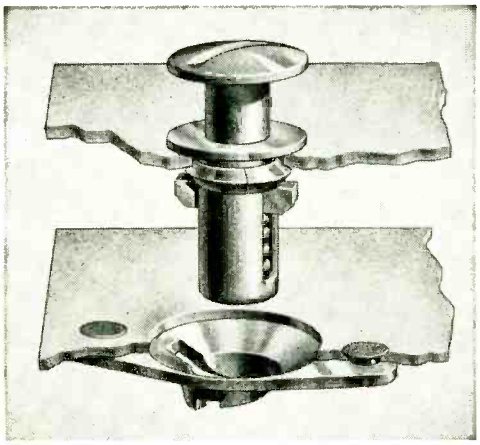

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Faster Assembly... Better Design

Why do leading electronic manufacturers order and re-order Simmons' QUICK-LOCKS in quantity? For good dollar-wise reasons:

IN ASSEMBLY—

- No special tools are needed for installation.
- Flexible mounting takes care of curved sheets and misalignment.
- Various material thicknesses can be handled.

IN DESIGN—

- Initial loads taken by helical spring. Increased loads carried on solid supports.
- 90-deg. rotation locks and unlocks fastener.
- Stud is self-ejecting when unlocked.
- Stud is self-aligning. Makes mounting and demounting detachable panels simple.

QUICK-LOCK can help reduce your assembly costs and can add unusual advantages to your designs. Send for data and samples today.

SIMMONS FASTENER CORPORATION
1750 No. Broadway, Albany 1, New York

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SPRING-LOCK
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NEW 36-PAGE CATALOG WITH APPLICATIONS.
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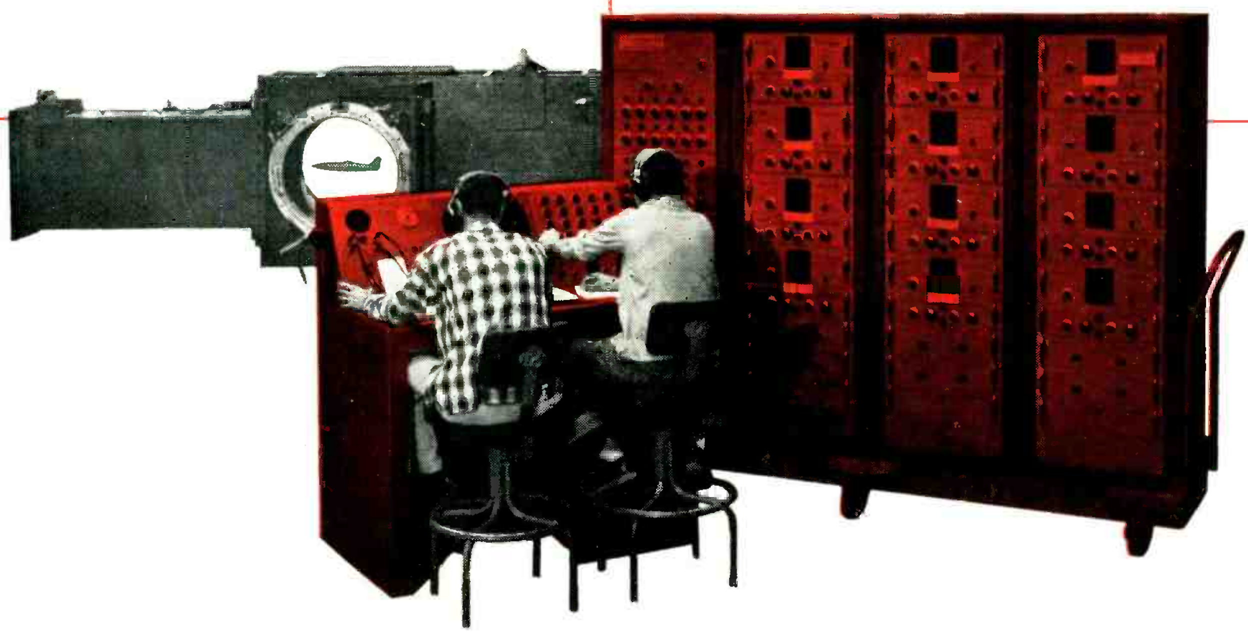
Fasteners that improve products and reduce assembly costs.

A CEC SADIC system *gives you* ***digitized test data*** *with speed, accuracy and low cost*

In many research and development projects today, full scale structures or scale models are tested and re-tested hundreds of times with only slight changes in the test conditions. Where this occurs, as it does in aerodynamic wind tunnels or rocket and reaction motor static-test stands, a staggering amount of test data may be accumulated in analog form. Before this data can be evaluated by the test engineer it must be converted into digital—i.e., numerical—form. CEC's high speed, high accuracy SADIC digital data-processing systems are unequalled for this purpose. Assembled from "building block" components to meet the precise requirements of the test project, they automatically convert analog voltages from thermocouples, pressure transducers, strain gages, etc., to digital form, with numerical readout on perforated tape, punch cards, or tabulators. Where large quantities of such test data have to be processed, automatic digital data conversion with a Consolidated SADIC system pays for itself many times over by eliminating the costly, laborious, time-wasting necessity for extracting thousands of points from an accumulation of analog plots. For full details send for Bulletin CEC-3002-X2.



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

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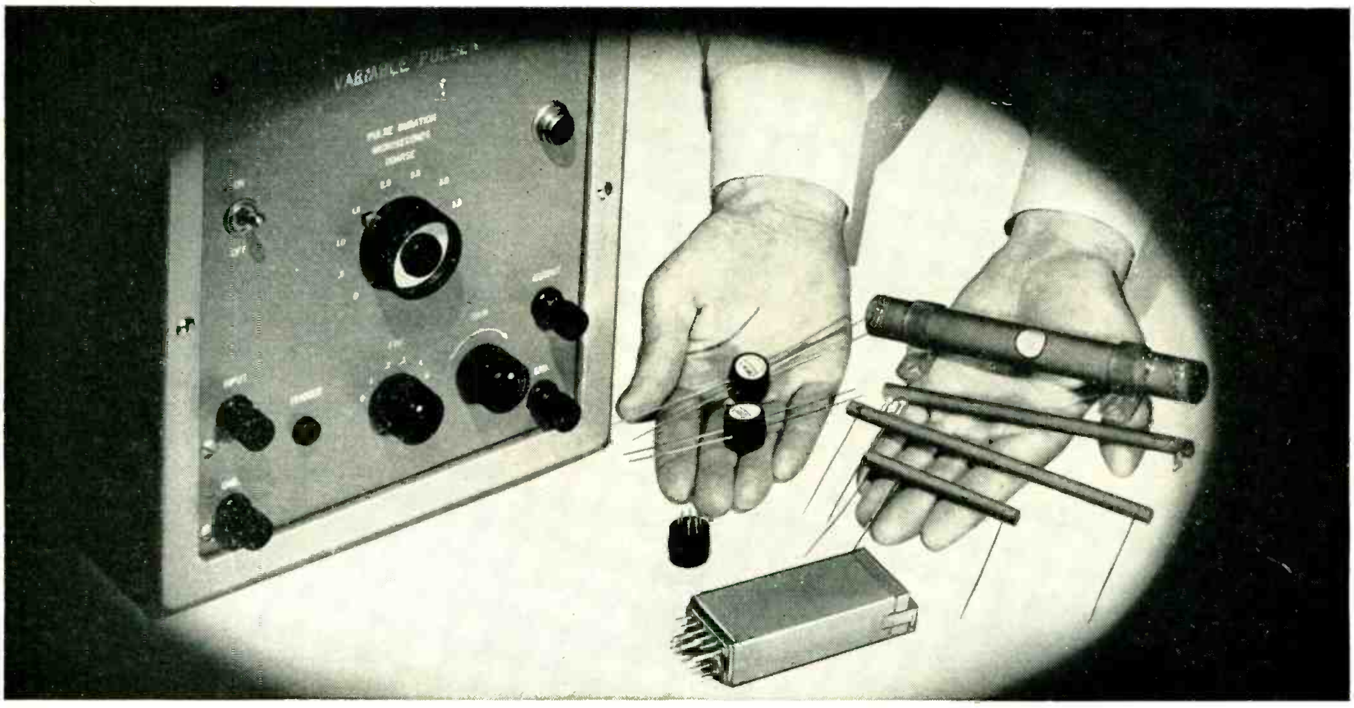


New Instruments and Components to Aid in Design and Reduce Costs

by

TECHNITROL

Unique Variable Pulser is Valuable Laboratory Aid

The Technitrol Variable Pulser is a reliable, versatile instrument which converts the output of a laboratory oscillator into a series of pulses.

One use has been as a low pulse rate device to study the response of components and networks to isolated pulses. Another use has been as a variable pulse rate source to study P.R.F. sensitivity. Still another use has been as a constant high frequency source for a temporary clock pulse generator.

Characteristics

- Wide range of frequencies from 2 cps. to over 2.0 mcs.
- Pulse characteristics optimized with rise and fall times approximately 0.04 μs. and 0.06 μs. respectively.
- Duration of pulse variable from 0.2 μs. to 5.0 μs. in steps of 0.1 μs.
- Accurate, stable pulse duration controlled by electric delay lines.
- Amplitude continuously variable without distortion from 0 to 45 volts.
- Trigger pulse precedes output pulse to synchronize oscilloscopes, etc.

Tiny Encapsulated Pulse Transformers Wound to Your Requirements

Technitrol Pulse Transformers are wound on ferrite cores and cast in resin to form a ¾" sealed unit.

Type TE has 2-inch pigtail leads of No. 20 wire. Type TP has 7-pin plug-in for miniature tube sockets. Lends itself admirably to printed circuits where holes can be drilled in the circuit board, the transformer plugged into these and the pins soldered to the circuit leads on the side opposite the body of the transformer.

When writing for information Specify application and requirements

TECHNITROL

ENGINEERING COMPANY

2751 North Fourth Street

Philadelphia 33, Pennsylvania

Very Compact Delay Lines Designed to Fit Your Need

A Technitrol Delay Line—with not more than ¼" diameter and 6¼" length, or in a package—will be designed for your particular circuit application. A variety of mountings offers you a wide choice.

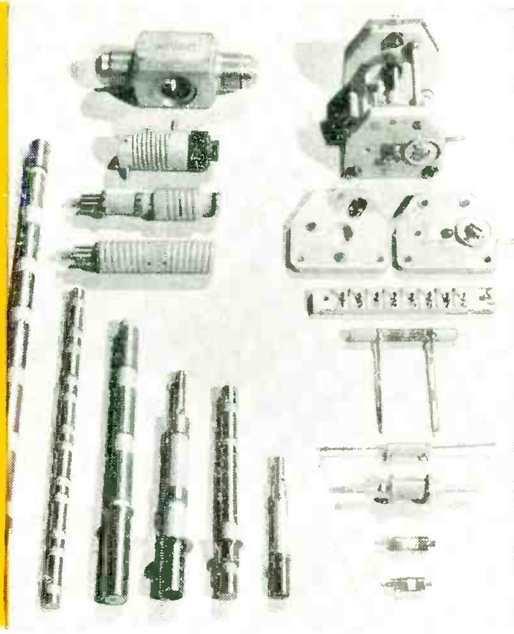
- Delay: 0.01 to 1.6 μs.
- Characteristic Impedance: 400 to 2500 ohms.
- Wide Frequency Response: 0.5 μs. at 1200 ohms.

  3 db down at 5 mcs
  6 db down at 8 mcs
  10 db down at 10 mcs

  Continuing intensive research and development is expected to make available even greater band-widths.
- Linear Phase: to 9 mcs and beyond

The continuously wound Technitrol Delay Lines provide minimum pulse distortion and are extremely stable with temperature variations. A covering protects the winding from abrasion and mechanical damage.

ceramics and metal are permanently and accurately combined



The metal bands on the rotor shafts shown at the left, above, are concentric with the shaft to within 0.001 in.

Stupakoff assemblies

Your production procedure is simplified when you use high-precision Stupakoff ceramic-to-metal assemblies. Extensive experience in the field of electrical and electronic ceramics, thorough familiarity with methods of metallizing, and the use of modern precision manufacturing methods insure the high quality and uniformity of Stupakoff Assemblies.

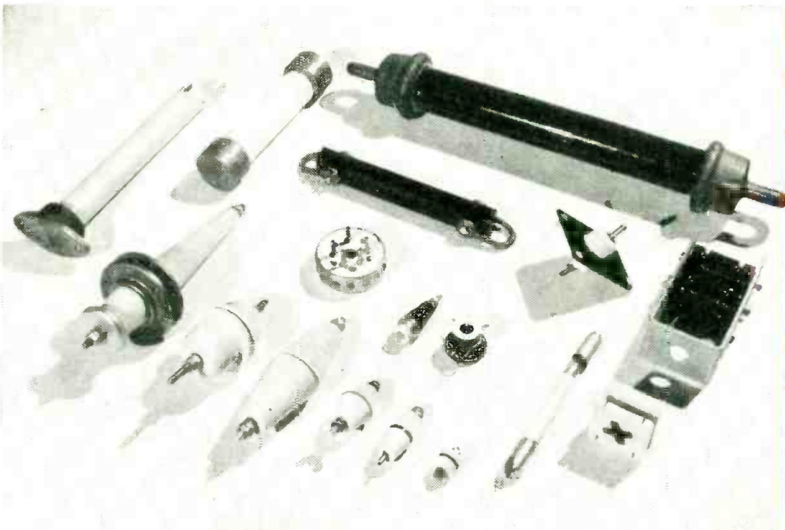
Among the assemblies made by Stupakoff are: rotor shafts, strain and spreader insulators, stand-offs and trimmers. Ceramic bodies are specially formulated for the intended service; metals used include silver, copper, brass, stainless steel and monel. Stupakoff's broad experience in this field insures the selection of a method of assembly best suited to meet service conditions.

A few types of Stupakoff Ceramic-to-Metal Assemblies are illustrated in the photographs on this page.

STUPAKOFF CERAMIC & MANUFACTURING COMPANY

LATROBE, PENNSYLVANIA

Some of the larger types of Stupakoff metallized ceramic parts.



Small metallized ceramic parts are accurately made and dependably uniform.

Want more information? Use post card on last page.

WIDE RANGE

FAST-PULSE GENERATOR

PG-200A
Pulse Generator
PGA-210
Range Extenders

SPECIFICATIONS

PULSE POWER

- Amplitude 100 volts open circuit
- Continuously variable over a range of -10 db
- 50 db attenuation in steps of approx. 10 db
- Driving impedance 50 ohms or less
- Max. average current (50 ohms load) 0.1 amp. for pos. pulses, 0.07 amp. for neg. pulses
- Max. recurrence rate at least 20,000 pps
- Max. duty cycle 50%, min. pulse interval (trailing edge to leading edge) approx. 40 µs

PULSE WAVEFORM

- Rise and decay times 0.03 µs or less (10% to 90% amplitude)
- Crest and base line overshoots and ripple less than 5% of average pulse amplitude
- Duration calibrated 0.1 to 50 µs, accuracy below 5000 pps within 5% or 0.1 µs whichever is greater, accuracy above 5000 pps subject to additional 0.3 µs error, min. pulse width less than 0.05 µs (50% amplitude)

PULSE POSITION

- Delay after external sync signal fixed at approx. 10 µs or adjustable from approx. 20 to 70 µs
- Advance or delay with respect to sync out trigger calibrated 0.1 to 50 µs, accuracy below 5000 pps within 5% or 0.1 µs whichever is greater, accuracy above 5000 pps subject to additional 0.3 µs error

features

- **DURATION AND POSITION .05 TO 1000 µs**
- **RISE AND DECAY TIMES CONSTANT .03 µs**
- **SINGLE PULSES TO 20,000 PER SECOND**
- **100 VOLTS, 50 OHMS DRIVING IMPEDANCE**
- **CALIBRATED WIDTH, POSITION AND RATE**
- **TRIGGER OR SINE WAVE SYNCHRONIZATION**
- **NEGLIGIBLE INTERACTION OF CONTROLS**

RANGE EXTENDER

- 19 additional time increments of 50 µs each
- Continuous calibrated coverage from 0.1 to 1000 µs, accuracy within 5%
- Plugs into top of Pulse Generator directly above position or duration control

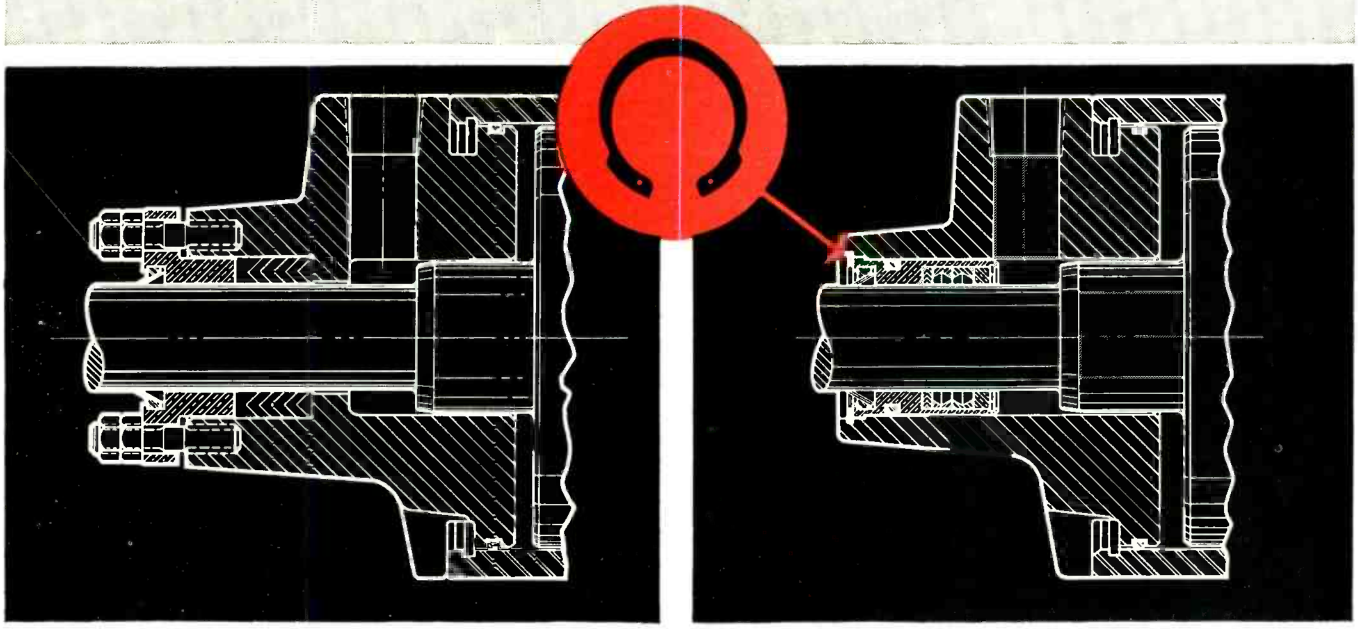
SYNCHRONIZATION

- Externally by almost any 5 volt waveform from essentially 0 to 20,000 per sec.
- Internal single pulses, power line freq. or adjustable from 20 to 20,000 pps
- Recurrence rate meter, accuracy within 5%
- Sync out trigger 50 volts, 1 µs duration

TELETRONICS LABORATORY INC.

54 KINKEL STREET, WESTBURY, LONG ISLAND, NEW YORK

Waldes Truarc Ring Saves $2.84 Per Unit, Cuts Labor-Time and Materials in Hydraulic Packing Unit



OLD STYLE stuffing box required skilled worker to install packing rings one at a time, then adjust packing glands by trial and error. Disassembly was equally difficult, time-consuming and costly.

NEW Monopak Cartridge is smaller, lighter, streamlined and installed with one Truarc Retaining Ring. Disassembly and reassembly with new cartridge takes unskilled worker just 1 minute.

Hydraulic Accessories Company of Van Dyke, Michigan, uses a single Waldes Truarc Inverted Ring (internal series 5008) to hold Monopak Cartridge in cylinder head.

New design eliminates costly machining and saves 2⅛ lbs. of material. Re-design with Waldes Truarc Retaining Ring reduces stuffing box diameter from 3½" to 2⅞", and reduces length from 5⅞" to 4⅜". Allows savings in assembly, adjusting and testing.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS PER UNIT

MACHINE TIME SAVED:	
Chucking, facing and boring	$ .72
Drilling and tapping 3 holes	.18
Drilling and counterboring 3 holes	.12
Assembling, adjusting, testing	.90
MATERIAL SAVED:	
1½ lbs. cast iron	.30
½ lb. bronze	.23
3 studs	.36
3 nuts	.03
TOTAL	**$2.84**

Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

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

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

See the Waldes Truarc exhibit at the A.S.T.E. Show, April 26-30. Booth No. 424, Precision Hall.

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

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

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

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print) E-046

Name............

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Company............

Business Address............

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

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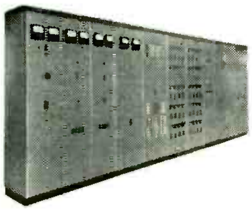
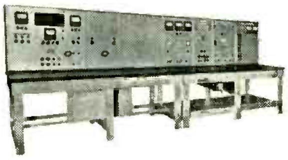
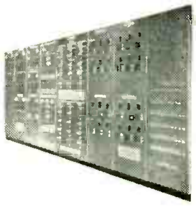

ARMSTRONG CORK CO.


BELL AIRCRAFT CORP.


NASH KELVINATOR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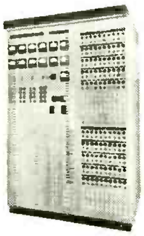
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ABERDEEN PROVING GROUNDS

STANDARD

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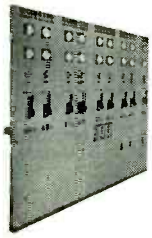
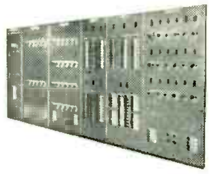
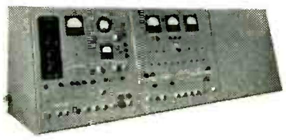

LOS ALAMOS
PROVING GROUNDS


RADIO CORPORATION
OF AMERICA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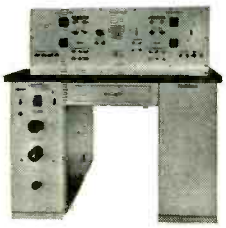
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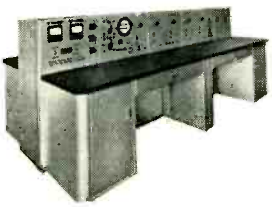
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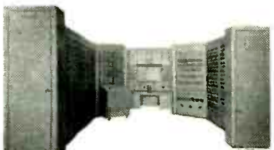
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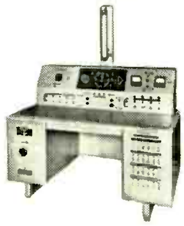
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The STANDARD ELECTRIC TIME COMPANY

97 Logan Street • Springfield 2, Massachusetts

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Another **FIRST** from -*hp*-!

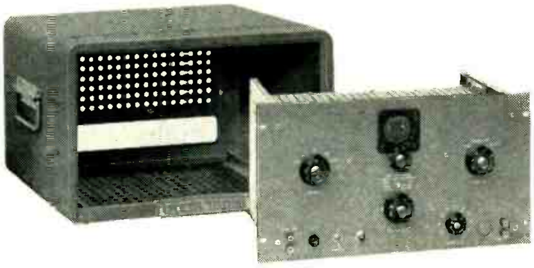
Standard test instruments mounted exactly as you want them!

- **all-metal cabinets**
- **relay rack**
- **end frames**

-*hp*- 100D Frequency Standard in streamlined metal cabinet now offered with -*hp*- instruments

Now you can buy -*hp*- instruments mounted any of three ways, and, later on, change to any other mounting you wish. This new versatility means greater utilization of your -*hp*- instruments, and can also increase the flexibility of your entire instrument setup.

Cabinets. -*hp*- instruments having the standard 10½" x 19" panel are now available in standardized -*hp*- AC 44 aluminum-and-steel cabinets. Equipped with sturdy carrying handles, these



cabinets give your -*hp*- instruments greater protection, better ventilation, and a clean, rugged, modern appearance. Either the separate back cover or the cabinet itself can be removed quickly and easily. Cabinets are finished in wrinkle grey matching the -*hp*- grey baked enamel panel faces. -*hp*- AC44 cabinets are now available with the following instruments when factory shipment is made: -*hp*- 100C,D, 202A, 202B, 205A,AH,AG, 206A, 212A, 330B,C,D, 520A, 522A,B, 624B, 650A and 712B. Model AC44 Cabinet, with instrument, $15.00; separately, $25.00.

End frames. To increase flexibility and convenience of -*hp*- instruments for bench use, -*hp*- Model 17 End Frames are offered. These frames are of heavy gauge aluminum, equipped with sturdy carrying handles and finished in -*hp*- grey baked enamel. They fit all late model -*hp*- instruments with panel size 10½" x 19", and may be attached in moments. -*hp*- 17 End Frames, $7.50 set.

Rack mounting. Many -*hp*- instruments are basically rack mounting and can be installed directly into 19" relay racks. Many other -*hp*- instruments can be equipped for relay rack mounting at slight additional charge. A complete list of instruments available for rack mounting will be sent on request.

Smaller -*hp*- instruments, too, are now being delivered in new, streamlined cabinets. -*hp*- 512A Frequency Converter, illustrated, shows the rugged, lightweight metal cabinet now offered with such instruments as -*hp*- 200AB, 200CD, 410B and 715A.

Write today for bulletin listing all -*hp*- instruments now available with new cabinets and other mounting options

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Field representatives in all major cities

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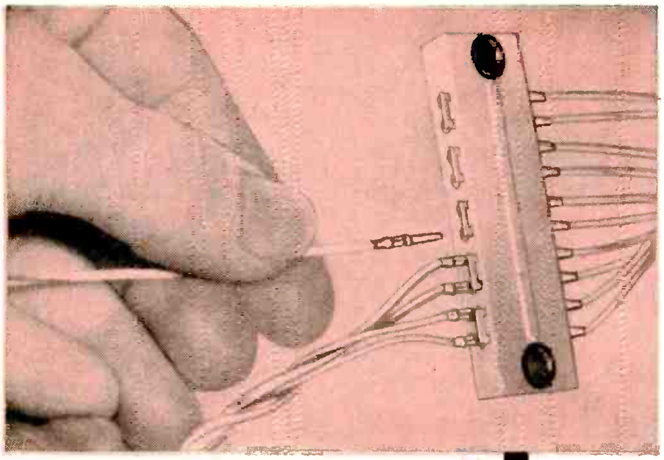
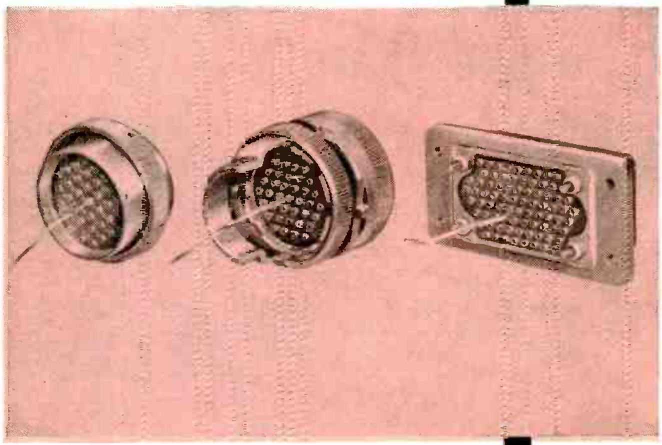


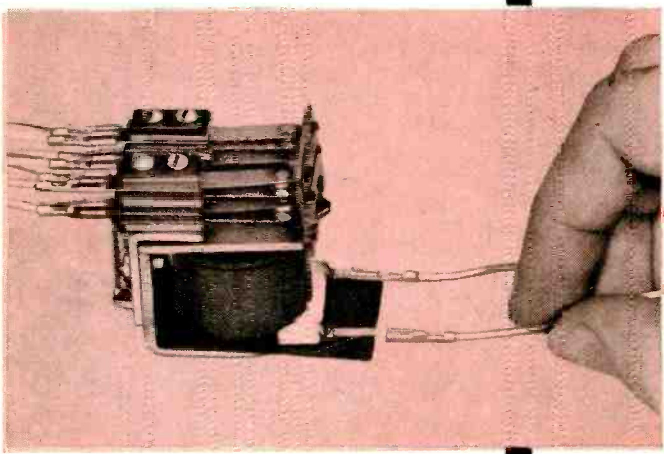
BASIC 10 CONNECTOR TAPER-BLOK WITH DUAL CONTACTS

Photo shows TAPER-BLOK with A-MP TAPER PINS in place. Strip measures only .610" x 2". Blocks, made of NYLON 10001, can also be stacked to accommodate hundreds of circuits.



TAPER PINS FOR MULTIPLE CONNECTORS, AN AND OTHER TYPES

Amphenol, Cannon, Continental and Winchester Connectors now are available with tapered receptacles for A-MP self-locking TAPER PINS. Saves over 80% of your wire assembly time and provides uniformly higher quality connections at lower cost.



TAPER TAB RECEPTACLE APPLICATIONS

More and more flat tabs on relays, switches and other components are being tapered to receive A-MP TAPER TAB RECEPTACLES. Fast easy assembly reduces costs and provides higher quality connections.

NEW AMP MINIATURE TAPER-BLOK

For AMP Taper Pins

(Wire Ranges: #26 to #16)

NEW TAPER-BLOK FOR A-MP'S TAPER PINS HELPS YOU SAVE SPACE AND WEIGHT, SPEEDS UP WIRING ASSEMBLY, SIMPLIFIES DESIGN, AND REDUCES COST!

The TAPER-BLOK shown full size at the right has receptacles for 1000 connections, yet measures only 4" x 5" x ⅝"! Receptacles are designed to receive A-MP self-locking Taper Pins which can be easily pushed in place with A-MP's CERTI-LOK measured energy insertion tool.

Extremely high contact pressure assures dependable, uniform, low resistance connections for electric and electronic circuits.

Assembled TAPER-BLOKS are available in 10 and 20 connector sizes with single or dual receptacles. TAPER-BLOK strips can be assembled by stacking to provide the number of connections required for your design. Write for specific information and latest prints.

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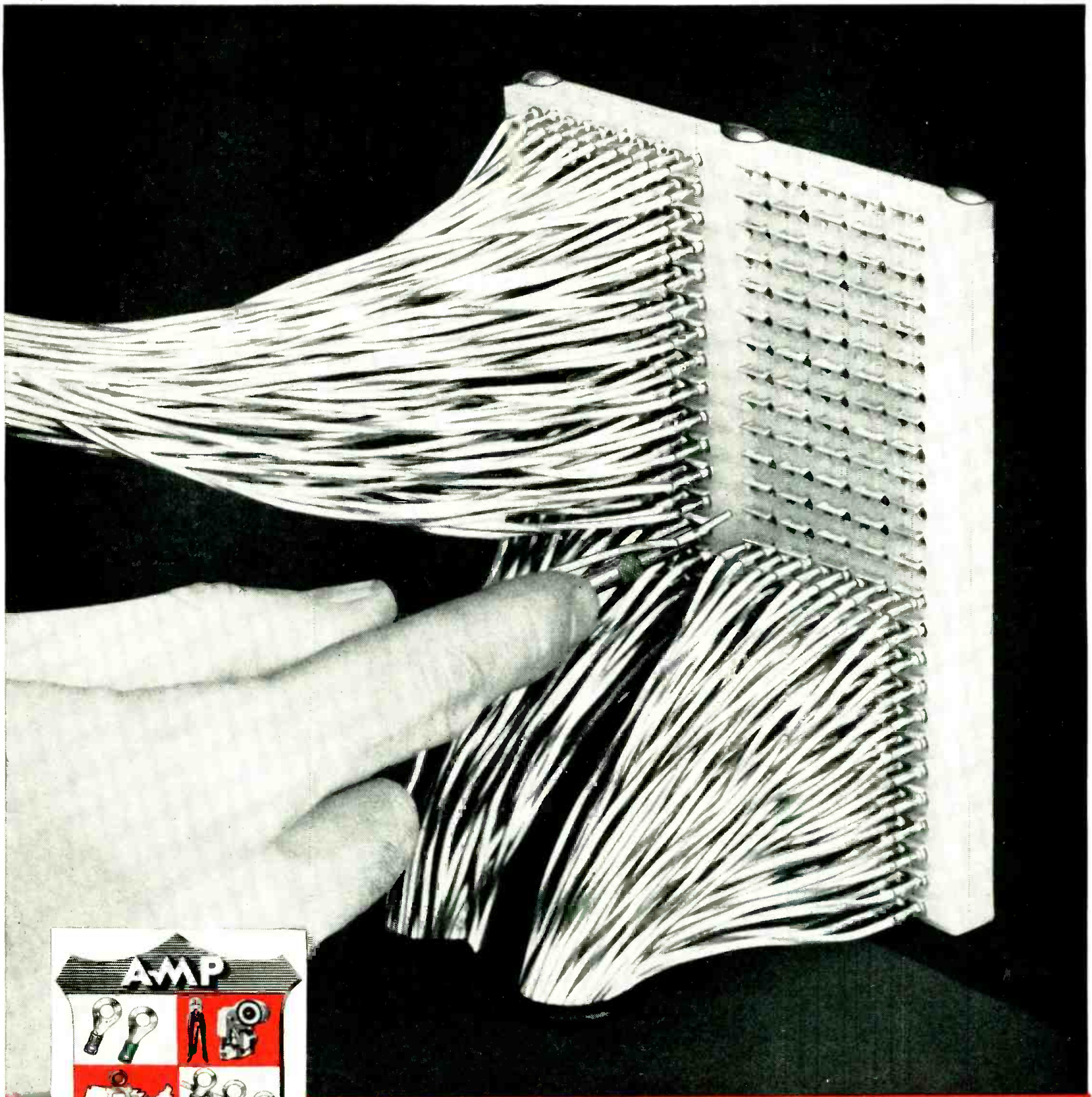

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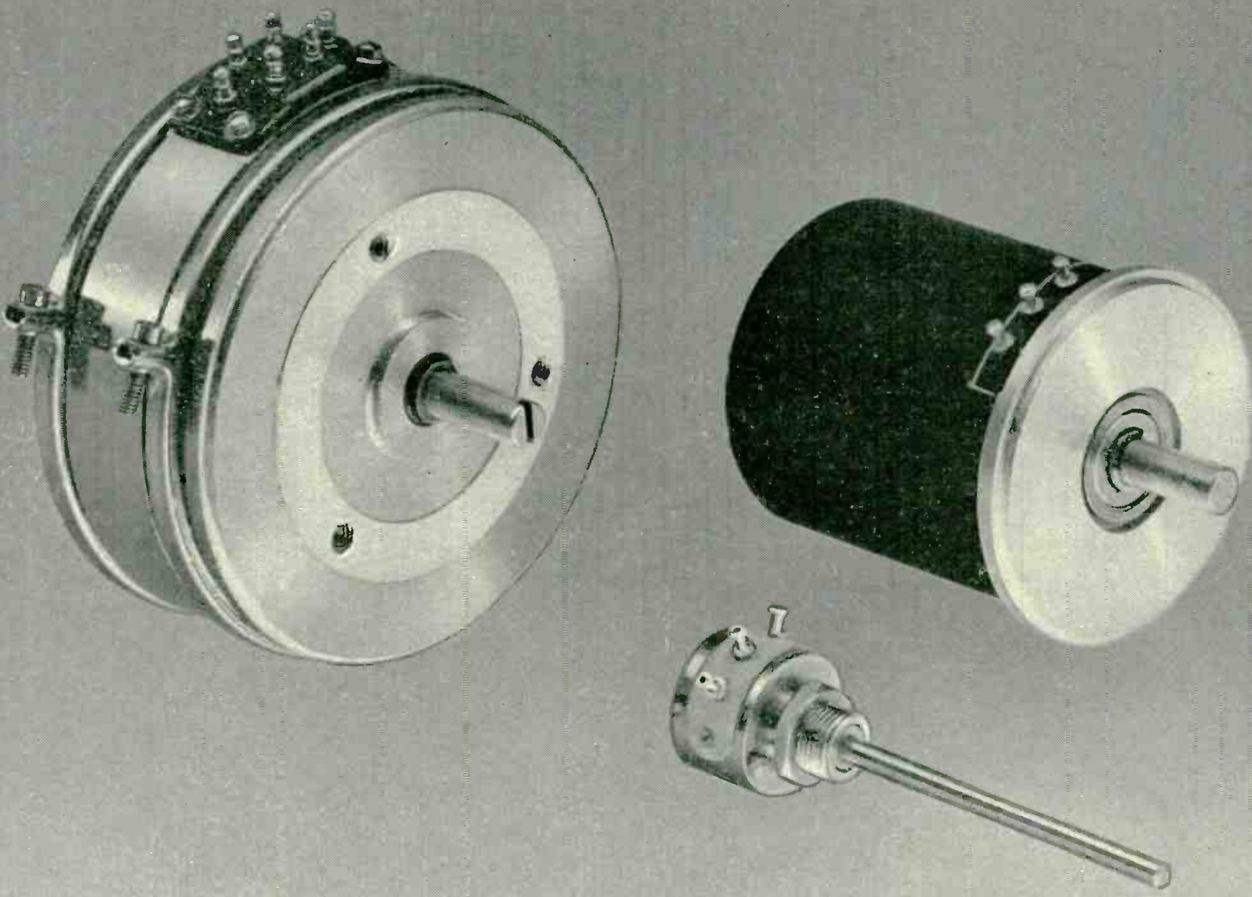
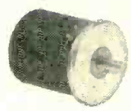


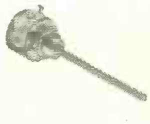
5 NEW

5 More reasons why FAIRCHILD can meet

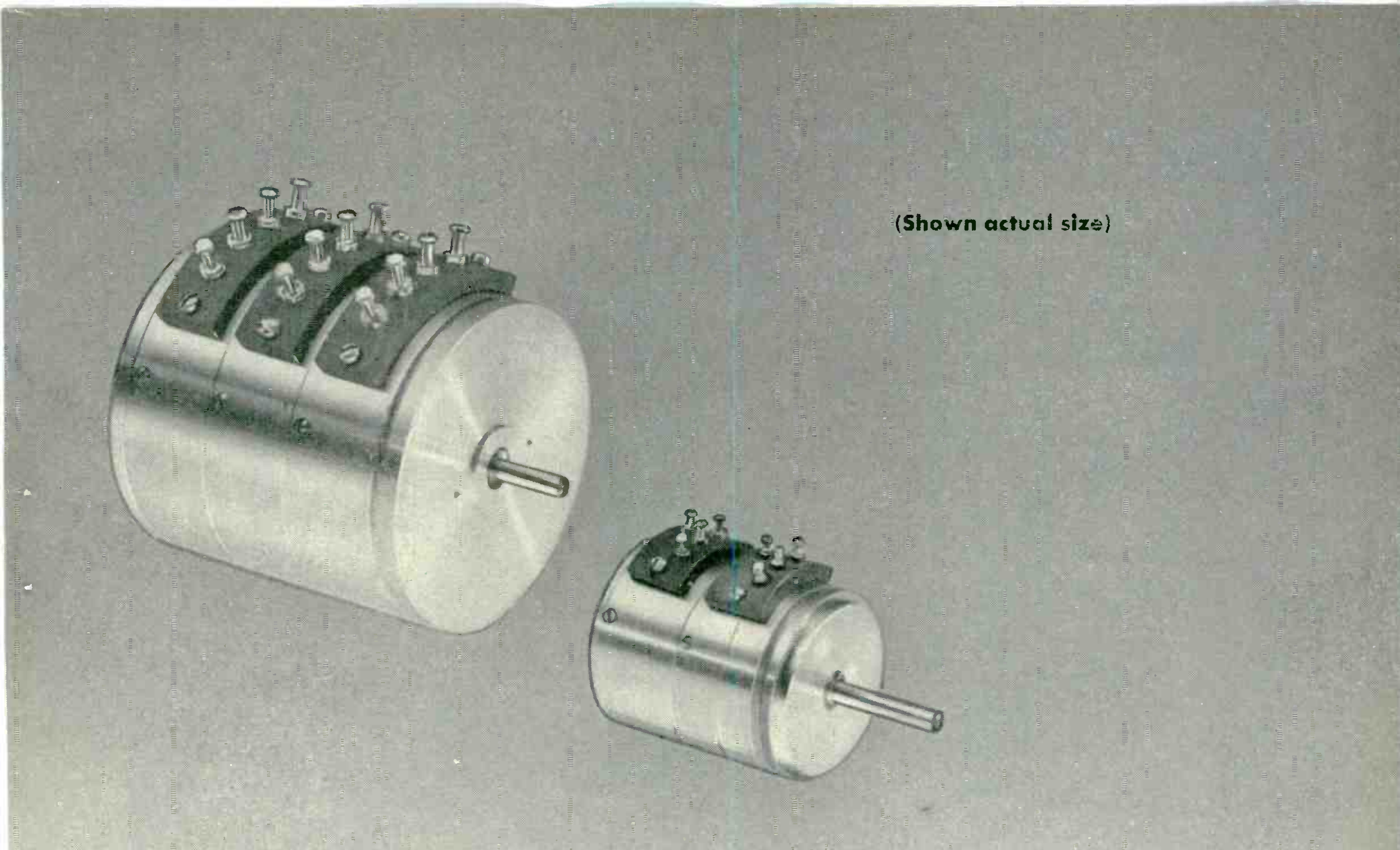
TYPE 753 – Sine-cosine potentiometer – Full sine-cosine function without mechanical cams and linkages – can be ganged up to 6 cups. 20,000 ohms per quadrant; linearity, ±0.5% peak-to-peak; 3" diameter, 1¼" long from front of servo flange to rear of cup. Also available as straight sine function.



TYPE 745 – 10-turn helical potentiometer – Meets rigid government requirements for humidity, salt spray, altitude, temperature, vibration, shock, sand, dust and fungus resistance. High electrical accuracy (linearity ±0.025%); resistance range 100 to 300,000 ohms. 2" diameter, 2$\frac{5}{32}$" long from front of servo flange to end of case. Mechanical and electrical rotation, 3600° (+2° –0°).



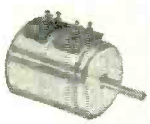
TYPE 771 – The FilmPot, metallic film potentiometer – Infinite resolution, high temperature operation (225°C). High wattage dissipation and exceedingly wide resistance range (100 to 200,000 ohms). Only ¾" in diameter and ½" long. Resistance element is precious metal deposited on an inorganic base. Available with servo flange or threaded bushing mounting.



POTENTIOMETERS

all your precision potentiometer needs

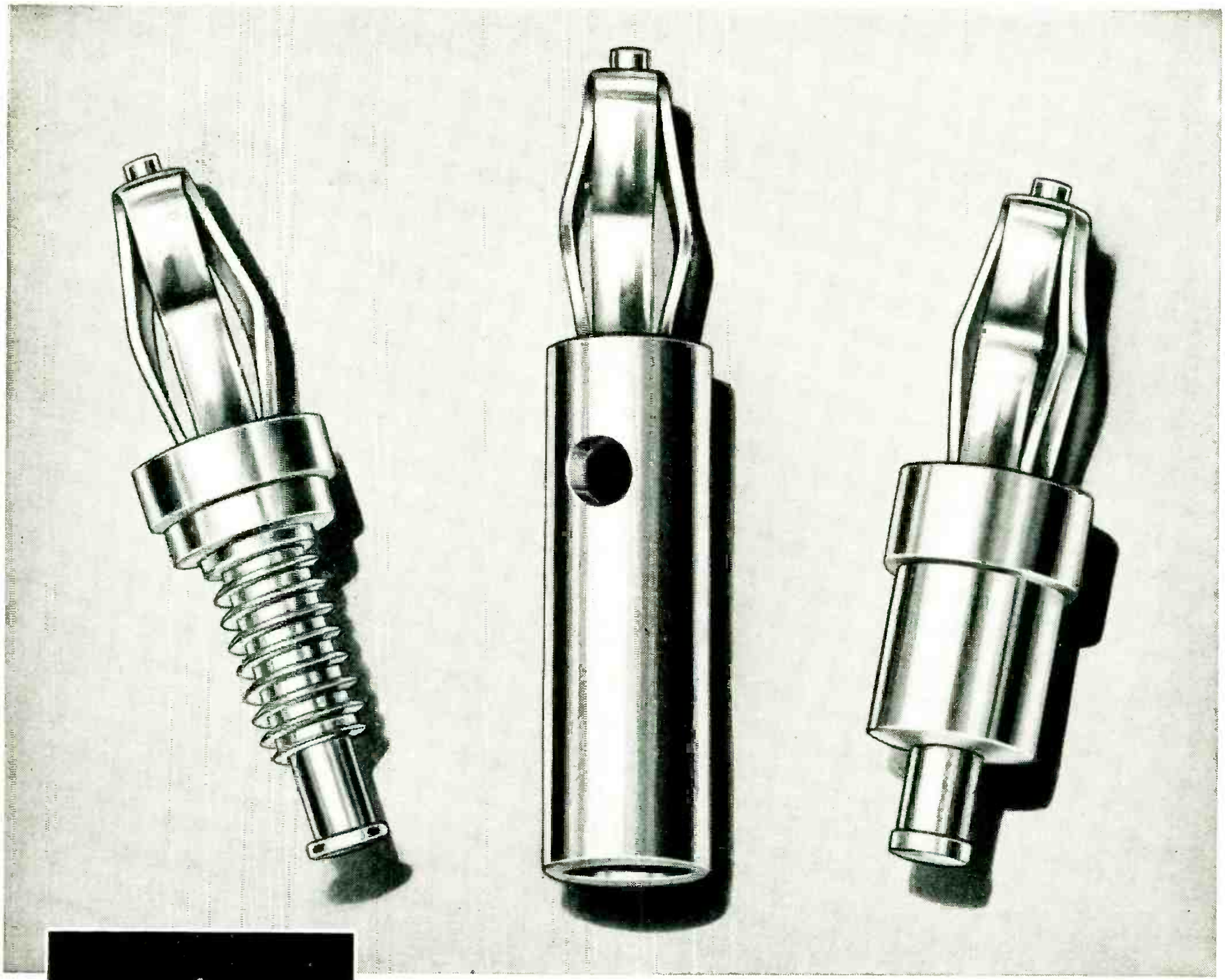
TYPE 754—2″ linear potentiometer—Resistance range from 800 ohms to 100,000 ohms. High linearity (±0.15% standard). Internal clamp rings permit ganging up to 8 cups on single shaft without increasing over-all diameter. AIA standard 2″ servo mount. Depth is 1″ with .594″ added for each cup section ganged. Gold-plated terminals are easier to solder and have better resistance to corrosion.



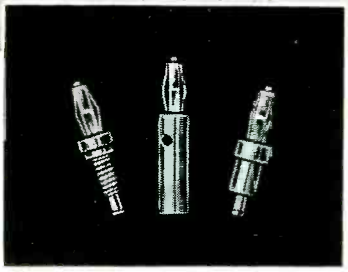
TYPE 741—1⅛″ linear potentiometer—Internal clamp rings permit ganging up to 5 cups on a single shaft without increasing the over-all diameter. Resistance range 500 to 25,000 ohms; linearity ±0.5% standard. Electrical angle 350°. Only 1⅛″ in diameter and 11/16″ long; starting torque is 0.25 oz.-in. The simplified slip ring construction and a one-piece paliney wiper give longer life and lower noise.

● ***Available immediately in sample quantities.*** Look to Fairchild for assistance in solving all your precision potentiometer problems. Fairchild has, or can make, a potentiometer to fit any requirement. For information write: *Fairchild Camera & Instrument Corp., Potentiometer Division, 225 Park Avenue, Hicksville, L. I., N. Y., Dept. 140-45A1.*

FAIRCHILD
PRECISION POTENTIOMETERS



6 times enlargement



Actual size

Ucinite Miniature Banana Pins

Heavy resistance to torque is a big feature of Ucinite miniature banana pins. The springs are mechanically riveted over and the large area around the tip of the pin is bonded by solder.

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

Built to withstand rough usage, Ucinite miniature banana pins are available in cadmium, silver or gold plate.

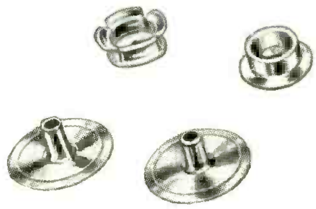
For further information, call your nearest United-Carr representative or write directly to us.

ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

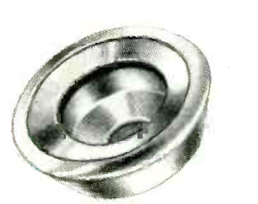
The UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

Tailor-Made Fasteners in Volume Quantities



MINIATURE BATTERY CONNECTORS
For use with small "B" batteries; afford quick and positive polarized electrical connections and worthwhile space savings on such small equipment as portable radios or hearing aids.

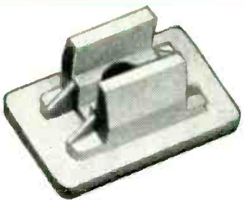


FEMALE ANODE CONNECTORS
Made from cold rolled steel and plated to specification, this part provides the high voltage connection to a metal picture-tube strap, or allied connections.

FISHTAIL RATCHET PLATE
Made in a wide range of sizes to hold on smooth metal, die-cast or plastic studs. For use on refrigerators, radio cabinets, washing machines and other products to hold medallions, nameplates, etc.

VIBRATOR GROUNDING FASTENERS
Holds 1½" dia. beaded or non-beaded vibrator in any position to radio chassis. Vibrator Can grounded to frame. Holding prongs designed to hold several types of Cans.

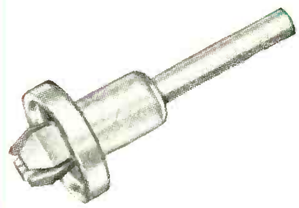
RUBBER FOOT
Snap-in Rubber Foot for Record Changers and Phonograph Mountings eliminates threaded member, lock washer and nut thereby speeding assembly time and reducing costs.

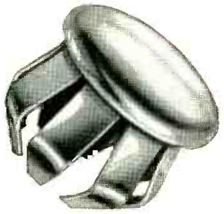


NYLON SNAP-IN NUT
Designed for the attachment of shelf supports or channels to porcelained sheet metal liners. Used with sheet metal screws they provide high pull-out values and no chippage.

INDICATOR-LIGHT PLUG BUTTONS
Snap-in type for electrical appliances. Removable. Jeweled or plain glass. Some plastic. Designed in a wide range of colors, shapes and sizes.

SHELF SUPPORTS
Plastic Shelf Supports designed to snap into porcelained hole. Driven pin expands Trimount section securing fastener without porcelain chippage. Variety of shapes and sizes.





PLUG BUTTONS
Made to snap into hole sizes ⅛" to 3". Can be embossed with ornamental or functional designs. Removable. Supplied with various finishes, in a variety of shapes and sizes.

TUBING AND WIRING CLIPS
For use in electrical and hydraulic systems. Holds wires and tubing firmly, without chafing, under extreme vibration. Made in hundreds of sizes.

TRIMOUNT STUDS
Designed to hold two or more thicknesses of material together. Easily installed by hand. Insure vibration proof attachment. Permanent or removable attachment. Wide variety of shapes and sizes.

DOT®

Parts illustrated are representative of the thousands of different specialized fasteners and allied devices designed and manufactured in volume by United-Carr and its subsidiaries for leading manufacturers of electronic equipment. United-Carr's wide and varied experience with special fastening problems in the automotive, aviation and appliance fields provides an unequaled background of technical knowledge which may well be applicable to your special needs.

UNITED-CARR
FASTENER CORP.
CAMBRIDGE 42, MASSACHUSETTS

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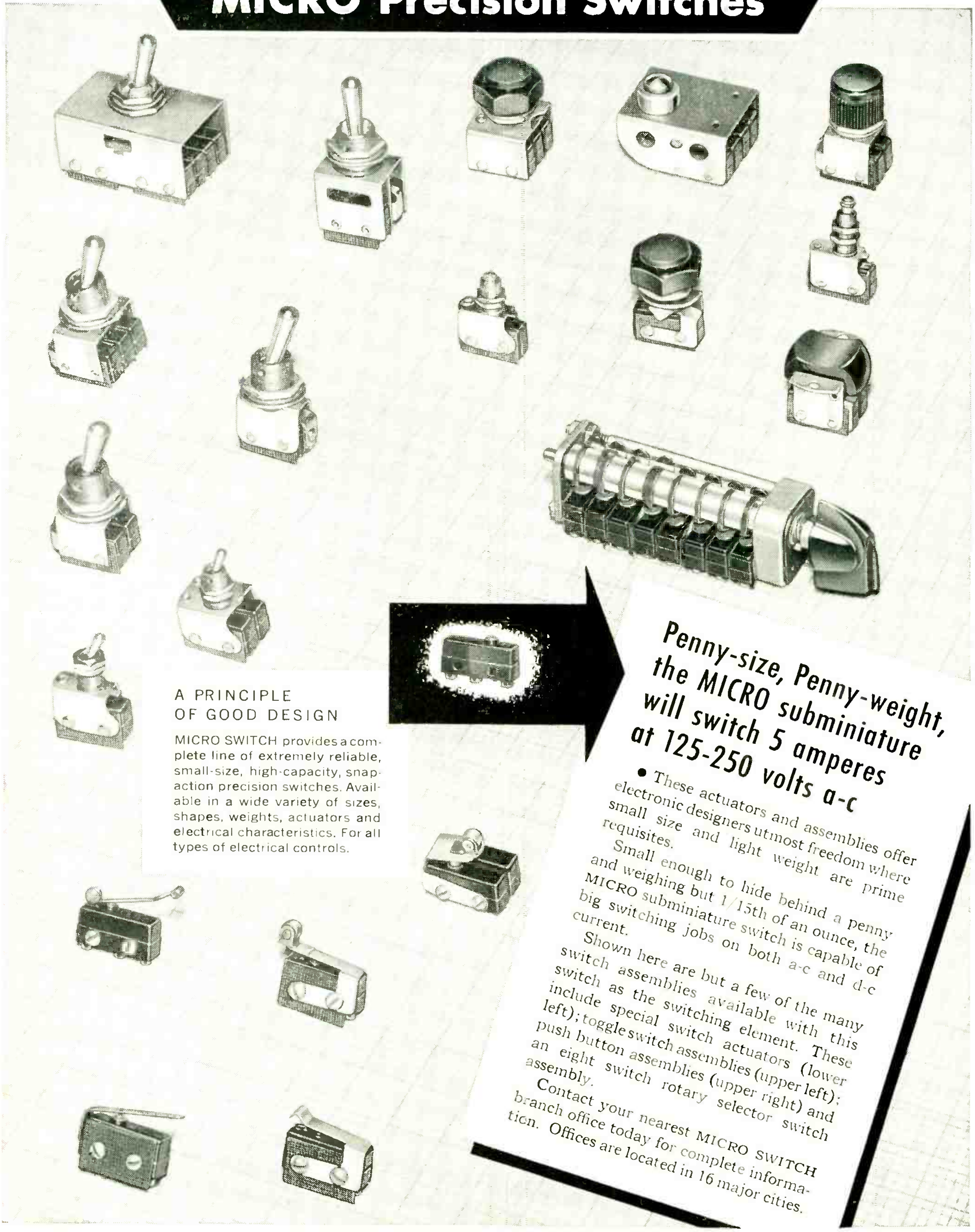
MICRO Precision Switches



A PRINCIPLE
OF GOOD DESIGN

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

Penny-size, Penny-weight, the MICRO subminiature will switch 5 amperes at 125-250 volts a-c

• These actuators and assemblies offer electronic designers utmost freedom where small size and light weight are prime requisites.

Small enough to hide behind a penny and weighing but 1/15th of an ounce, the MICRO subminiature switch is capable of big switching jobs on both a-c and d-c current.

Shown here are but a few of the many switch assemblies available with this switch as the switching element. These include special switch actuators (lower left); toggle switch assemblies (upper left); push button assemblies (upper right) and an eight switch rotary selector switch assembly.

Contact your nearest MICRO SWITCH branch office today for complete information. Offices are located in 16 major cities.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
FREEPORT, ILLINOIS

H HONEYWELL

DU PONT

Better Things for Better Living . . . through Chemistry

ELECTRICAL ENGINEERING NEWS

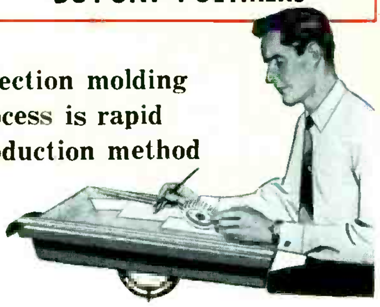
PROPERTY AND APPLICATION DATA ON THESE VERSATILE PLASTIC MATERIALS: DU PONT NYLON, "ALATHON," "TEFLON," "LUCITE."

No. 1 — 1954

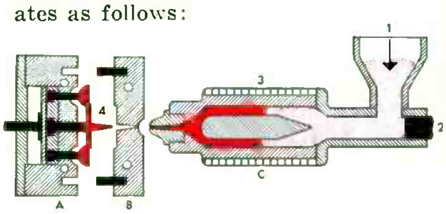
Properties of Du Pont Nylon Provide Design Versatility

POINTERS ON PROCESSING OF DU PONT POLYMERS

Injection molding process is rapid production method



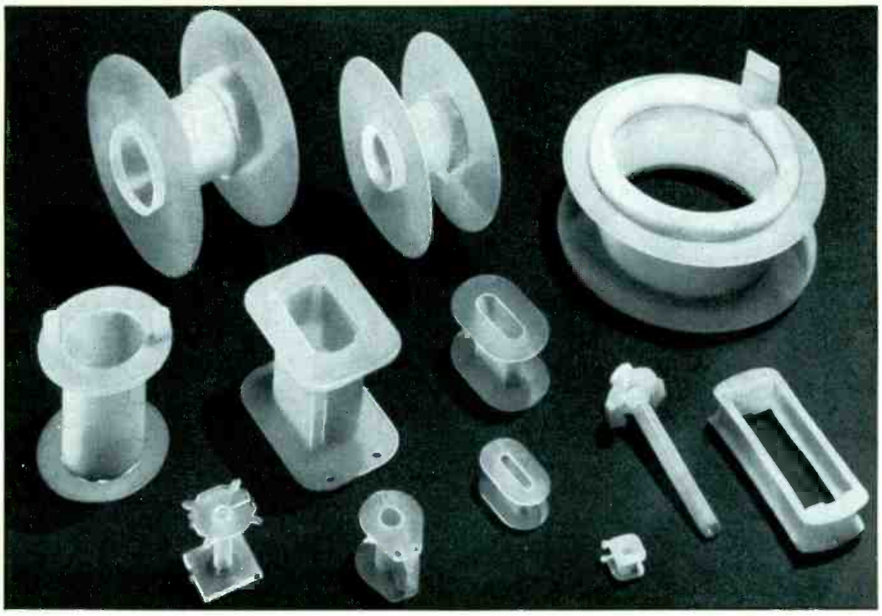
Injection molding is one process for producing large quantities of plastic parts. A typical injection-molding assembly, shown in the diagram, operates as follows:



Parts marked *A* and *B* close and lock to form the *mold;* they move to contact part *C* which contains molten plastic. Measured quantities of the granulated plastic *(1)* are fed into the machine. The reciprocating *ram (2)* forces this material into the *heating chamber (3)*, where the powder liquefies. Each forward motion of the ram *(2)* forces molten plastic into the closed mold *(A* plus *B)* where the plastic solidifies, and forms the *molded part (4)*. Then the mold opens as shown in the diagram and the plastic part is ejected. In the meantime, the ram moves back, allowing more powder to feed into the machine, preparing it for another molding cycle.

The production rate depends on a number of variables, including the size of the part, and the number of identical cavities cut into the mold. If molded parts are small, dozens of them can be made at one shot, whereas large parts may be produced one at a time. Cycles *(Continued reverse side, column 3)*

Examples include coil forms, grommets, phone signal device, and wire jacketing



These coil forms show how Du Pont nylon can be molded into thin, intricate sections.

Du Pont nylon is well established for a wide variety of uses in the electrical field. Among the outstanding properties of nylon accounting for this acceptance are: good insulating characteristics; superior toughness and high temperature resistance (to 250°F.); strength in thin sections; and the ability to be formed into intricate pieces by injection molding.

Also of interest to electrical design engineers are nylon's abrasion resistance, good impact strength and resiliency. Many electrical parts have been redesigned for longer life by utilizing the unique combination of properties Du Pont nylon has to offer.

One proved application of molded nylon is for coil forms. Because nylon is tough and has strength in thin sections, compact and intricate designs are possible. Often, assembly steps are eliminated by incorporating various parts into the coil form itself. Magnetic cores and other metal inserts can be molded right into the nylon.

Another established use for Du Pont nylon is the strain-relief grommet. Toughness and resiliency of nylon allow the grommets to be snapped into position. The heat-resistance, strength and insulating properties of Du Pont nylon meet requirements of commercial electrical equipment. These grommets carry the U. L. Seal.

A telephone interrupter cam of Du Pont nylon is an interesting application. This cam regu-

OVER

DU PONT

Better Things for Better Living
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ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE PLASTIC MATERIALS: DU PONT NYLON, "ALATHON," "TEFLON," "LUCITE."

No. 1 — 1954

(Properties of Du Pont Nylon, Con't)
lates the timing of coded rings and busy-signals for phones. Rotating to actuate a leaf spring switch, the nylon cam helps provide the necessary signal. A single part replaces a complicated assembly; nylon gives better performance, and longer service life. Particularly valuable properties of nylon for this application are abrasion-resistance and resilience.

Du Pont nylon finds wide application as extruded coatings for wire and cables. Nylon is used as both primary insulation and as jacketing which covers other insulation. Nylon resists abrasion and attack by oil or gasoline. Nylon increases the service temperatures of some primary insulations and also retards volatilization of plasticizers from the primary insulations. Coatings in commercial use are from 3 to 15 mils thick. A thin coating is adequate because of the toughness of nylon. The coating is smooth, light in weight and flexible at low temperatures. Extrusion methods apply nylon at speeds as high as 1,000 feet per minute.

INVESTIGATE Du Pont plastic engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design.

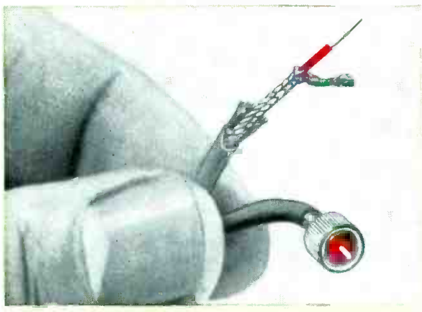
The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and Du Pont nylon are helping solve industrial design problems.

NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and application of Du Pont plastic engineering materials.

Dielectric properties of "Teflon" aid designers of miniature circuits

Miniature circuits can develop high temperatures, which combined with an increased electrical load, may result in the failure of tiny parts. The problems of insulating components of miniaturized circuits were investigated by Microdot Division, Felts Corporation, S. Pasadena, California, in conjunction with their development of a complete line of miniature coaxial connectors and assemblies.



Coaxial connectors and cable are insulated with Du Pont "Teflon." These miniature-circuit parts are made by Microdot Division of Felts Corp.

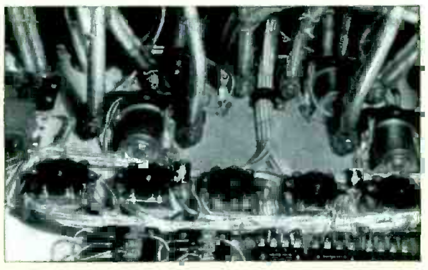
The material which Microdot needed for the connectors and primary wire insulators had to have superior dielectric properties and heat-resistance. Durability and resistance to moisture were also essential.

Du Pont "Teflon" tetrafluoroethylene resin was chosen after extensive tests. "Teflon" is an excellent insulator. It has a dielectric constant of 2.0; the power factor is less than 0.05%, at frequencies as high as 30,000 megacycles. Exposure to arc leaves no carbonized path. The dielectric properties of "Teflon" remain constant at temperatures from -80°F to 500°F. "Teflon" absorbs no water by ASTM Test D570-42.

Where resistance to high temperatures, good dielectric properties and durability are needed, Du Pont "Teflon" has proved its versatility.

Du Pont nylon useful in components of aircraft wiring systems

The properties of Du Pont nylon make this versatile engineering material particularly adaptable for aircraft electrical systems. Nylon is used for cable clamps, strain-relief clamp blocks, grommets, wire guides and support blocks, terminal blocks and similar devices. Du Pont nylon is specified for these applications because it is tough, resists abrasion and extremes of temperature; it has the necessary dielectric characteristics, can be molded readily into intricate shapes, and is



strong in thin sections. One type of airplane carries sixteen miles of cable jacketed with Du Pont nylon. Here, other properties of nylon are important—resistance to gasoline and high temperature, and lightness of weight.

Du Pont nylon is used continuously at temperatures (to a maximum of about 250°F.) Its heat-resistance permits component parts to be soldered without affecting the nylon.

Many manufacturing economies are obtained with nylon. Injection molding allows fast production of complicated shapes. Often a single part molded of nylon replaces an assembly of several parts. And because nylon can be molded around metal inserts, further design simplification is often possible.

(Injection molding, continued)
of 1 or 2 moldings a minute are not uncommon.

Here are some of the advantages of injection molding:

1. High rate of production
2. Economical production in quantity
3. Little or no finishing cost
4. Parts molded to close tolerances.

E. I. DU PONT DE NEMOURS & CO. (INC.)
Polychemicals Department
Room 224 Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont plastic engineering materials checked:
☐ *Du Pont nylon;* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in the application of these materials for:* ____________

NAME ____________ TITLE ____________
COMPANY ____________
STREET ADDRESS ____________
CITY ____________ STATE ____________
TYPE OF BUSINESS ____________

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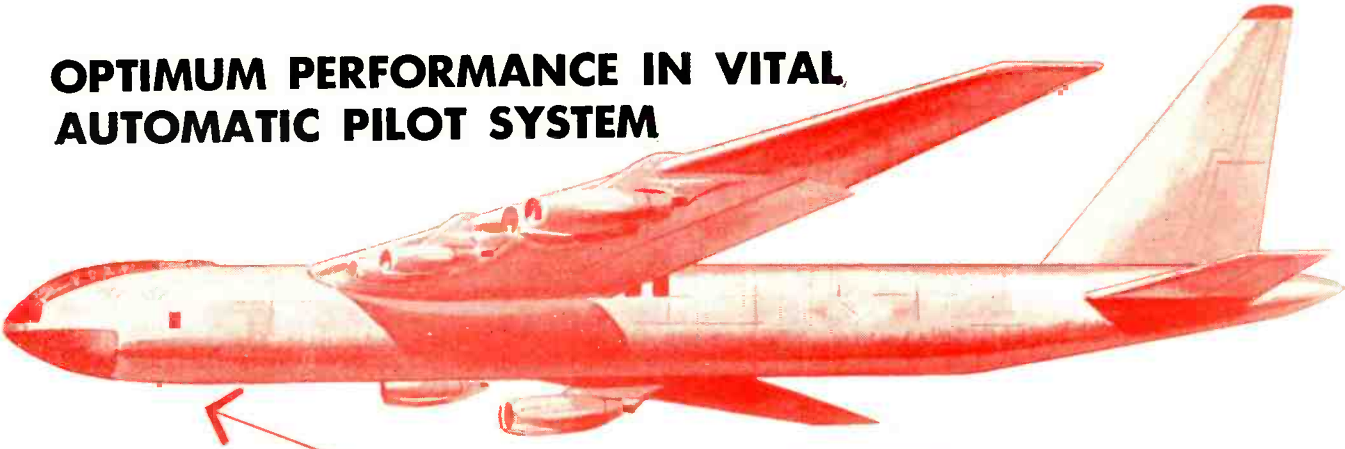
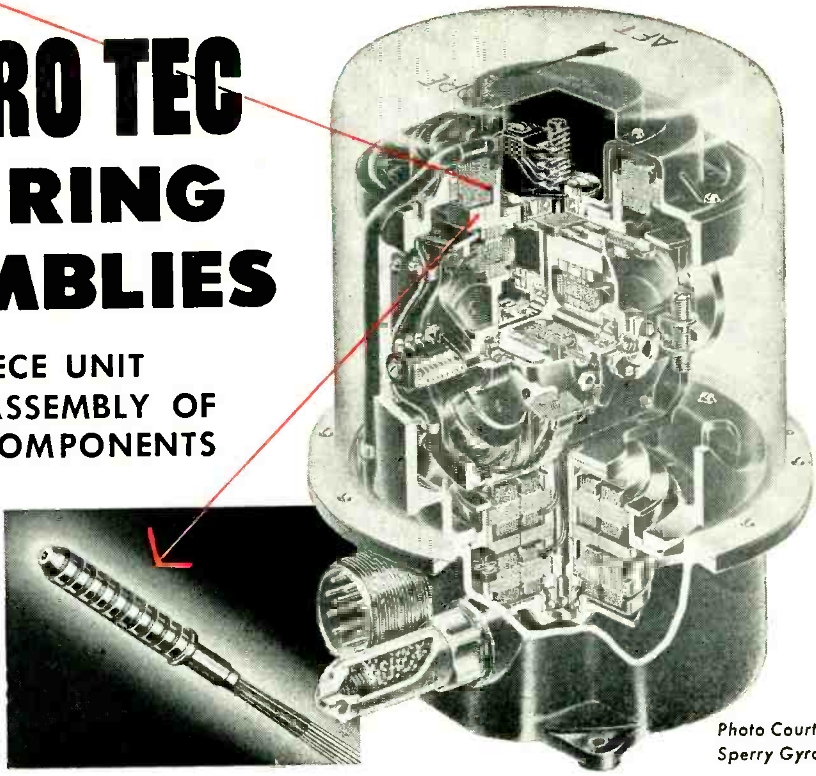
OPTIMUM PERFORMANCE IN VITAL AUTOMATIC PILOT SYSTEM



ELECTRO TEC SLIP RING ASSEMBLIES

ONE PIECE UNIT REPLACES ASSEMBLY OF MULTIPLE COMPONENTS



The instrument shown is a Sperry "Gyrosyn"® compass which combines the advantages of gyroscopic stability and magnetic correction to provide an accurate directional reference.

Photo Courtesy Sperry Gyroscope Company

Offering Closer Tolerances, Absolute Uniformity and the Ultimate in Miniaturization:

- ONE PIECE, UNITIZED CONSTRUCTION
- ABSOLUTE MINIMUM FRICTION TORQUE
- DIAMETERS FROM .035" to 24.0"
- MINIMUM 1000 V.A.C. HI-POT INTER-CIRCUIT
- HARD SILVER RINGS PLATED TO PRECISELY MACHINED ONE-PIECE PLASTIC FORM
- SPECIAL SURFACE DEPOSITS PREVENT TARNISH, MINIMIZE FRICTION, BRUSH NOISE AND WEAR

—*featuring* SUPER DEPENDABILITY!

The Sperry "Gyrosyn" compass is an outstanding example of precision and dependability. Electro Tec is proud to furnish slip ring assemblies which are consistent with the high accuracy and unfailing performance of this instrument. In this application, as in hundreds of others, Electro Tec meets specifications with a degree of accuracy unattainable with built-up or molding methods of manufacture. This extreme precision plus the many other advantages that result from Electro Tec manufacturing techniques have resulted in leadership throughout the industry. For complete cooperation in applying Electro Tec "know-how" to specific problems call or write the Sales Engineering Department.

ELECTRO TEC CORPORATION

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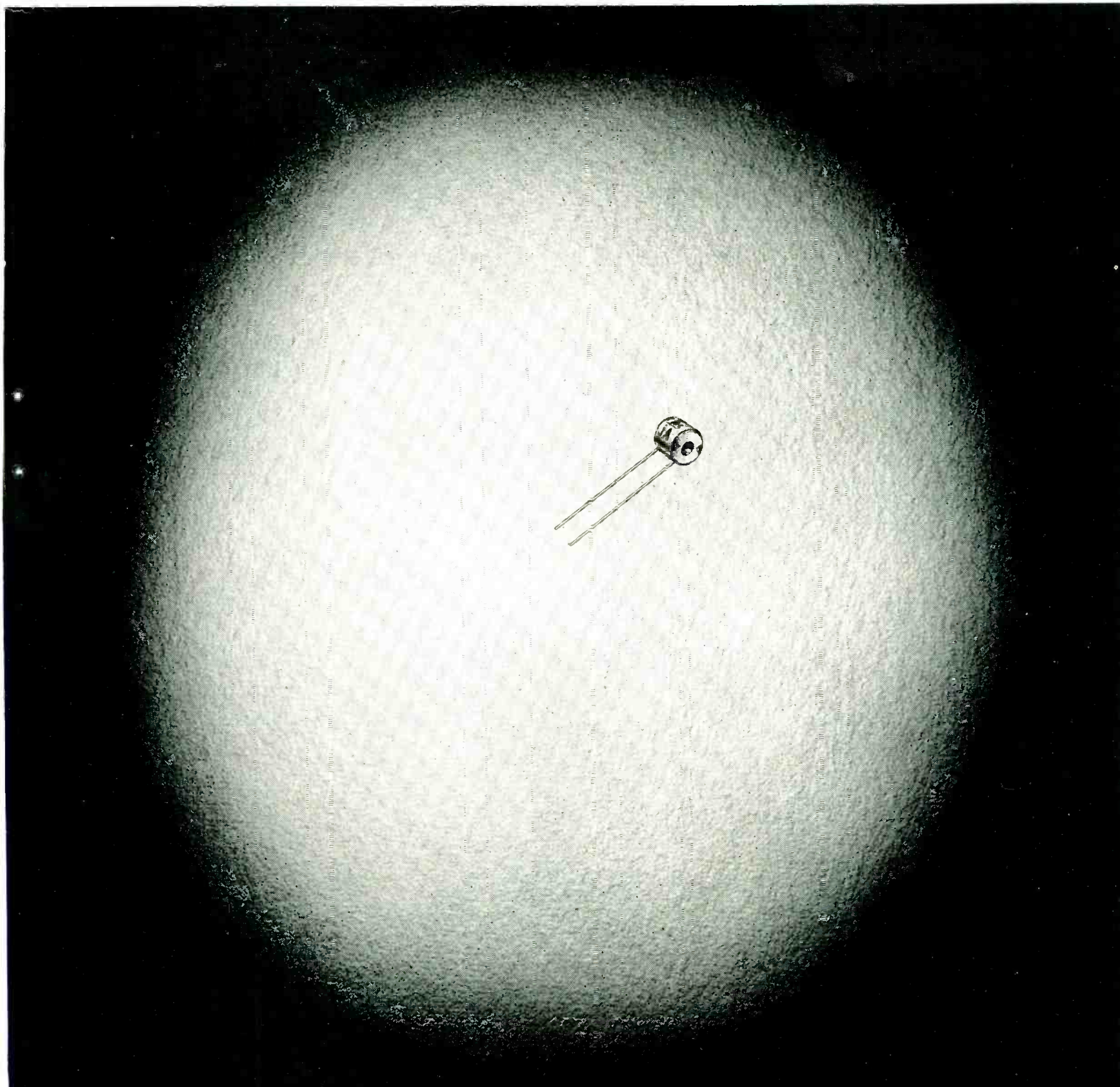
*PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS **

** Patent Pending*



RPC Type J resistors where subminiature requirements specify full size reliability and performance

Precision Wire Wound

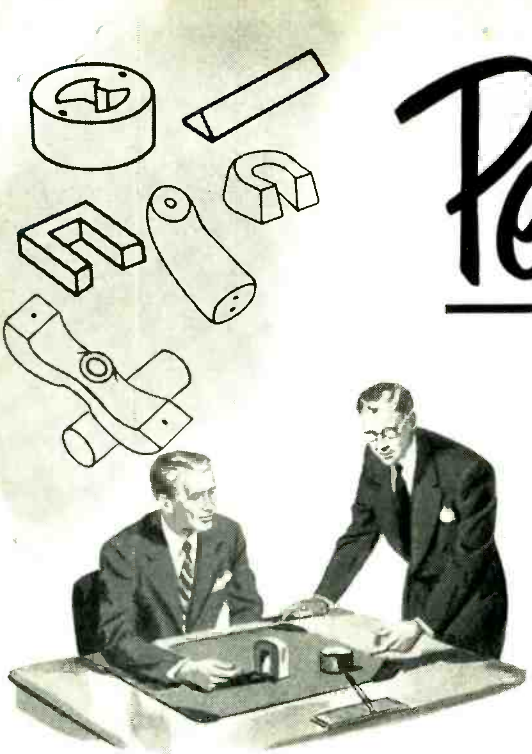
Type JA ¼" diameter X ¼" ong. Maximum resistance 125,000 ohms. 0.10 watt.
Type JC ¼" diameter X ⅜" ong. Maximum resistance 250,000 ohms. 0.15 watt.
Tolerance 1% standard, tolerances to 0.05% available. All resistors furnished with low temperature coefficient alloys.
Special wire and impregnation available for greatly increased power rating.

rpc

RESISTANCE PRODUCTS CO.

714 Race Street • Harrisburg, Pa.

Perpetual Energy



Consumer Market

Perpetual energy is at work all around us. Shown here are only a few of the many examples of permanent magnets at work—all of which *add to the salability* of the product.

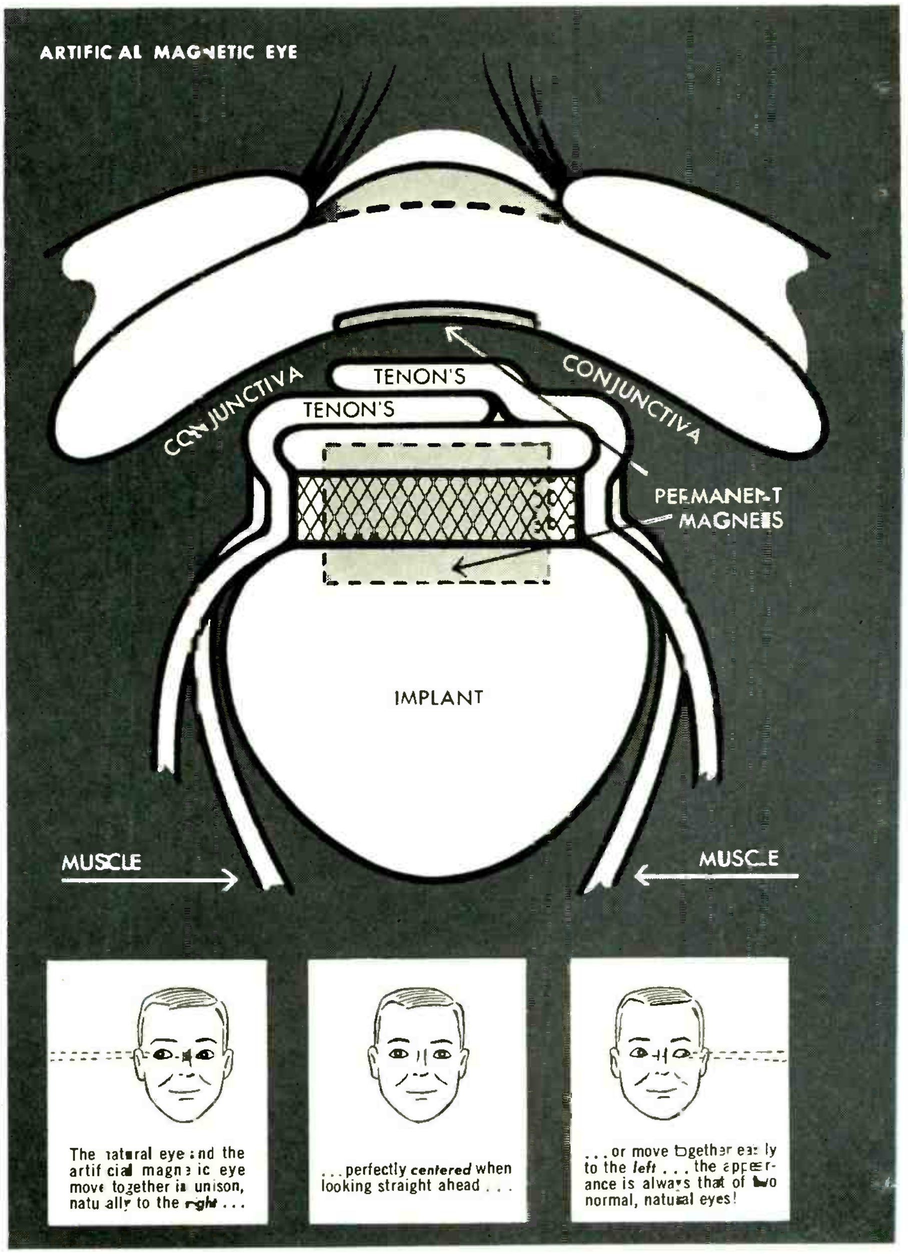
Artificial Magnetic Eyes —

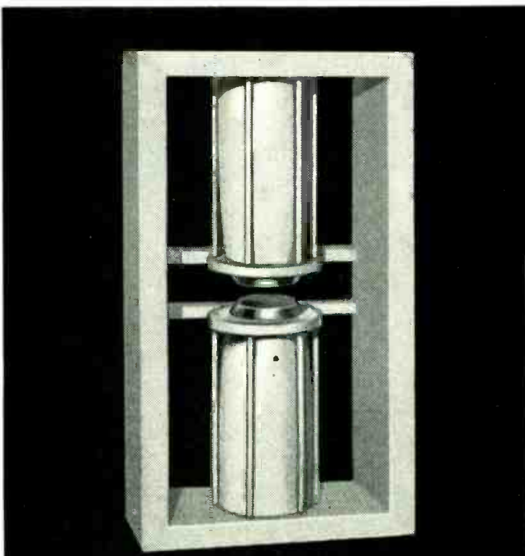
An artificial eye looks practically normal if it moves in unison with the natural one. To achieve this, a New York doctor developed an implant wherein is imbedded an Alnico permanent magnet.

After removal of a diseased or injured eye, recti muscles, originally attached to the natural eye, are attached to an implant, thereby imparting motility to this implant. Further operative procedure requires that the implant be covered with layers of tissue (tenons and conjunctiva) in order that the implant may be completely buried.

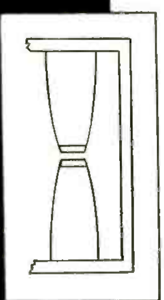
A custom-fitted plastic artificial eye is then made which also has a very thin Alnico magnet. As a result of the attraction between the magnet in the implant and the one in the artificial eye, and also due to the shape of the artificial eye, the eye can then move in unison with the natural one, as motility is imparted from the recti muscles to the implant and, in turn, to the artificial eye.

Applications: Among other consumer products that rely on permanent magnets are can openers with a magnetic lid-lifter, and the thermostat used in your home.





NUCLEAR RESONANCE RESEARCH ASSEMBLY



Permanent Magnet

Basic Research

*Research—*A highly specialized example of the use of permanent magnets in research is the nuclear resonance assembly shown on the left.

The Alnico V permanent magnets used in this assembly built for the University of Chicago by INDIANA produce a field of approximately 5,500 gauss. The assembly not only is *much less costly* than the electromagnetic models but it also does not require much of the expensive equipment required to maintain a stable field.

Can Work For You!

Perpetual Magnetic Energy...a Timeless Force... is hard at work in many fields and in many products...from Artificial Magnetic Eyes to Nuclear Resonance Research!

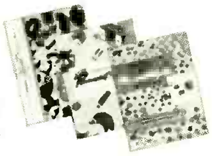
You can't see it . . . smell it . . . or hear it. Nor can you taste it or feel it, but the "perpetual energy" of permanent magnets is at work for you in each one of these applications—and thousands more. Permanent magnets won't wear out. They can't be used up. They're a source of permanent energy instilled in your product "perpetually."

. . . Unlimited are the future possibilities of permanent magnets in new product designs. The field produced by the myriad of spinning electrons, the essence of permanent magnets, can work for you in these three ways: transformation of mechanical to electrical energy • transformation of electrical to mechanical energy • tractive effort. If you need a component to perform one of these three functions, INDIANA PERMANENT MAGNETS may be the solution to your design problem.

INDIANA provides you with the largest facilities in the world for the manufacture of permanent magnets and complete permanent magnet sub-assemblies. It will pay you to take advantage of INDIANA's wealth of experience, research leadership, and specialized engineering "know-how."

The Indiana Steel Products Co.
VALPARAISO, INDIANA

SALES OFFICES FROM COAST TO COAST—BOSTON • CHICAGO
CLEVELAND • NEW YORK • PHILADELPHIA • ROCHESTER • LOS ANGELES



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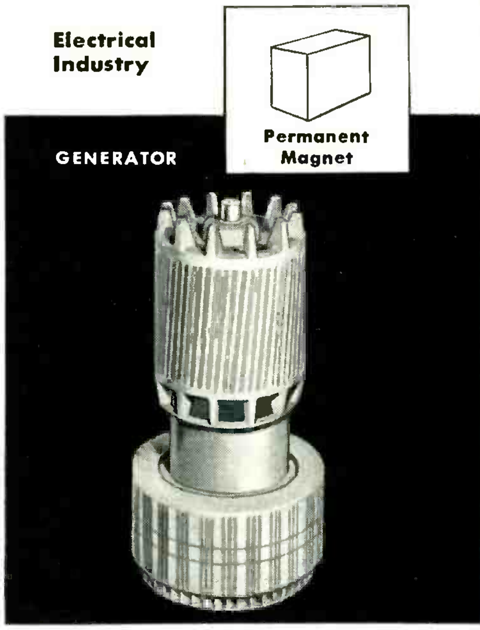
Electrical Industry



Generators—A well-known application in the electrical field is the permanent magnet generator. This 15 kva, 120/208-volt, 400-cycle model incorporates 28 Hyflux Alnico V, bar-shaped permanent magnets.

Long service and *minimum maintenance* are two things sought by users of generators. Permanent magnets help to provide these qualities. *Elimination of slip rings and commutators* means no sparking or radio interference. And there's no heat from the field coils nor is excitation power needed.

Applications: Magnetos, motors, gyroscopes.

In 24 Hours—You can have INDIANA PERMANENT MAGNETS for your experimental work

Loudspeakers—Typical of the applications in this field is this 15-inch high fidelity speaker which uses a $10\frac{1}{2}$ lb INDIANA Hyflux Alnico V magnet to achieve a frequency range from 30 to 16,500 cycles per second! INDIANA Hyflux Alnico V provides an energy product of $5\frac{1}{4}$ million BH Max or more, thereby assuring a magnetic field of high strength. Permanent magnets, in this case, are a *functional necessity* to this design—no substitute can do the job.

Applications: INDIANA magnets are consistently doing an outstanding job in many other typical products in this field such as focusing coils, ion traps, centering devices, radar, and guided missiles.

Magnetic Separators—There is almost an endless list of mechanical or holding applications. One of the more widespread, industrial applications is this permanent magnet separator, using three or more Hyflux Alnico V, U-shaped magnets each of which can exert a pull of 150 lb.

Here permanent magnets exert an effective pulling force through a distance of several inches . . . permitting your product to do the job better and safer, insure *uninterrupted production* flow by snatching "tramp" iron from materials to be processed . . . thereby preventing damage to machinery. And permanent magnets *require no electrical power, no wiring*... hence, they never spark, eliminating a definite fire hazard.

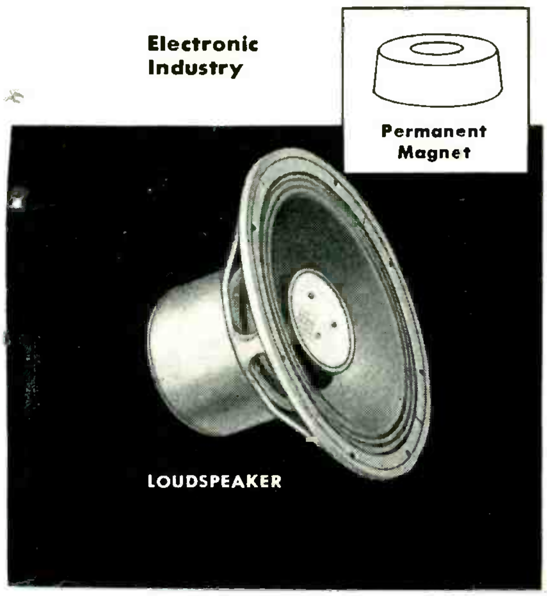
Applications: Among the many mechanical applications are: magnetic conveyors, magnetic sweepers, magnetic chucks and clutches.

Watt Hour Meters—One of the hundreds of different instruments requiring permanent magnets is this single-phase, 15-amp, 240-volt rating for 3-wire services watt hour meter. It uses an Alnico 1, horseshoe-shaped magnet weighing only 0.2 lb.

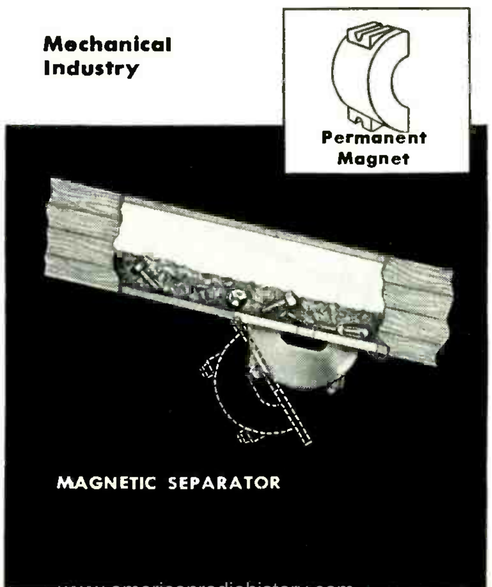
Here, the high quality of this permanent magnet material provides the uniformity and stability of field so necessary for *maintaining the initial accuracy* of this meter over a long period of years.

Applications: Mass spectrometers, vibration pickups, galvanometers, medical instruments, speedometers, fluxmeters.

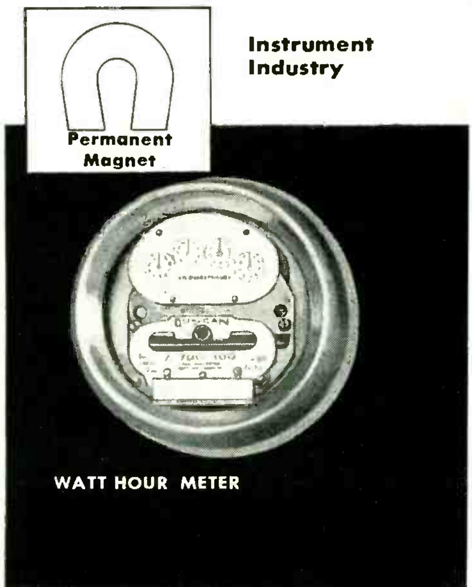
Electronic Industry



Mechanical Industry

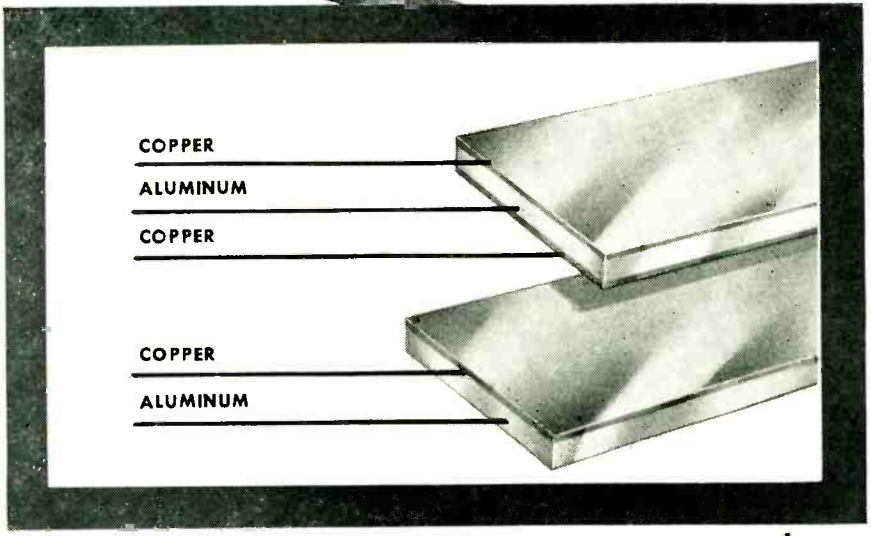


Instrument Industry



GENERAL PLATE
ALCUPLATE®
(COPPER ON ALUMINUM)

Cut Costs 15 to 30%



ALCUPLATE Plus Features

- High Electrical Conductivity
- Excellent Heat Dissipation
- Soft-Soldering Surfaces
- Easy Fabrication
- Light Weight

Manufacturers of various products are reducing costs by 15 to 30% or more over an equal area of copper or brass with General Plate ALCUPLATE... Copper clad on one or both sides of aluminum.

Here's how ALCUPLATE saves — by permanently bonding a thin layer of copper to thicker less expensive aluminum. You get solid copper performance at a lower cost over solid copper. This combination has practically the same physical and electrical properties as copper plus the light weight of aluminum.

ALCUPLATE can be fabricated by stamping, drawing, spinning, and forming. Its malleability permits its use in the manufacture of many parts from work-hardened rather than annealed or dead soft materials.

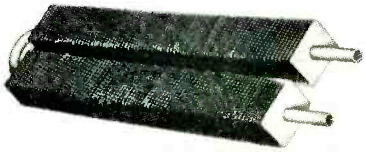
ALCUPLATE is available in coils and flat cut lengths, copper clad on one or both sides of aluminum, 1/16" thick x 13" wide and under.

Technical Data Bulletin No. 702C gives full details. Write for a copy today.

You can profit by using General Plate Composite Metals!

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

A Few of the Many Products Made from General Plate ALCUPLATE



HEAT TRANSFER UNITS — ALCUPLATE provides ideal fin sections at reduced cost over solid copper fins. The copper surface permits soft soldering of the fins to the tubes.

ELECTRONIC CHASSIS — Minimum weight combined with copper surface required for soft-soldering operations, electroplating, and low-resistance shield connections are advantages obtained by using ALCUPLATE.

COMPONENT CASES — ALCUPLATE is successfully drawn and formed into lightweight cases or cans and intricate parts.

BUS BARS — ALCUPLATE provides high conductivity, light weight, solderability ... and is lower in cost than solid copper bus bars.

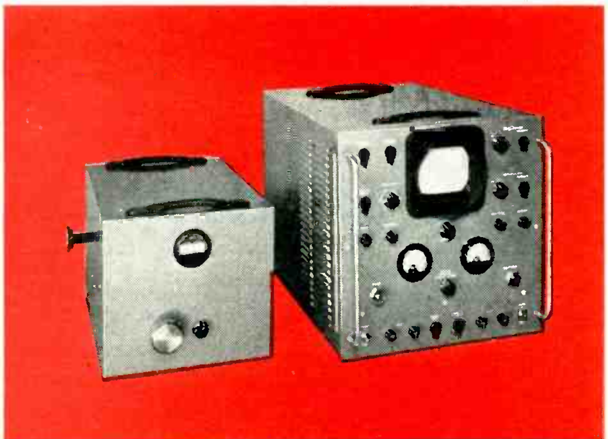
ELECTRICAL TERMINALS — Small terminals and large pressure-type connectors use single-clad ALCUPLATE ... alleviates galvanic corrosion which otherwise results from aluminum and copper junctions.

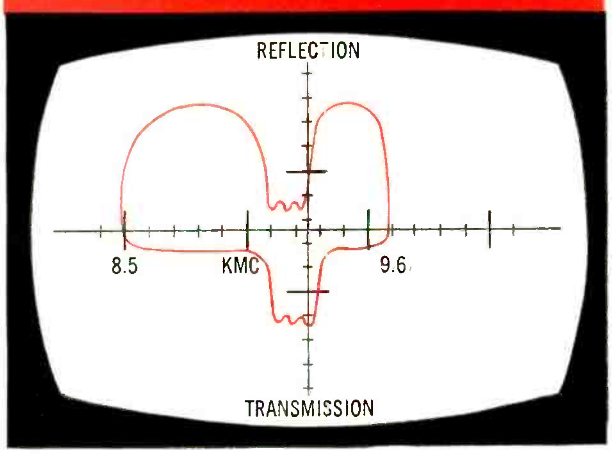
first of its kind

X-BAND SWEEP OSCILLATOR

wide band -- 8500 to 9600 mc

dynamic testing of microwave components and systems -- utilizing unique crt display





Now, for the first time, an instantaneous graphic display of the entire frequency range 8500 to 9600 MCS. This new Polarad X-Band Sweep Oscillator makes possible rapid, dynamic testing of microwave components such as TR tubes, antennas, crystal mounts, even complete microwave systems over a 1100 MC sweep at X-band. Eliminates laborious point-by-point testing methods. A unique display unit shows both reflection and transmission characteristics simultaneously, since two deflection amplifiers are utilized.

The X-Band Sweep Oscillator is an important instrument for laboratory and production line application. It gives one quick answer where formerly hours of checking were necessary. For further information, write to your nearest Polarad representative or the factory.

A Typical Scope Display (at left)
Shows transmission and reflection characteristics of a double tuned cavity under test. This is an example of how the dynamic display reduces time required to test X-band components and systems. As a design tool in the laboratory, the effects of electronic or mechanical changes may be evaluated instantaneously. As a production tool, "go" and "no go" limits may be checked visually.

SPECIFICATIONS

Frequency Range:	8.5 to 9.6 KMC
Output:	+ 12 dbm minimum into matched load
Output Variation:	± 1 db maximum
Sweeper Rate:	12 cycles per second
Operating Voltage:	115 V ± 10%
Input Power:	400 watts
Type of Output Connector:	UG-52A/U
Size of Control and Display Unit:	15 5/16" wide x 20 7/8" deep x 16 3/8" high
Size of Sweeper Oscillator:	12" wide x 16 1/4" deep x 12" high
Approx. Wt. of Control and Display Unit:	135 lbs.
Approx. Wt. of Sweeper Oscillator:	55 lbs.

Polarad ELECTRONICS CORPORATION 100 METROPOLITAN AVENUE, BROOKLYN 11, NEW YORK

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

Want more information? Use post card on last page.

Automatic, maintenance-free, instantaneous voltage stabilization

Static-magnetic constant voltage transformers are a practical and efficient solution for controlling input voltage to voltage-sensitive electrical and electronic equipment.

Sola Constant Voltage Transformers are widely used both as built-in components and as accessory units. They differ from regulators which depend solely upon saturation of core materials for their regulating action, or electronic types employing tubes. Sola Constant Voltage Transformers have the following characteristics:

1. Regulation within ±1%, with primary voltage (transient or continuous) variations as great as 30%.
2. Response time less than 1½ cycles.
3. No moving or wearing mechanical parts, nor vacuum tubes; requires no manual adjustments.
4. Completely automatic, continuous regulation.
5. Self-protecting against short-circuits on output.
6. Current-limiting characteristics protects load equipment.
7. Can often be substituted in place of conventional non-regulating transformers.
8. Generally smaller than other types of regulators for similar duty.
9. Isolates the input and output circuits.

Forty-three Sola stock units are available in a wide variety of ratings, voltages and types. In addition, custom-designed units can be manufactured (in production quantities) to meet specific requirements.

The experience of the world's largest manufacturer of constant voltage transformers is available to you. We invite you to discuss your voltage stabilizing problems with a Sola Sales Engineer.

SOLA *Constant Voltage* **TRANSFORMERS**

WRITE FOR LITERATURE. Sola Constant Voltage Transformers are completely described in a 24 page manual. Write for a copy of 7D-CV-170 on your letterhead, please.

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Mercury Vapor Lighting • Luminous Tube Signs
SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois, Bishop 2-1414 • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464*
PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988 • BOSTON: 272 Centre St., Newton 58, Mass., Bigelow 4-3354
CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • Reps. in Other Principal Cities

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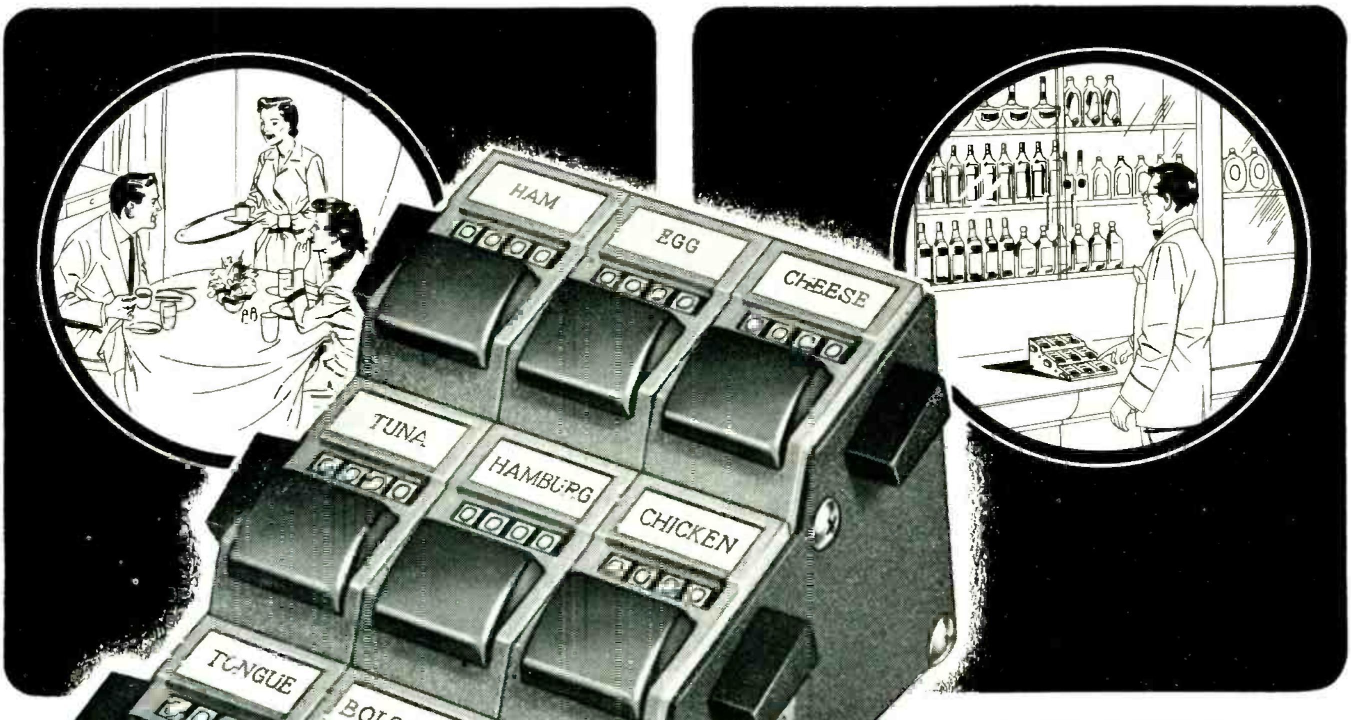
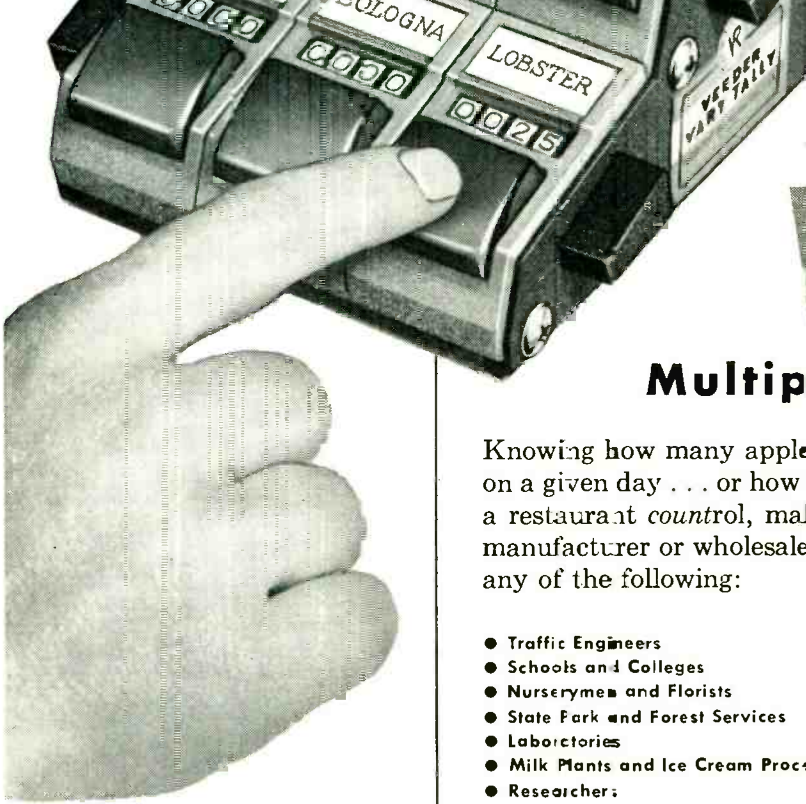
Want more information? Use post card on last page.

Ham on Rye or Rye on Hand?





Count BOTH

(and 1,001 Other Items)

with this New Veeder-Root

VARY-TALLY

Multiple-Unit Reset Counter

Knowing how many apple versus lemon pies, for instance, are ordered on a given day . . . or how many cases of what are in the cellar . . . helps a restaurant *count*rol, make plans, make profits. The same goes for a manufacturer or wholesaler seeking tighter inventory control . . . or for any of the following:

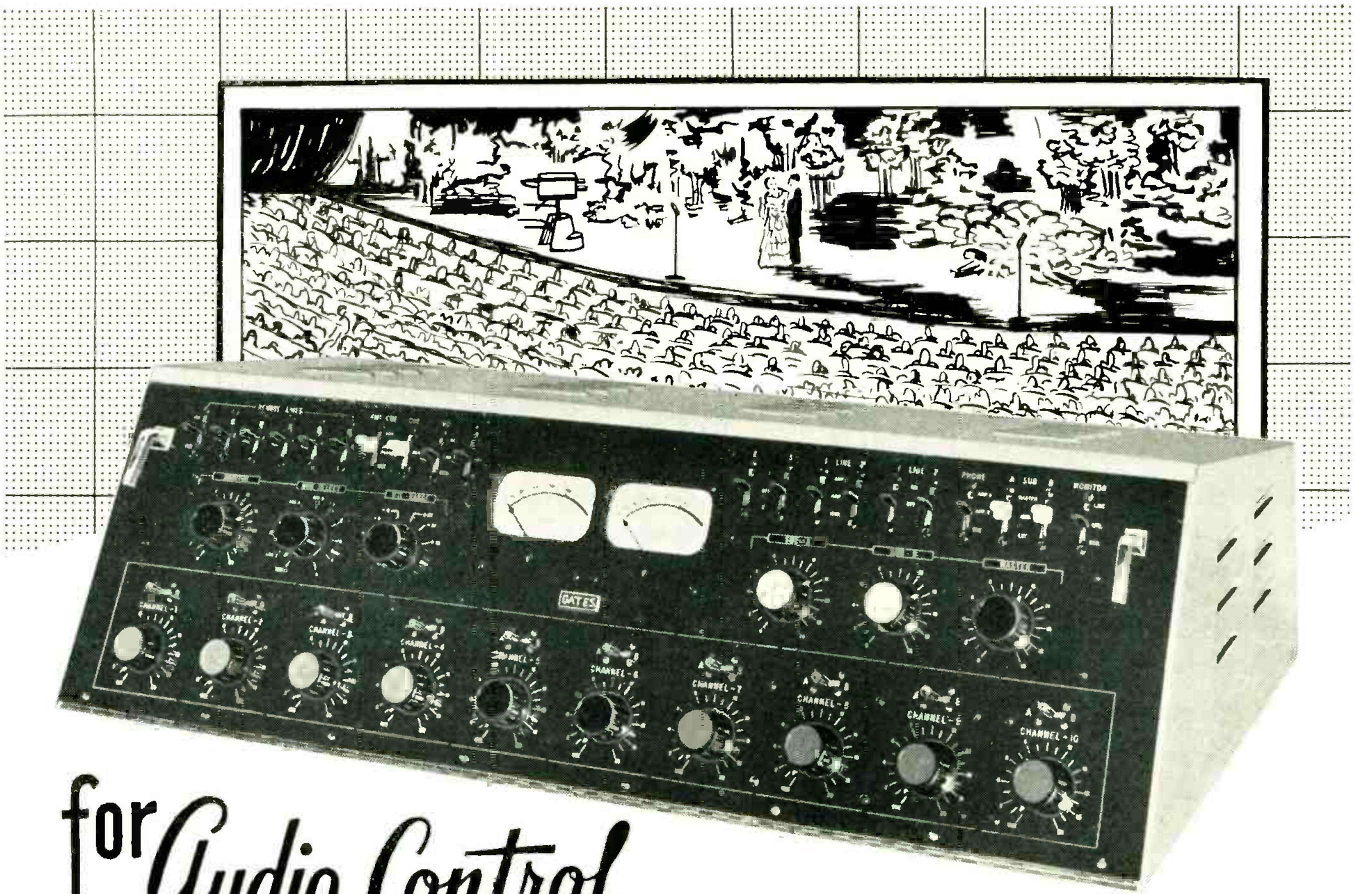
- Traffic Engineers
- Schools and Colleges
- Nurserymen and Florists
- State Park and Forest Services
- Laboratories
- Milk Plants and Ice Cream Processors
- Researchers
- Industrial Plants
- Textile Mills
- Inspection and Quality Control
- Jobbers, Wholesalers, Distributors
- Restaurants and Hotels
- Mail and Phone Order Departments
- Laundries and Linen Supply Houses
- Manufacturers of equipment for:
  - Order Control
  - Stock Control
  - Inventory Control
  - Traffic Control
  - Sales and Market Analysis
  - Laboratory Analysis
  - Payroll Preparation
- and What Do You Want to Count?

Arranged compactly on stands in tiers, the Vary-Tally can be supplied in any of 66 combinations, up to 6 banks high and 12 units wide, with a minimum of 2 units wide. Write for news sheet and prices.

"The Name that Counts" VEEDER-ROOT INC.

HARTFORD 2, CONNECTICUT

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



for *Audio Control*

THERE'S JUST NOTHING FINER!

The Gates CC-1 all plug-in audio console is *superlatively fine* — commercially beautiful to look at — warmingly satisfying to operate — technically superb — functionally complete beyond expectation — and upholds the tradition of those that have long been associated with the very best.

There is indeed a lot of pleasure and contentment in the operation of a speech input console so quality filled—that behind the control panel are parts and workmanship that spell complete reliability and assurance that your audio quality and handling cannot be excelled—anywhere.

Your 240-page Gates master catalog, Pages 120-124, or speech input catalog DS-534, tells the CC-1 story. If your copy has been misplaced, only the asking will send another on its way to you.

This Console is on display at all GATES stock-carrying branches in ATLANTA, HOUSTON and LOS ANGELES.

GATES

GATES RADIO COMPANY QUINCY, ILL., U. S. A.

Manufacturing Engineers Since 1922

Houston, 2700 Polk Avenue
New York, 51 East 42nd Street

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Los Angeles, 7501 Sunset Blvd.
New York, International Div., 13 East 40th St.

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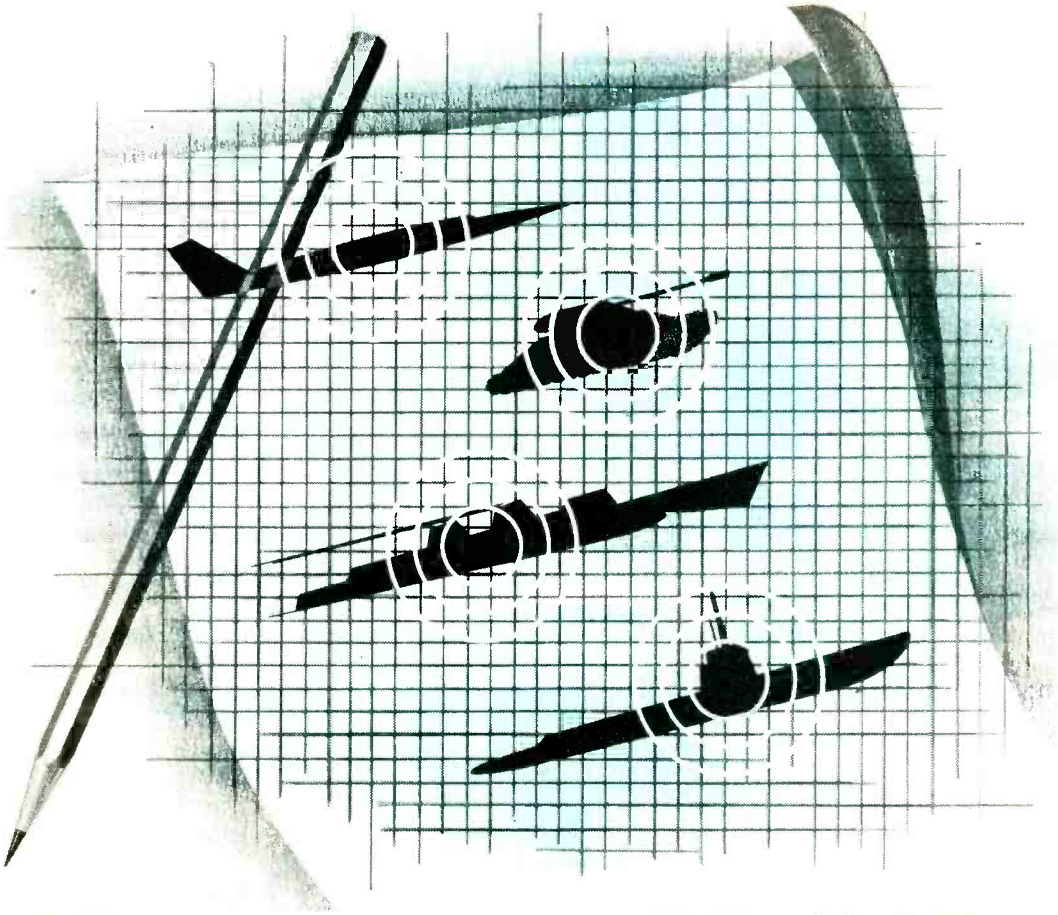
Montreal, Canadian Marconi Co.



EXPERIENCE...

When it comes to electronics . . . experience is our single greatest virtue.

The average experience of our electronic engineers is more than ten years in this specialized field.

Their contributions to this fast-developing industry are attested to by our producing acoustical-electronic firing error indicators . . . portable, high-powered, 1kw-plus long-range transmitters . . . and one-man, multi-channel UHF transceivers. If you have a problem which may be solved by the use of electro-mechanical, hydraulic, pneumatic or electronic equipment, let's talk it over.

"WE DISTRIBUTE A WIDE RANGE OF AIRCRAFT EQUIPMENT FOR A NUMBER OF AMERICA'S LEADING MANUFACTURERS. A NEARBY BRANCH WILL BE HAPPY TO SERVE YOUR NEEDS. DO MORE BUSINESS . . . REALIZE MORE PROFIT WITH AIR ASSOCIATES' EQUIPMENT."

J. E. Ashman

PRESIDENT

AIR ASSOCIATES, INC.

TETERBORO, NEW JERSEY

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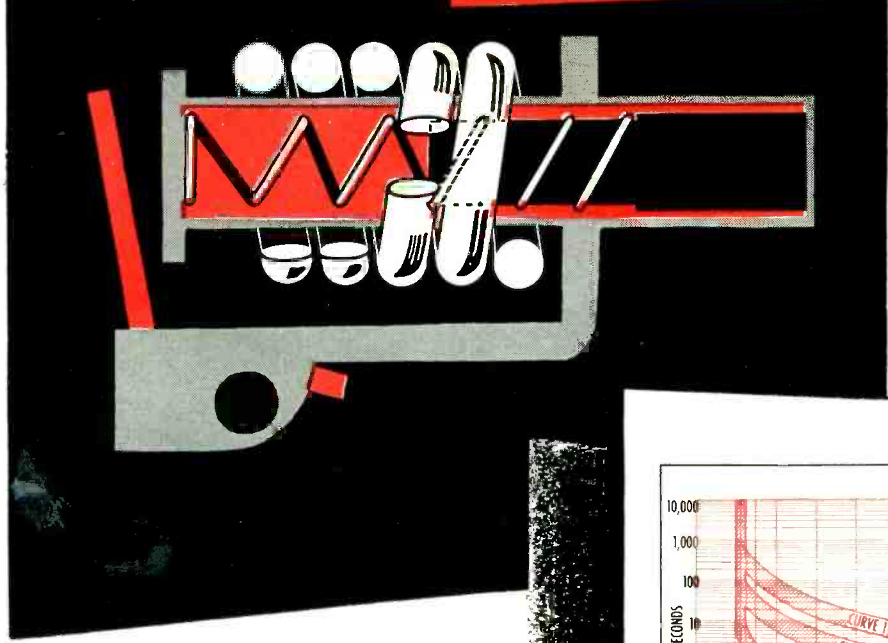
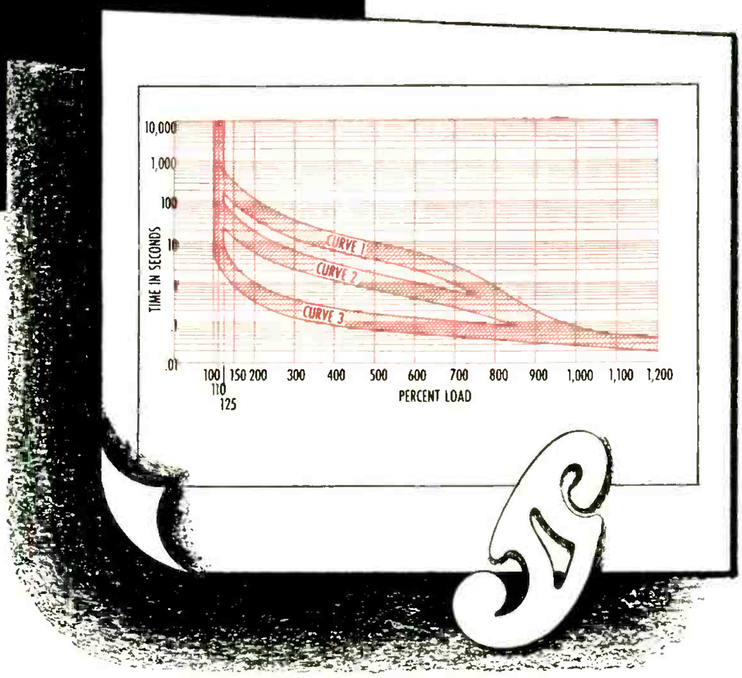
THIS PRINCIPLE...





provides custom fitted overload protection...

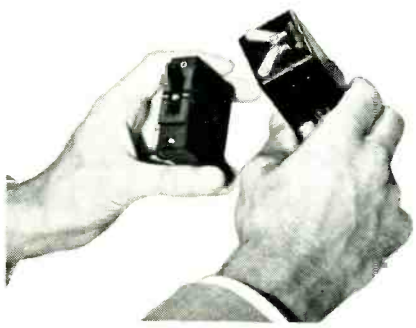
With the HEINEMANN hydraulic-magnetic principle, you can have overload protection in circuit breaker or relay form precisely designed for your product.

First, you are not limited to the nearest "standard" rating—you specify the exact rating based on the normal running current of your equipment.

Second, you have a selection of time delay response curves. Your choice is based on normal inrush characteristics as well as the size and duration of overloads that should be permitted—specifically in your product.

Furthermore, since Heinemann Circuit Breakers and Overload Relays do not employ thermal elements, their ratings never change . . . de-rating for ambient temperature is never necessary . . . nuisance power interruptions never occur. Yet, on dangerous overloads or short circuits, they provide the fastest circuit interruption available.

Send for descriptive literature.



MORE INFORMATION? *On circuit breakers (left), send for Bulletin SW; on overload relays (right) send for Bulletin 5101A.*

HEINEMANN ELECTRIC COMPANY

97 Plum Street • Trenton 2, N. J.

EST. HECO 1888

NOW—the modern successor to the galvanometer

the new ElectroniK Null Indicator

electrical characteristics

INPUT IMPEDANCE
1500 ohms

CURRENT SENSITIVITY
0.6×10^{-9} amperes per millimeter

VOLTAGE SENSITIVITY
1 microvolt per millimeter

OPERATING VOLTAGE
115 volts, 60 cycles

If you use galvanometers, you'll be interested in the new *ElectroniK* Null Indicator. For here, at last, is the lab man's ideal d-c null balance detector . . . completely free from all the limitations of galvanometers.

It's easy to use—no "loss of spot" from excess signal; bridge balancing operation is simplified.

It's self-protecting—will take heavy over-loads without damage.

It's vibration-proof—undisturbed by nearby traffic or machinery.

It goes anywhere—needs no leveling or special mounting; plugs into 115-volt 60-cycle line; small case fits readily into experimental set-ups.

It's stable—holds steady zero after warm-up.

It's fast—indicates in less than one second; ideal for production testing.

It's sensitive—suitable for use with high precision measuring circuits.

The *ElectroniK* Null Indicator is priced within reach of any budget. It will be a valuable asset to your lab. Write today for complete information.

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

● **REFERENCE DATA:** Write for Instrumentation Data Sheet No. 10.0-12.

H HONEYWELL

MINNEAPOLIS **Honeywell** BROWN INSTRUMENTS

First in Controls

DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

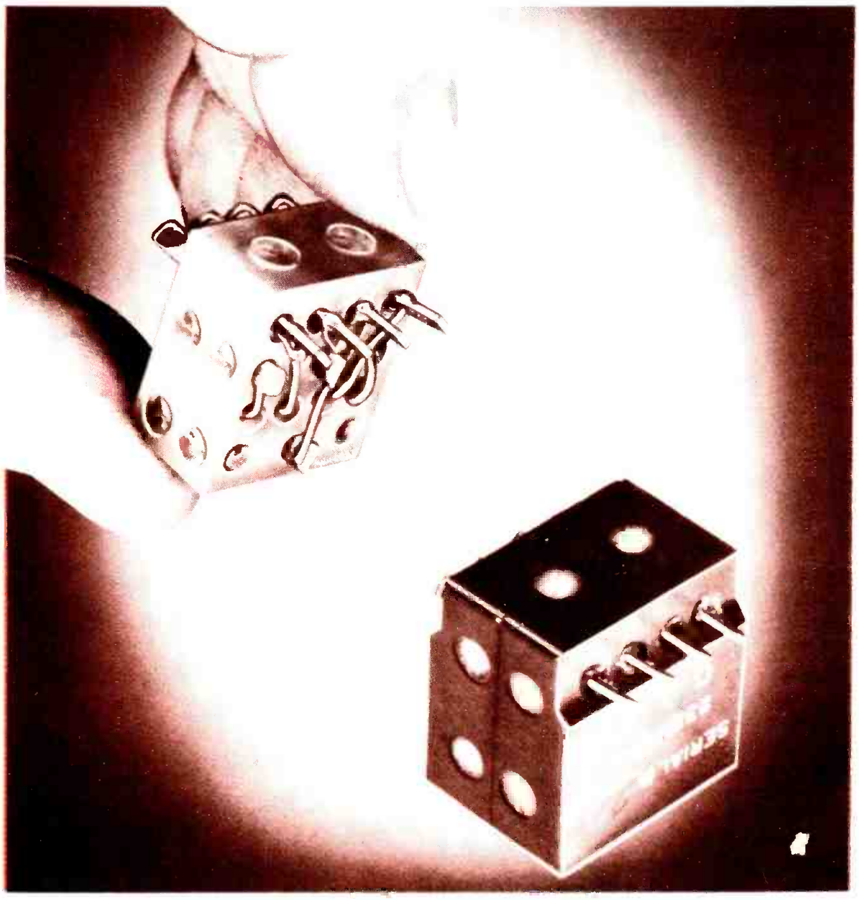
Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company APRIL-MAY 1954

Rectifier Molded in Kel-F® Plastic, Smaller Than a One-inch Cube ... Boasts 100-G Shock Resistance

Unmatched compactness, high electrical efficiency under severe conditions, and exceptional durability are advantages gained by using "Kel-F" trifluorochloroethylene polymer to insulate this double-bridge instrument rectifier. The size of the rectifier belies its 3-ma output from each of two 130-volt rms full-wave bridges. Insulation of the many rectifier wafers and resistors in the unit is enhanced by the exceptionally high electrical resistance of "Kel-F". The high strength and stability of the molded fluorocarbon block also enable it to serve as a mount for parts, since the plastic is unaffected by high thermal and shock loads.

The parts of the rectifier are assembled in a block of injection-molded "Kel-F", which, in turn, is encased in plastic. The unit is made by International Resistance Company, Philadelphia, Pa., to specifications of the Raytheon Manufacturing Company, Waltham, Mass. Rectifier is employed in phase-comparator applications, has many other potential uses.

For further information ask for Application Report E-122



Magnetic Stirring Bars Sealed in Kel-F® to Stop Corrosion and Breakage

A vacuum-tested casing of "Kel-F" permits these metal bars to be used indefinitely to "mix" highly corrosive acids, alkalis, solvents and peroxides—at from minus 200°C to plus 200°C—without corrosion or breakage. The fluorocarbon "skin" cannot crack or chip. Non-porous and non-absorbent, the covering is virtually self-cleaning, can even be sterilized.

Three sizes of stirring bars are now made by the Arthur H. Thomas Company of Philadelphia, Pa., by sealing cylindrical permanent magnets into extruded tubing. Extruded from unplasticized "Kel-F" Grade 300 by the Plax Corporation of Hartford, Conn.

For further information ask for Application Report C-115

(SEE REVERSE SIDE)

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

MOLDING POWDERS

KEL-F

FLUORO CHLORO CARBON PLASTIC

KEL-F

DISPERSION COATINGS

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

OILS WAXES GREASES

 CONTINUED FROM PRECEDING PAGE

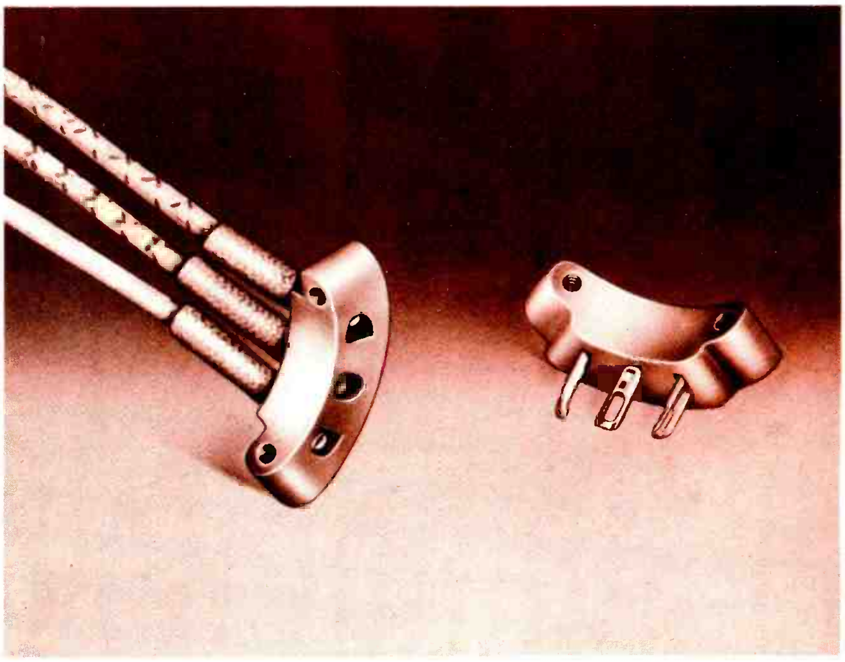
Coil Connector of Kel-F® Boosts Actuator Motor Performance and Output, Simplifies Maintenance

Molding this coil connector for a miniature motor from "Kel-F" made possible the addition of a vital brake clutch, a sharp increase in output and the use of time-saving solderless terminals—without increasing the unit's size.

High insulation resistance of "Kel-F" under thermal cycling, allowed specification of a lighter connector for effective insulation over the temperature range of minus 65°F to 200°F without tracking or shorting. Exposed to high humidity, the plastic's zero water absorption prevents arcing or dissipation. Then non-wetting and smooth surface of the molded connector is fungus-inert.

The connector is injection molded from "Kel-F" unplasticized polymer by the United States Gasket Company of Camden, New Jersey. The Grand Rapids Division of Lear, Incorporated, manufacturers of precision aircraft instruments and electronic systems, uses this connector in a D.C. motor.

For further information ask for Application Report E-123



Molders & Fabricators of the Month

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

Brilhart Plastics Corporation
Mineola, N. Y.
Injection, Compression & Transfer Molding
Electrical & Electronic Components
Gaskets, Diaphragms & "O" Rings

Fluoro Plastics, Incorporated
Philadelphia, Pa.
Compression & Transfer Molding
Gaskets & "O" Rings; Valve Seats; Containers
Electrical & Electronic Components

The Garrison Company
Kenilworth, N. J.
Extrusion & Production Machining
Electrical & Electronic Components
Wire Insulation

Penn-Plastics Manufacturing Co.
Glenside, Pa.
Compression & Transfer Molding
Electrical & Electronic Components

Porous Plastic Filter Company
Glen Cove, N. Y.
Porous Filters

Recent Significant Developments in "Kel-F"

Electronic Tube Caps boost performance of high-altitude communications equipment, removing interference from thermal cycling, high humidity.

Asbestos, Glass Fiber, other fillers being successfully incorporated in molded parts in high temperature, corrosive valve service, structural electrical members.

Float Bodies of "Kel-F" and powdered metal incorporated in flowmeter bodies machined of "Kel-F" for smaller, more accurate measuring devices for severe corrosives, liquid or gaseous.

Welding, by "hot gas" method being used in fabrication of corrosion-resistant feed hoppers.

Visit the Kel-F POLYMER EXHIBIT at the Basic Materials Show May 17-20 -- Chicago, Ill.

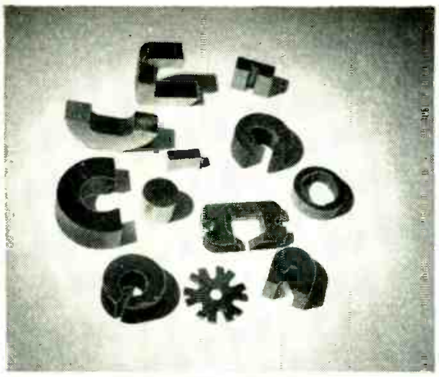
® *Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymer products.*

...that's why it's smart business to buy from a specialist

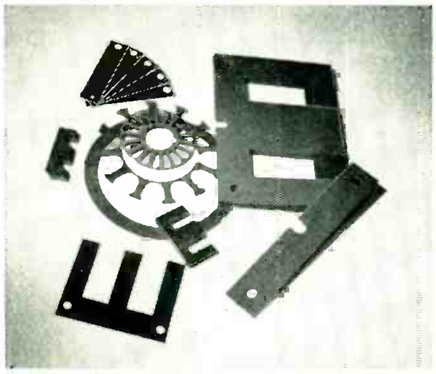
Through more than 50 years of specialization in the development and production of magnetic materials, Thomas & Skinner has gained the skills and know-how that *assures* you the *best* in engineering assistance—the *best* in quality production . . . at prices that may be lower than you are now paying.

It will pay you to investigate the many advantages offered by Thomas & Skinner . . . *specialists in magnetic materials* . . . permanent magnets, electrical laminations, and wound cores.

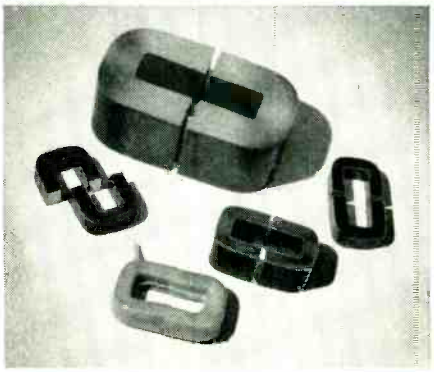
Specialists in magnetic materials, Permanent Magnets, Electrical Laminations and Wound Cores



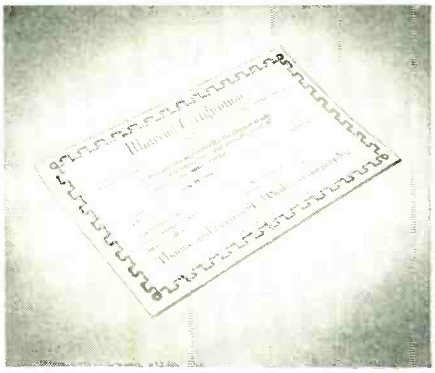
PERMANENT MAGNETS Whatever your needs — Alnico, cobalt, chromium—Thomas & Skinner can meet your specifications for either standard designs or special shapes. Typical of T&S advanced materials is Alnico 5Cb, offering an energy product of 5.70 million *nominal*. And typical of T&S advanced techniques is shell-molding, offering intricate shapes with tolerances as close as ± .005" without grinding or finishing.



ELECTRICAL LAMINATIONS Geared to high volume production, T&S uses the most modern equipment available to produce high quality laminations in quantity at the lowest prices possible. Rigid quality control is maintained through each phase of production—stamping—atmosphere annealing— every vital step in producing top quality laminations. For every type application, T&S can provide all grades, all gauges to meet your demands for standard or special laminations. T&S's OrthoSil is also available for applications requiring directional electrical characteristics with extreme high permeability and low core loss.



WOUND CORES You can save on both assembly costs and time —and reduce both size and finished weight—with "C" Type and Toroidal Wound Cores made from T&S OrthoSil. The directional magnetic characteristics and extremely rectangular hysteresis loop of oriented OrthoSil have proved advantageous on hundreds of applications, particularly in 400 cycle equipment at flux densities of 15,000 gauss and over.



Did you know... that you can now buy electrical laminations that are pre-tested with the certified reports sent to you with each shipment. Yes, Thomas & Skinner certifies that each order of laminations is tested and meets the most rigid specifications . . . you receive test figures for both core loss and exciting current *at* 10M gauss on each heat annealed. This means an additional savings to you since it eliminates the need for retesting on your part. Many of the leading transformer manufacturers specify T&S CERTIFIED LAMINATIONS. Perhaps you should too!

write today for free catalogs!

- ☐ Magnet Design — Bulletin 151 (for the design engineer)
- ☐ Standard Magnets — Catalog SM-1252 (complete data with dimensional drawings)
- ☐ Alnico 5Cb — Bulletin 1253 (details on today's newest Alnico)
- ☐ Laminations — Bulletin L-752 (applications, specifications, value graphs)
- ☐ Wound Cores — Bulletin WC-353 (specifications, value graphs)

Name and Title ________________

Company ________________

Address ________________

City ________________

Thomas & Skinner
STEEL PRODUCTS COMPANY, INC.

1122 EAST 23RD STREET
INDIANAPOLIS, INDIANA

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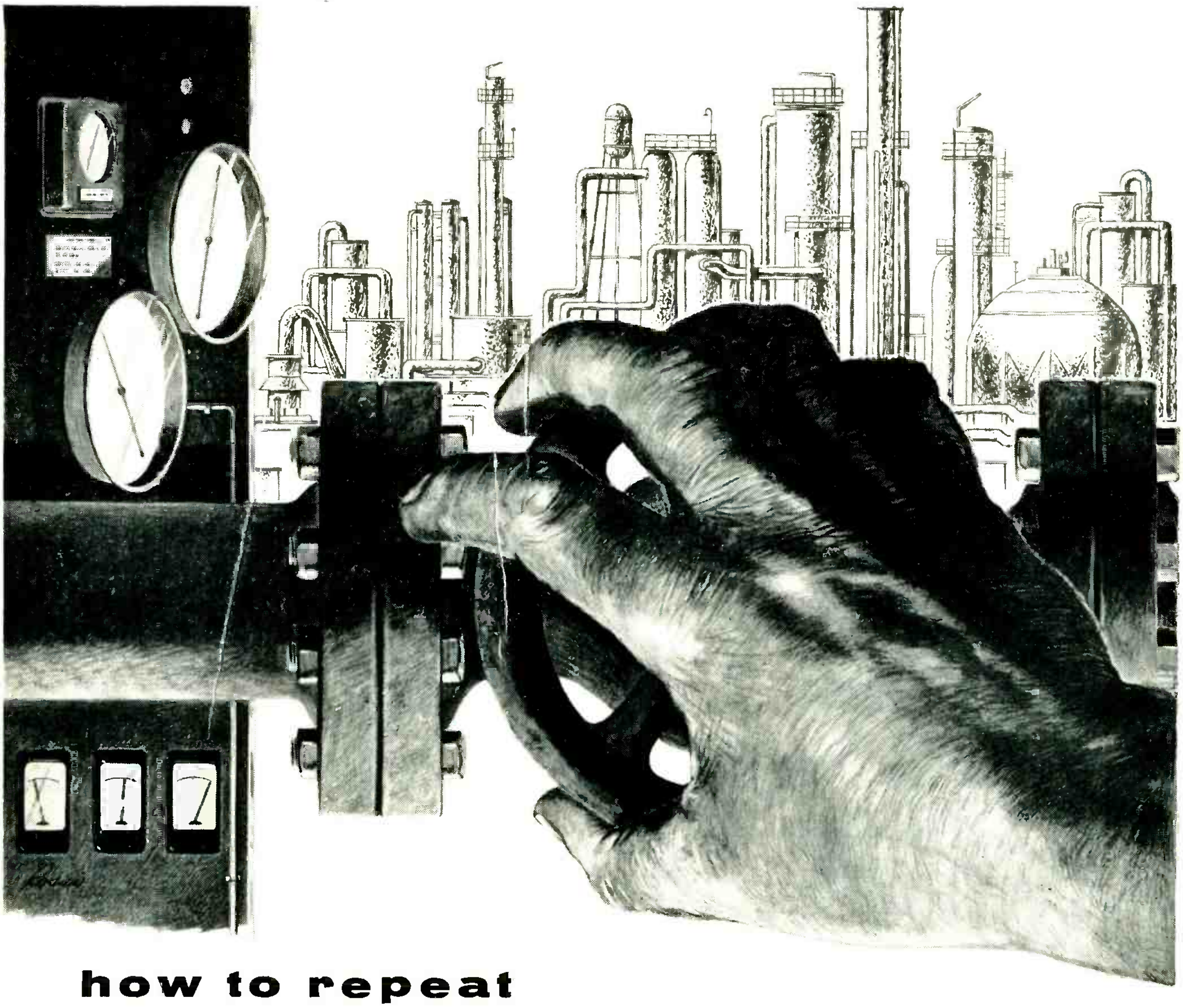

how to repeat a master touch

an electronic answer to process control

"The master touch" by which a process achieves a perfect result may be a lucky combination of temperatures, pressures, agitation, timed feeding of ingredients and numerous other variables. But the desired results could be achieved every time — provided an exact process pattern could be fed to electronic controls.

Ampex recordings provide a "perfect memory" — Practically any chemical, metallurgical or manufacturing process can be "remembered" intact on magnetic tape by an Ampex Recorder. Any likely number of variables can be recorded concurrently and with high accuracy. They occupy parallel channels on a single width of magnetic tape; timing and synchronization are inherently perfect.

The Ampex playback can actuate any reaction — From this magnetic tape, the process is "played back" as a pattern of electrical signals. These can operate valves, thermostats or pressure controls and can run motors, adjust speeds or control any other necessary mechanical or electrical responses. Thus a magnetic tape can repeat any process sequence that previously achieved a successful result, controlling it more closely than even a standby operator.

Wherever you control a sequence of operations, magnetic tape may achieve important advantages. For further information, write today to Dept. ***E-1447***

AMPEX
CORPORATION

AMPEX CORPORATION
934 Charter Street • Redwood City, California
Branch offices: New York, Chicago, Atlanta, San Francisco and College Park, Maryland (Washington, D.C. area).
Distributors: Radio Shack, Boston; Bing Crosby Enterprises, Los Angeles; Southwestern Engineering & Equipment, Dallas and Houston; Canadian General Electric Company, Canada.

ERIE

Complete line of

DISC CERAMICONS®

HIGH VOLTAGE

HIGH VOLTAGE DISC CERAMICONS employ the same basic diameters that have been standardized in 500 volt Ceramic capacitors. Careful and detailed life testing has been accomplished over a long period of time to establish required dielectric thicknesses to assure conservative ratings in the high voltage line. Standard voltage ratings range from 1,000 through 6,000 Volts, D.C., Working.

TEMPERATURE COMPENSATING

TEMPERATURE COMPENSATING DISC CERAMICONS, in four sizes, offer all standard combinations of temperature coefficient and capacitance value. They are tested for conformance to Erie specifications for Tubular Ceramicons and meet all requirements for RETMA REC-107A Class 1 ceramic capacitors. They are available in capacity ranges up to 1940 mmf.

GENERAL PURPOSE

GENERAL PURPOSE DISC CERAMICONS have low series inductance which assures efficient high frequency operation. They are made in sizes from 5/16" to 3/4" diameter, and in capacitance values ranging from 4.5 mmf to .02 mfd.

ERIE DISC CERAMICONS are available in three classes, each having a wide range of capacitance values for the basic applications. These capacitors consist of flat ceramic dielectrics with fired silver electrodes. Lead wires are firmly soldered to the electrodes, and completed units are given a protective coating of wax impregnated phenolic. For complete description and specifications, write for catalogs and samples.

ERIE components are stocked by leading electronic distributors everywhere.

TRADE ERIE MARK
RESISTOR CORP.

ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

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RATIOS FROM 20:1 TO 3125:1

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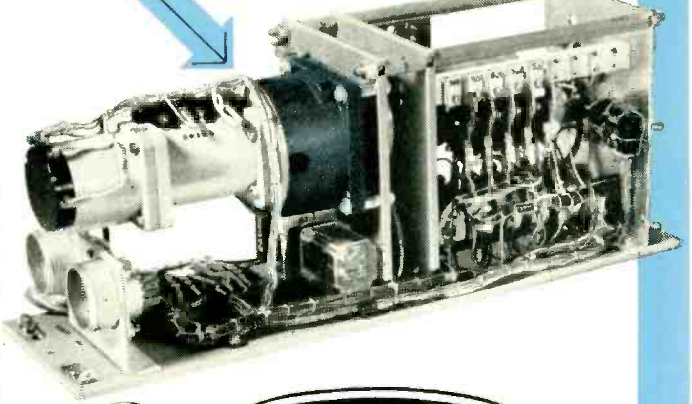
This light weight, lifetime lubricated gear box is now being produced in quantity – with custom craftsmanship.



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Manufacturers of the world-famous Link Trainers, servo-mechanisms, servo-amplifiers, graphic recorders, fractional h.p. wide range variable speed drives, spur gear differentials, friction and overdrive clutches, index dials, phase angle meters, ratio voltmeters, precision potentiometers and other special electronic devices.

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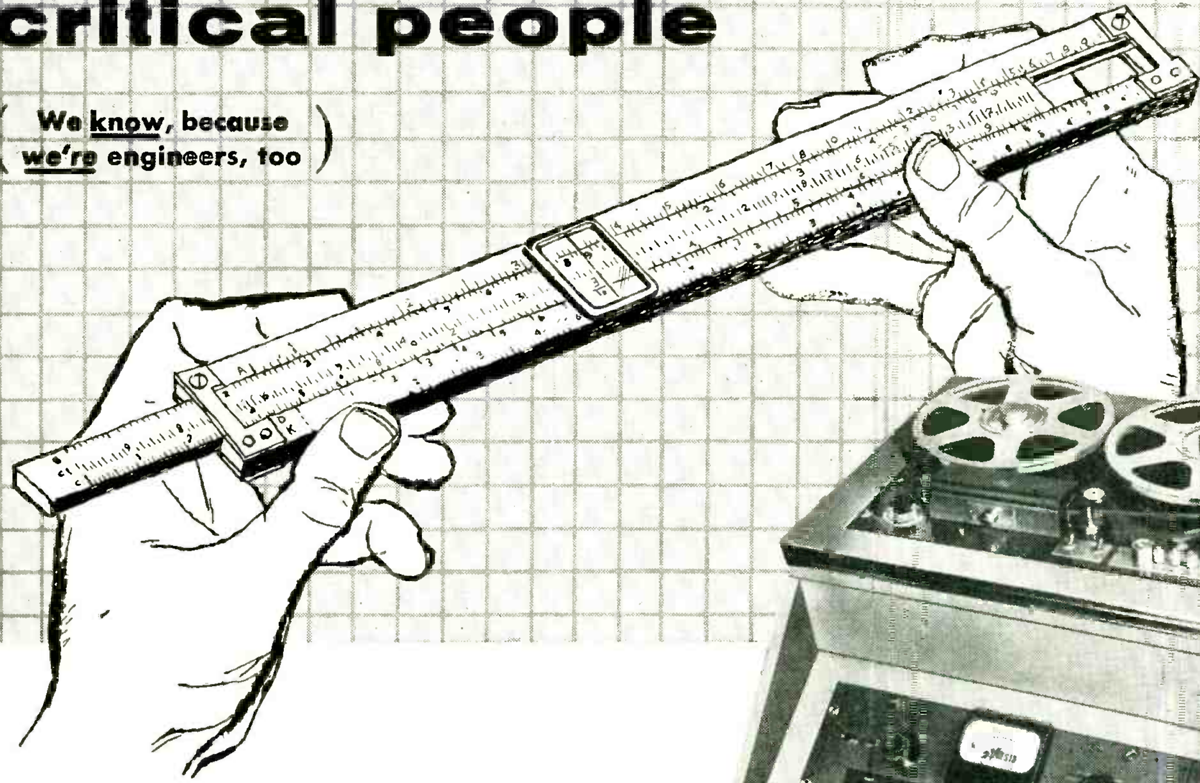
(We know, because we're engineers, too)



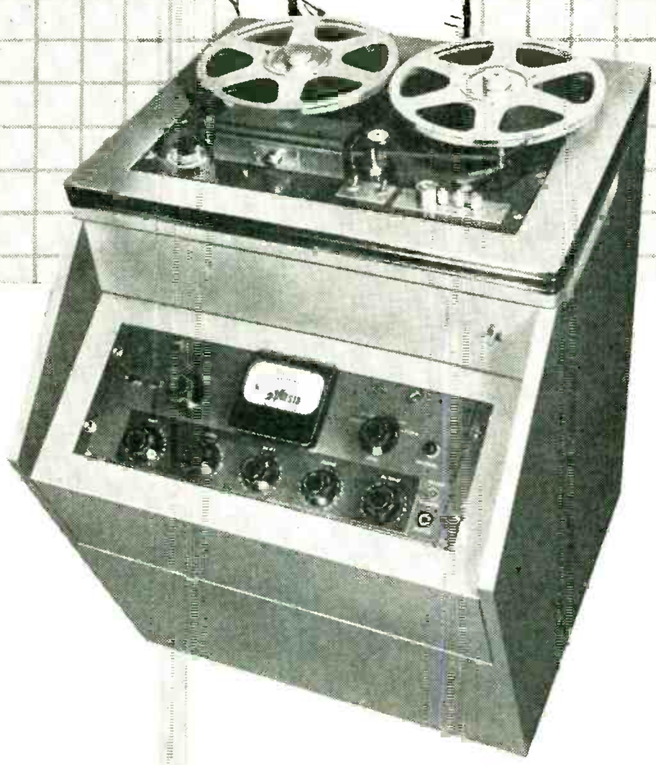
Radio and TV stations, recording studios, commercial and industrial film studios, testing laboratories, program production organizations and a host of others have long needed a thoroughly professional, well designed, easily maintained tape recorder.

More than a year ago, Presto's top engineers were assigned to the development of such a recorder. Months later a test model was completed which not only met these specifications, but embodied a completely new principle of recorder design . . . unitized construction; the entire capstan drive is a separate, easily removed unit.

The instrument was designated "Model RC-11," and then a series of rigorous tests were begun. The RC-11 was run continuously for hours at a time under the most adverse conditions. These tests resulted in further improvements.

Finally, when we were satisfied that this was the finest tape recorder of its type that could be built, we tooled up and put it into production.

By reputation engineers are the most critical people on earth. (We know, because *we're* engineers, too.) And, some of the most qualified recording engineers who have seen and operated the RC-11 share one opinion . . . that here is the finest, easiest to operate, best performing tape recorder available today.



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IN CONSOLE WITH 900-A3 AMPLIFIER

- Self-contained Capstan Drive Unit—3 motor drive.
- Three magnetic heads in metal enclosure.
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- Reel capacity to 10½" diameter.
- Response: 50 to 15,000 cycles ± 2 db.
- Flutter: less than 1½% at 15"/sec.
- Signal to noise: 55 db. at 2% distortion.

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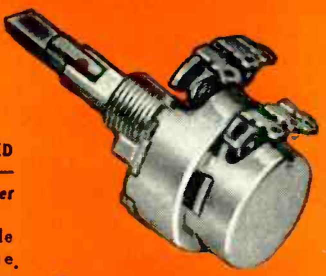
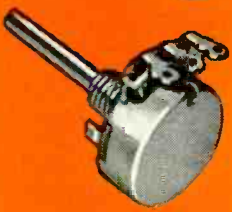
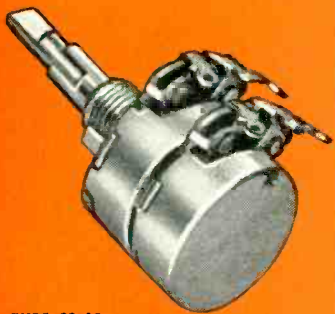


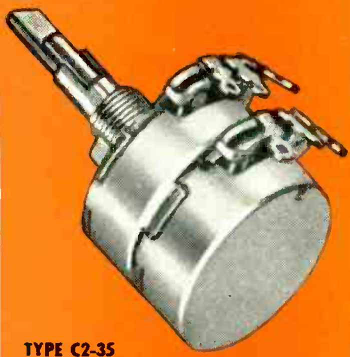
TYPE C45-70



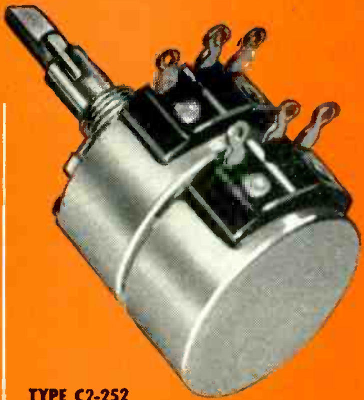
NEW HIGH QUALITY MINIATURIZED "DIME-SIZE" CIVILIAN CONTROL—*Performance Fully Equals Larger Types.*
TYPE 70, 3/4" diameter variable composition resistor. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms. Also available in concentric shaft tandem construction C45-70 as shown above.



TYPE C2-45



TYPE C2-35



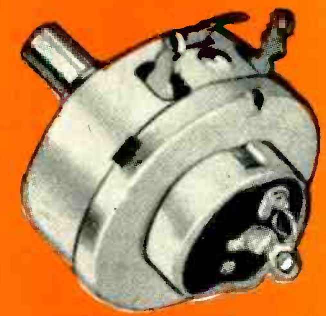
TYPE C2-252

TYPE C2-25

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

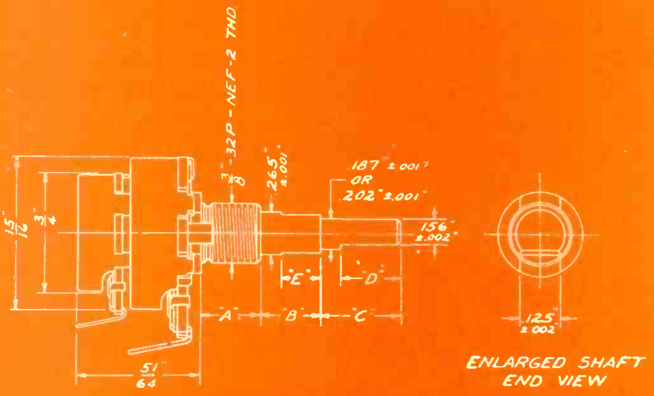
TYPE GC-35, 1 1/8" diameter variable composition resistor. Wattage rating: 3/4 watt for resistances through 10,000 ohms, 2/3 watt for resistances over 10,000 ohms through 25,000 ohms, 1/2 watt with 500 volts maximum across end terminals for resistances over 25,000 ohms. Available with or without illustrated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

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



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

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



TYPE C45-70

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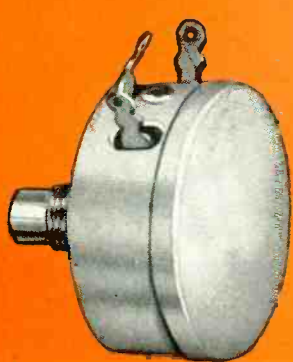
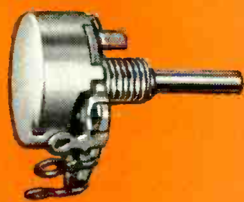
TYPE 45, (JAN-R-94, Type RV2)
1/4 watt, 15/16" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

TYPE 35, (JAN-R-94, Type RV3)
1/2 watt, 1 1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

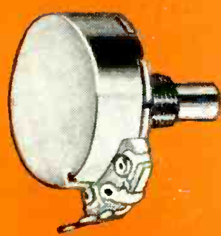
TYPE 252, (JAN-R-19, Type RA20)
2 watt, 1 17/64" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.



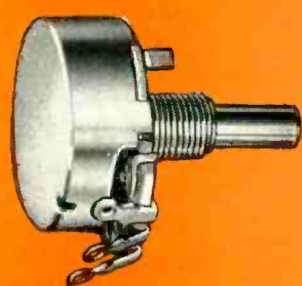
TYPE 25, (JAN-R-19, Type RA30)
(May also be used as Type RA25)
4 watt, 1 17/32" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.



TYPE 65, (Miniaturized)
1/2 watt 70°C, 3/4" diameter miniaturized variable composition resistor.



TYPE 90
1 watt 70°C, 15/16" diameter variable composition resistor. Attached switch can be supplied. Also available in concentric shaft tandem construction.



TYPE 95, (JAN-R-94, Type RV4)
2 watt 70°C, 1 1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

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Specially designed for military communications equipment subject to extreme temperature and humidity ranges. −55°C to +150°C...aridity to saturation.

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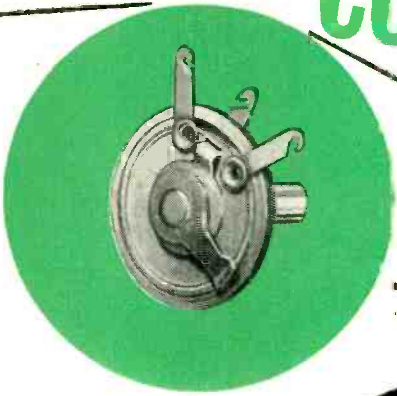

The original "Humdinger" Series MH. Compact, rugged, wire-wound control. Virtually millions in use. Fibre base holds resistance winding. Movable arm and shaft. 1-watt. 2 to 1000 ohms.

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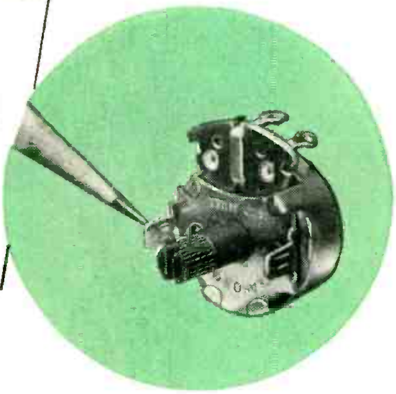
Agents in all principal cities. ★ Wire Western Union — we have a direct wire. ★ Telephone Dover 975 — we have added trunk lines to render service. ★ Teletype — our TWX number is Dover 275-U.



Twist-Tab Mounted Series 47. Eliminates usual bushing, lockwasher, nut. Composition-element control. Metal or plastic shaft. Plastic shaft has rear slotted protrusion, therefore adjustable from front or rear.

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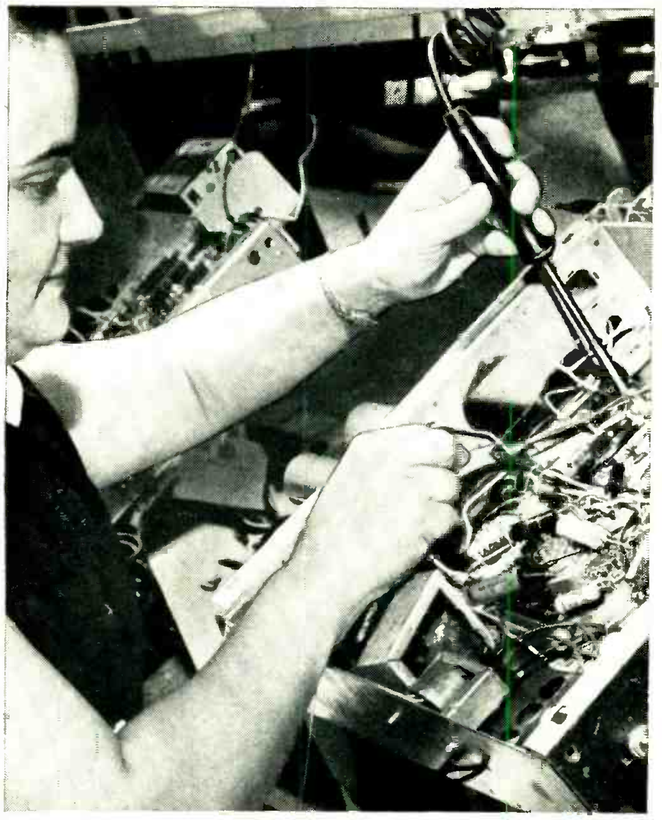

LIGHT-AS-A-PENCIL G-E MIDGET reduces operator fatigue, has longer-lasting Ironclad tip. The Midget solders like a pencil dots an "i."

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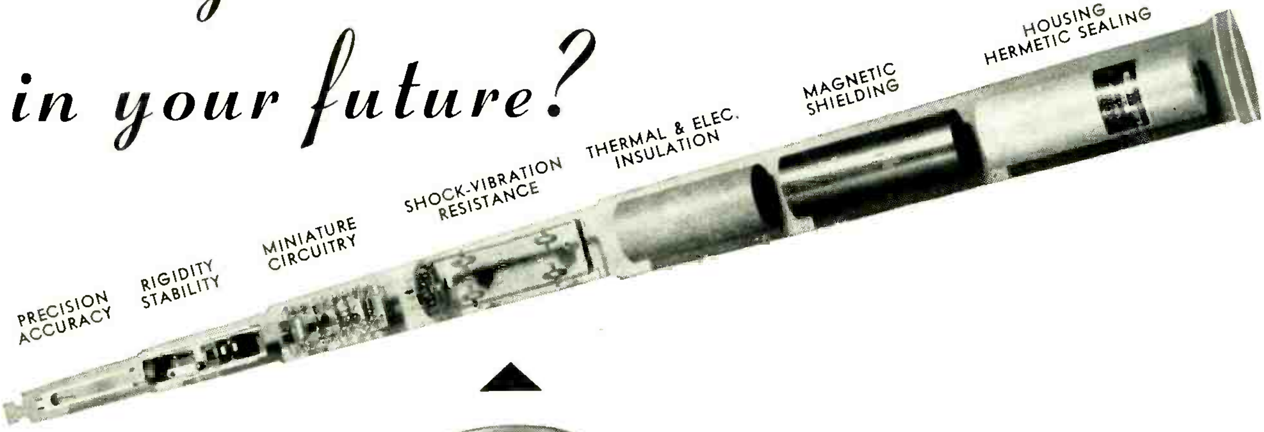

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FEATURES — Plug in
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Shock-vibration resistant
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Meets JAN-MIL specifications

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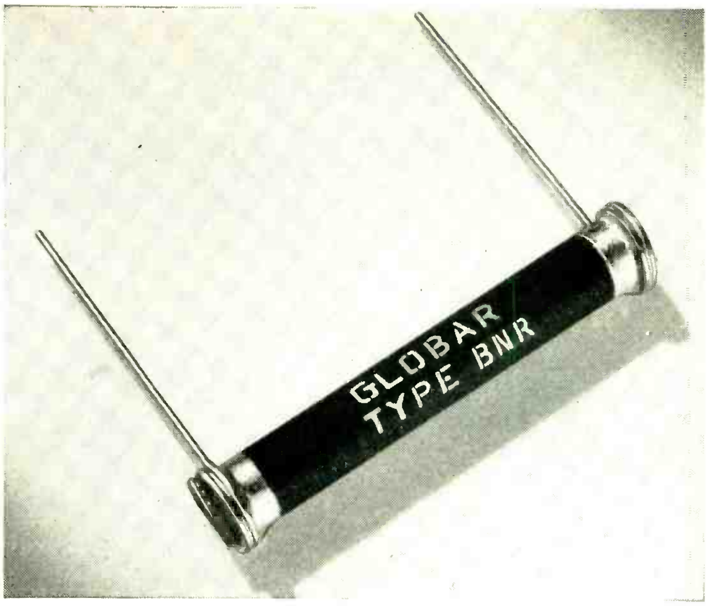
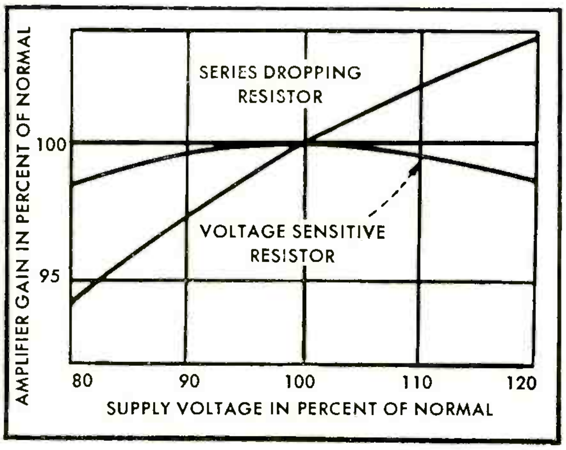
Stabilize Amplifier Gain with

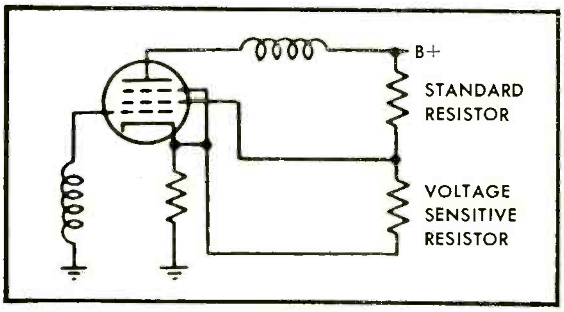
GLOBAR® TYPE BNR VARISTORS





◀ Variation of gain with supply voltage for 12SK7 pentode in circuit using linear resistors and voltage sensitive (non-linear) resistors.

Circuit using voltage-sensitive resistors has voltage divider returned to ground through cathode resistor. ▶



Varying supply voltages need *not* affect performance of pentode amplifiers. A GLOBAR® Type BNR Voltage Sensitive Resistor in the low potential section of the voltage divider—returned to ground through the cathode resistor, as shown in this circuit for a 12SK7—effectively limits gain fluctuations to within ±0.2% when supply voltage varies from −10% to +10%. The same supply variation in a conventional circuit, with a regular series dropping resistor, results in fluctuations up to ±2.5%... more than 12 times as great.

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temperature & low voltage characteristics

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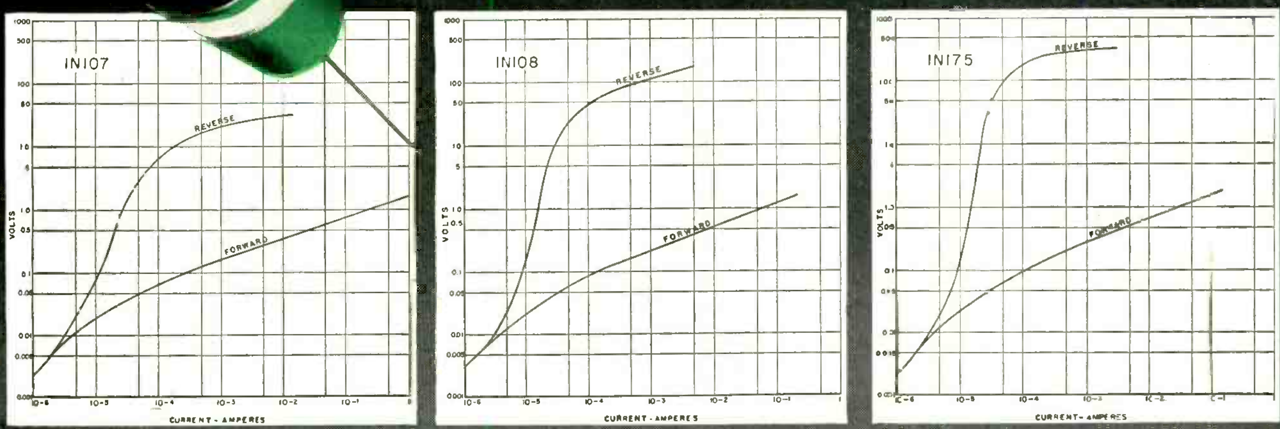
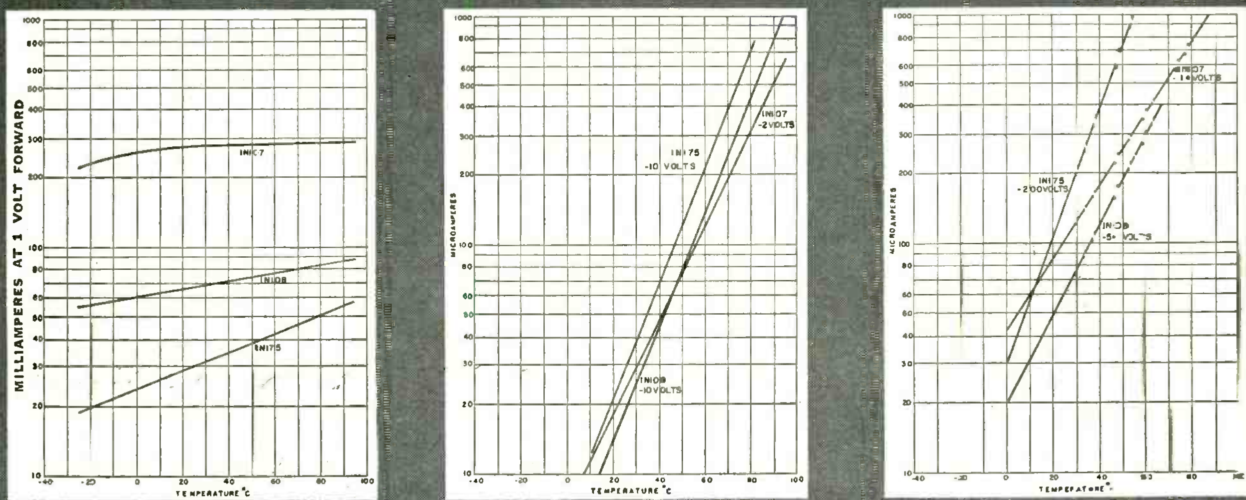


FORWARD & REVERSE CHARACTERISTICS OVER CURRENT & VOLTAGE RANGES



FORWARD & REVERSE CHARACTERISTICS UNDER TEMPERATURE CHANGES

Your inquiries are invited on the many uses of Union Diodes exclusive with National Union. You will find that Union Diodes have characteristics particularly useful to the circuit designer interested in small signal and pulse applications. For example, the turn-on and turn-off time of the 1N107 is equal or superior to most point-contact diodes.

The accompanying charts show the Union Diode's behavior with temperature variations. Also plotted, over wide ranges of voltage and current, are their forward and reverse characteristics.

Important to you is the fact that Union Diodes are produced by the electronics engineers who helped pioneer the original research and development leading to such devices.

NATIONAL UNION RADIO CORP.

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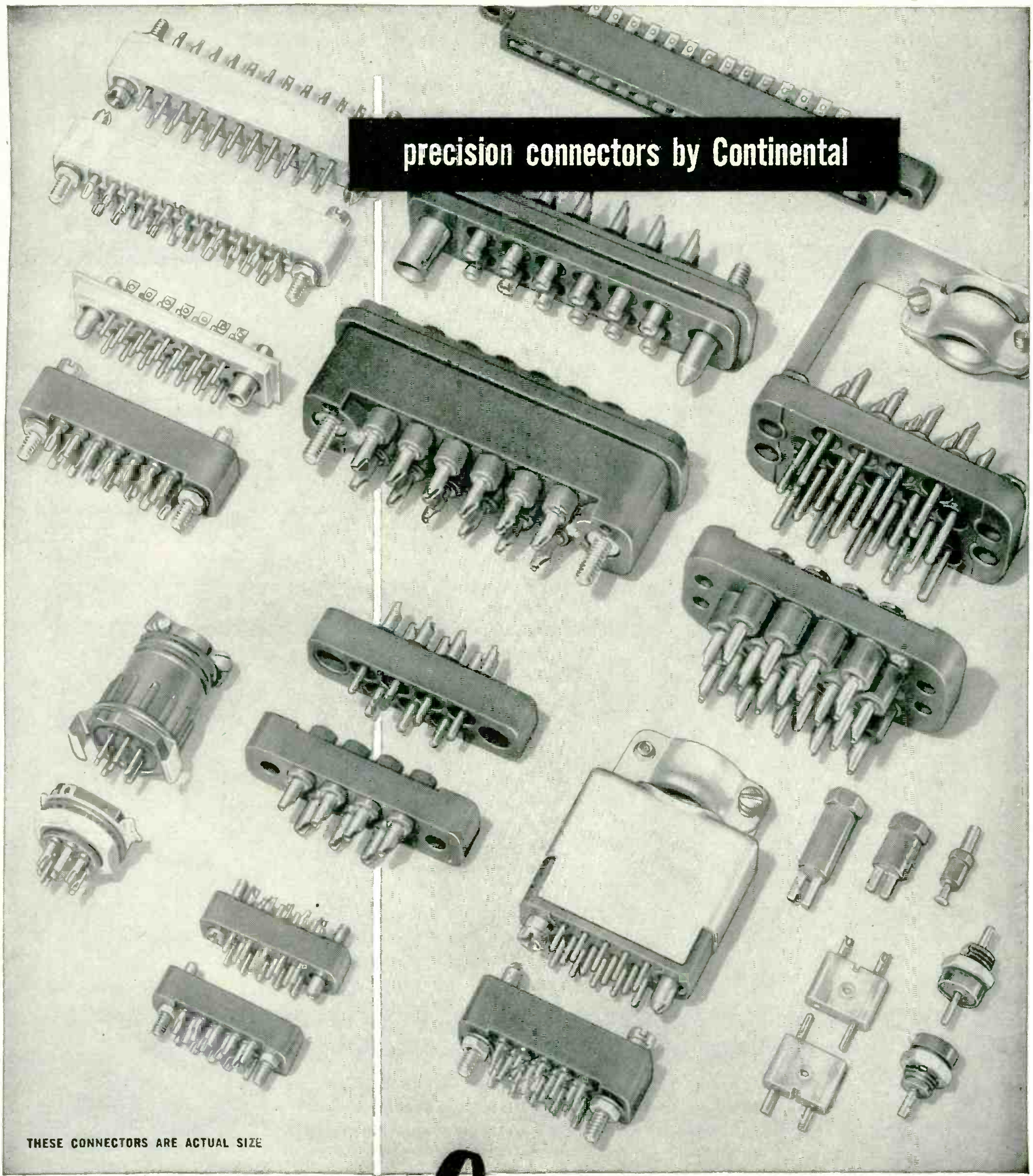

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SPECIFY *Micro* BEARINGS

TO MEET DESIGN NEEDS IN SMALL BEARINGS . . . . .

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THE MICRO FAMILY OF RETAINERS ▼

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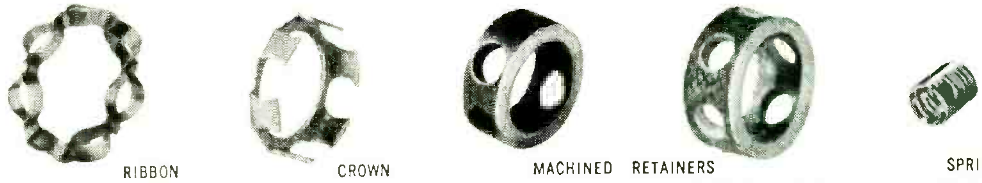
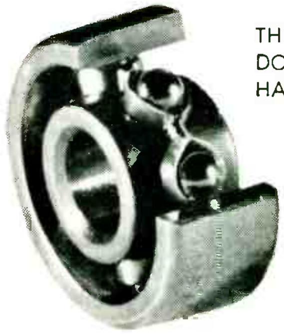


RIBBON RETAINER — CROWN RETAINER — MACHINED RETAINERS METAL — PHENOLIC PLASTIC — SPRING SEPARATOR

A MICRO FIRST



THE NEW RIBBON R2 DOES NOT WIND-UP HANG-UP OR FALL OUT

For Easier Mounting, Simplified Design and Lower Machine Costs, Specify Micro Flange Type

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH, N. H.
MICRO CIRCLE **TELEPHONE 424**

Look to PHELPS

REALISTIC APPROACH TO

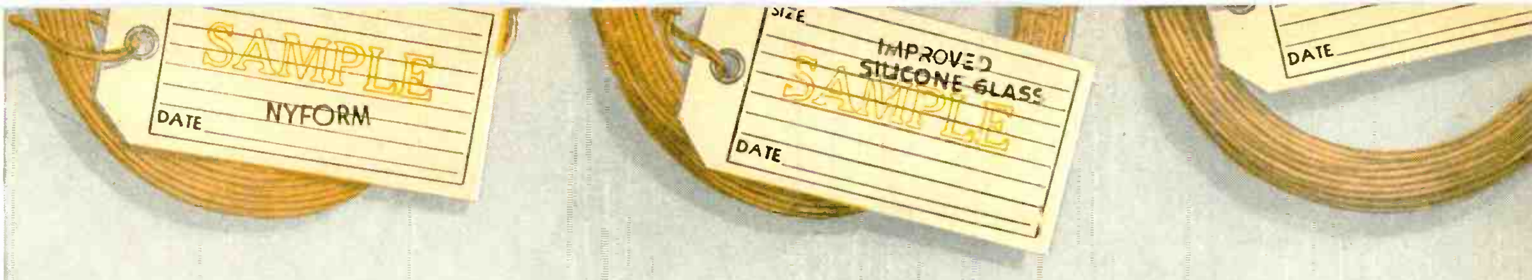
PRACTICAL KNOWLEDGE of magnet wire application problems and trends.

CONTINUING INVESTIGATION of existing insulations to improve quality and performance.

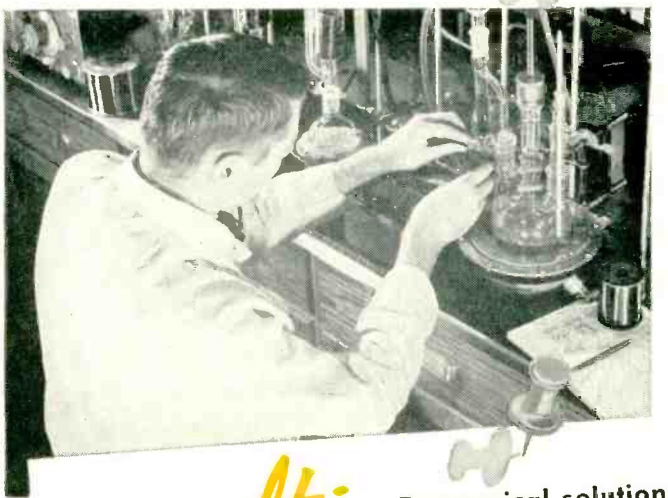
EXHAUSTIVE TESTING and evaluation of new organic and inorganic insulation materials to determine fundamental properties and application possibilities.

ENGINEERING ASSISTANCE in selection and use of exactly right magnet wire for specific motor, transformer or coil.

First for Lasting Quality—from Mine to Market



DODGE for a MAGNET WIRE RESEARCH!



Result: Economical solutions to many varied and complex application problems!

The magnet wires pictured here illustrate the wide range of the Phelps Dodge line. Some of these wires—developed specifically by Phelps Dodge to answer special problems—suggest unlimited new applications for the future with overall savings to the user. Bondeze and Sodereze are examples of this kind of research.

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

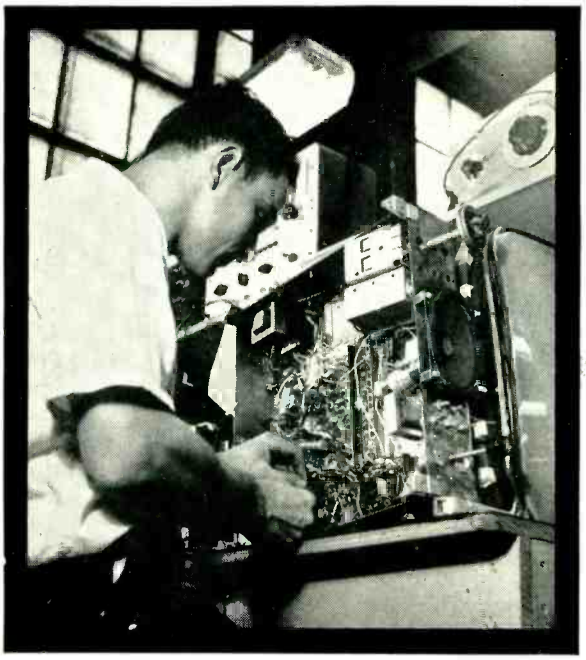
PHELPS DODGE COPPER PRODUCTS CORPORATION — P D — MINE TO MARKET — REG. U. S. PAT. OFF.

PHELPS DODGE COPPER PRODUCTS
CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

A career in

advanced electronic development



Designers for Industry, Inc. is helping many well-known electronics manufacturers meet the "challenge of change" by providing a pool of technical talent unsurpassed by any product development organization.

Our 180-man engineering organization not only generates product ideas. We are also equipped, by experience and facilities, to carry the project through its various stages of development to a final, tested, pre-production model.

In the Electronics field, the DFI organization has built a particularly strong background in miniaturization and modular construction techniques. Some of the many types of development projects we handle are listed below.

Opportunities for unlimited advancement are available at DFI for engineers who have proven records in electronics, electrical, electromechanical, hydraulic and mechanical engineering. Write for further information regarding opportunities in creative engineering work at DFI, as well as DFI employee benefits.

DFI development work in electronics includes:

COMMUNICATIONS
- VHF, UHF, and HF Receivers
- Television Receivers
- VHF and UHF Transmitters
- Microwave Systems
- Mobile and Specialized Military Equipment

MISSILE GUIDANCE
- Systems
- Servomechanisms

RADAR
- Circuitry
- Servo Systems
- Display Systems
- Mechanisms
- Beacons
- Systems
- Fire Control

CONTROLS
- Electromechanical
- Servomechanisms

COMPUTERS
- Test Equipment
- Systems Planning
- Circuitry
- Servomechanisms
- Intricate High-speed Mechanisms

COMPONENT PARTS
- Mechanisms
- Evaluation Programs
- Special Components

DESIGNERS FOR INDUSTRY, Inc.

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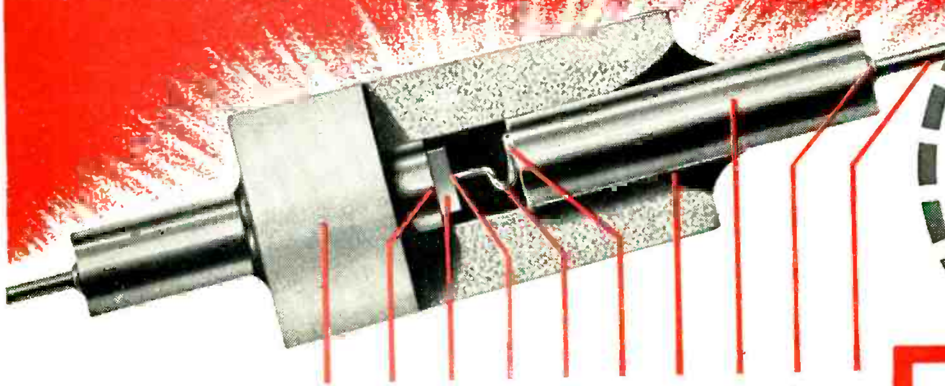
Incorporated 1935

PLANNED Dfi PRODUCTS

Now... at no increase in price...

HERMETICALLY SEALED Germanium Diodes

JAN TYPES



A. Ceramic Case
B. Solder
C. Germanium Pellet
D. Weld
E. Platinum-Rhuthenium Whisker
F. Weld
G. Solder
H. Nickel Pin
I. Weld
J. Leaded Copper Clad Wire

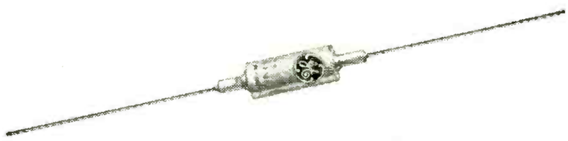
COMPLETE METAL TO CERAMIC SEAL. Gas-tight ceramic cases with metalized ends permit solder seal to nickel pins.

MOISTURE PROOF. These new diodes exceed the requirements of JAN humidity specifications.

REQUIRED ELECTRICAL PROPERTIES. More than two years of development were necessary to perfect this combination of hermetic seal and superior performance.

MECHANICAL STABILITY. Platinum-rhuthenium whisker is welded to the germanium pellet.

LONG-LIFE. The elimination of moisture effects adds years to the life of your equipment!



Production quantities of hermetically sealed types 1N69, 1N70, and 1N81 are now available. Hermetically sealed commercial types are expected to be ready in a few months. Be sure to include them in your design planning now! For complete information write: *General Electric Company, Section X444, Electronics Park, Syracuse, New York.*

MAXIMUM RATINGS (At 25°C)

Hermetically Sealed DIODES	1N69	1N70	1N81*
Peak Inverse Voltage	75	125	50
Continuous Operating Inverse Voltage	60	100	40
Min. Forward Current (MA) at + 1V	5.0	3.0	3.0
Max. Inv. Current (μa c) At — 50V	850	300	—
At — 10V	50	25	10
AV Rectified Current (MA)	40	30	30
Peak Rectified Current (MA)	125	90	90
Surge Current (MA)	400	350	350

*JAN approval applied for

You can put your confidence in—

GENERAL ELECTRIC

NEWS FROM OUR ADVANCED DEVELOPMENT LABORATORIES

● A four-terminal junction transistor has been developed having a region of negative output impedance. This switching device is unique in that two coincident trigger signals are required to turn it on. Thus two gating functions may be accomplished by a single transistor.

Want more information? Use post card on last page.

designer's

INSTRUMENT guide

FOR PRODUCTION MACHINES— WESTON "per-cent load" ammeters and wattmeters make it easy for operators to secure optimum production from lathes, milling machines, automatics, grinders, etc. Prevent overloading—reduce tool breakage — assure uniform quality with fewer rejects. Other scale calibrations also available.

FOR ELECTRONIC EQUIPMENT— WESTON panel instruments are available in 1½", 2½", 3½", 4½" and 5½" sizes in all required ranges and types, including d-c, a-c, rectifier and thermocouple types. Approved ruggedized and sealed instruments available in all types in 2½" and 3½" sizes. Special panel bulletins give complete information.

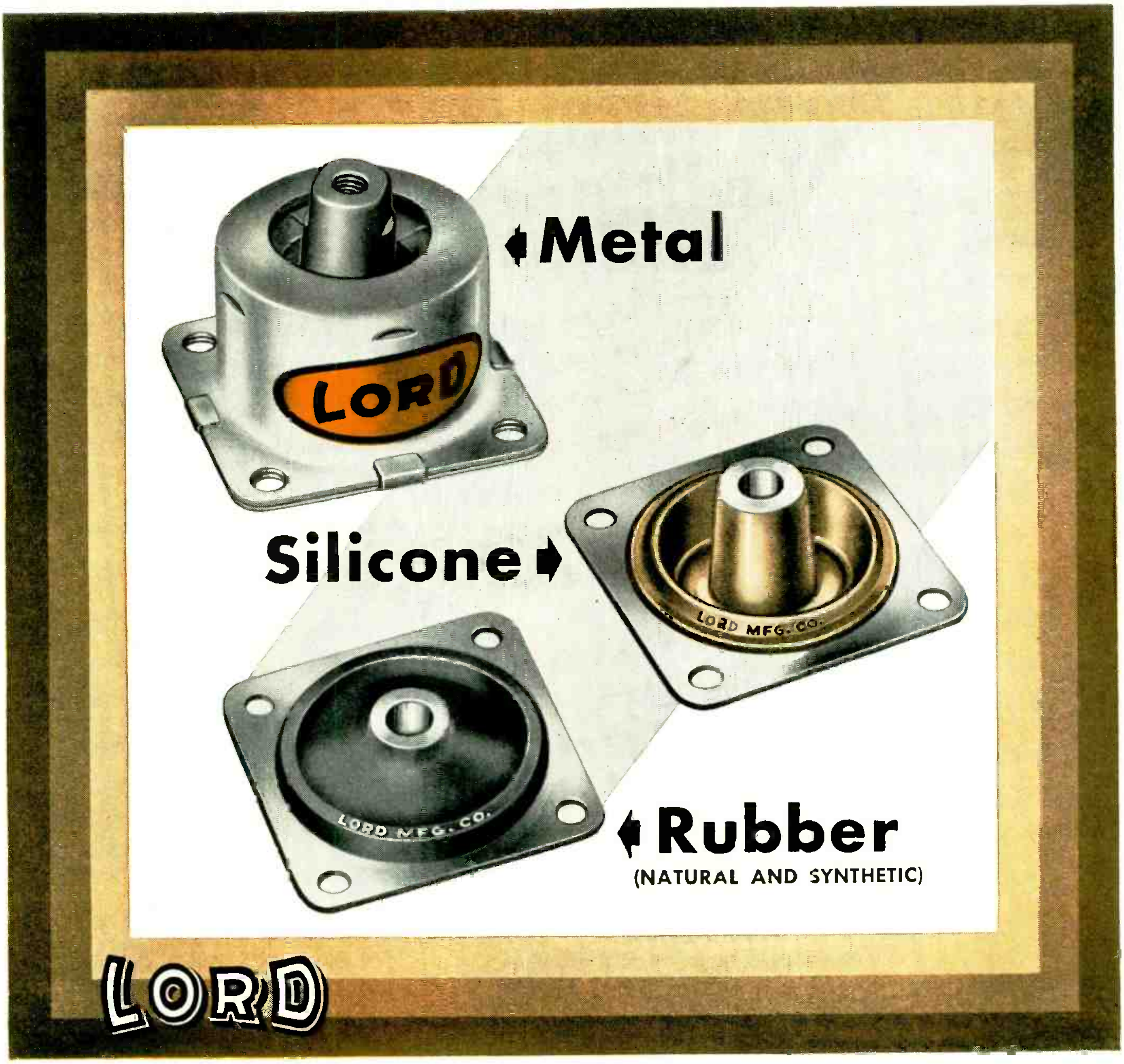
FOR RPM MEASUREMENTS— WESTON electrical tachometer indicators are available with scales calibrated in RPM, or any function of RPM, such as feet per min.—pieces per hour, etc. Indicators can be mounted remotely; and if required, more than one indicator can be operated from one generator. Special compact, lightweight a-c and d-c generators permit wide flexibility in mounting and connection arrangements. Directly indicate speeds from 1 RPM to 40,000 RPM or higher.

FOR TEMPERATURE MEASUREMENTS— WESTON Bi-metal thermometers are rugged and dependable, and are readily adaptable for built-in needs. Available in angle and straight stem types, stem lengths from 2" to 72", scale lengths 3.40" to 9", ranges low as −100°F. and high as +1000°F. Corrosion resisting stainless steel stems — accuracy 1° of thermometer range.

6402

Literature on any of the above instruments sent on request.
WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*



Recommends Materials Best Adapted to your Vibration Control Requirements

Metal—Natural Rubber—Silicone—Neoprene—Buna S—Buna N—and others are selected by LORD Engineers to satisfy your specific environmental conditions and assure the most economical solution of your vibration control problem.

LORD research is constantly developing and evaluating new materials and processes to insure that the most complete line of vibration control mountings is at your disposal.

LOS ANGELES 28, CALIFORNIA 7046 Hollywood Blvd.	DALLAS, TEXAS 313 Fidelity Union Life Building	PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building	DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 311 Curtis Building	NEW YORK 16, NEW YORK 280 Madison Avenue	CHICAGO 11, ILLINOIS 520 N. Michigan Ave.	CLEVELAND 15, OHIO 811 Hanna Building

LORD MANUFACTURING COMPANY • ERIE, PA.

Over 27,000 basic designs and their variations are already available from which to choose.

Headquarters for
VIBRATION CONTROL

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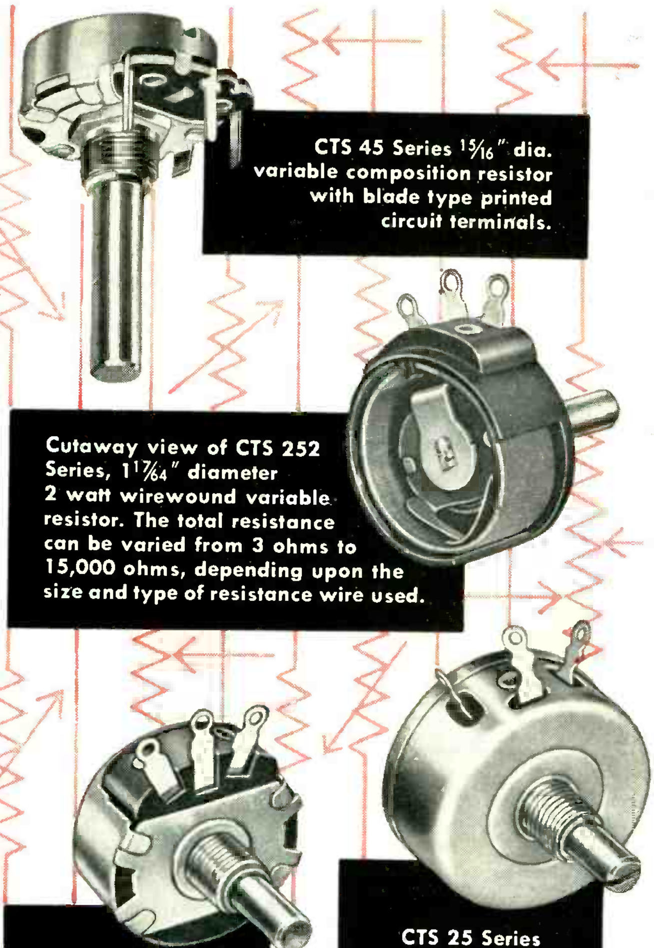
"DRIVER-HARRIS ALLOYS

have contributed greatly in making our performance possible"

says

CTS

CHICAGO TELEPHONE SUPPLY
Corporation



CTS 45 Series $1\frac{5}{16}$" dia. variable composition resistor with blade type printed circuit terminals.

Cutaway view of CTS 252 Series, $1\frac{17}{64}$" diameter 2 watt wirewound variable resistor. The total resistance can be varied from 3 ohms to 15,000 ohms, depending upon the size and type of resistance wire used.

CTS 252 Series
2 Watt
Wirewound
3-15,000 ohms

CTS 25 Series
2 Watt
Wirewound
3-25,000 ohms

Chicago Telephone Supply Corporation has succeeded in accomplishing two things indeed difficult to combine, as summed up in their slogan "Specialists in Precision Mass Production of Variable Resistors." They manufacture the high quality variable resistors indispensable to radio, television, and military electronics. In fact, they are the world's largest producers of variable resistors.

To achieve this outstanding record, they concentrate their entire effort on variable resistors, they maintain close control over all manufacturing processes, and fabricate their own parts under close supervision from basic raw materials. Naturally, they make no secret of the importance to them of high quality materials.

States Chicago Telephone: "To make our raw material program effective, we have stressed the importance of dependable, quality-minded sources of supply. Driver-Harris is a supplier with these qualities, *and Driver-Harris alloys have contributed greatly in making our performance possible.* For many years we have been using Driver-Harris Nichrome*, Karma*, Advance*, and other D-H Alloy wires for our resistance windings, with excellent results. We can strongly endorse Driver-Harris' dependability and high quality products."

Nichrome, Advance, and Karma are at your service too, as are more than 80 other D-H alloys developed for application in the electrical and electronic fields. If a high degree of resistance and absolute uniformity of output are "musts" for *your* product, let us have your specifications. We'll be glad to make recommendations based on your specific requirements.

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

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

Sole producers of Nichrome, Advance, Karma

Driver-Harris Company

HARRISON, NEW JERSEY

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

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

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

VOLTAGE REGULATED POWER SUPPLY

Model 2400

MULTIPLE POWER SUPPLY

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-150 Bias	0-5 Ma.	*	5 Mv.
2	0-400	0-150 Ma.	0.5%	5 Mv.
3	0-400	0-150 Ma.	0.5%	5 Mv.
2 & 3 Parallel	0-400	0-300 Ma.	0.5%	5 Mv.
2 & 3 Series	0-800	0-150 Ma.	0.5%	5 Mv.
4	6.3 AC	10 Amp.	★	
5	6.3 AC	10 Amp.	★	

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

*Regulation Bias Supplies: 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

★All AC Voltages are unregulated.

KEPCO LABORATORIES

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

INDEPENDENCE 1-7000

NEW POWER SUPPLY CATALOG AVAILABLE ON REQUEST. WRITE DEPARTMENT 789

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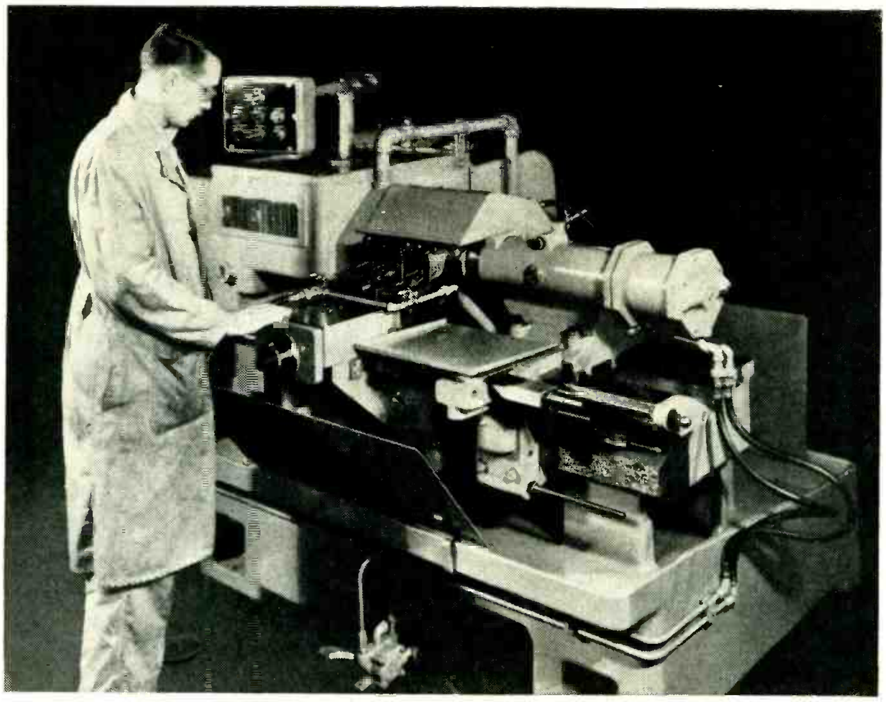
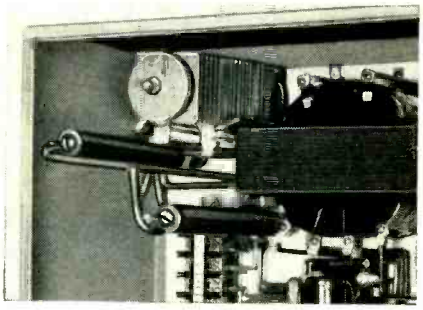


FASTER STARTING AND STOPPING HELPS THIS AUTOMATIC LATHE TO PRODUCE MORE

General Electric Selenium Rectifiers Help Make This Lathe More Productive

Speeding up starting and stopping operations has increased the productivity of many of today's finest machine tools. In the Sunstrand automatic lathe pictured above, an electric brake and clutch combination starts and stops the machine spindle. Another electric brake provides a fast stop when the tool carriage is advanced to the work, or backed off to the unloading position.

D-C POWER to operate the electric brakes and clutch on this lathe is supplied by General Electric selenium rectifiers shown in the smaller photograph. Their high quality (see C.E. Hamann's article at right) makes G-E selenium rectifiers ideal for almost all machine tool applications.



D-C POWER for the lathe's clutch and brakes comes from this selenium rectifier.

TOP PERFORMANCE of G-E selenium rectifiers is the result of a unique "evaporation" process and careful inspection and testing. Besides providing stacks with exceptionally low forward voltage drop and low reverse leakage, this process assures greater uniformity of these characteristics among different stacks. These qualities last in service. On test in the laboratory, and on-the-job in almost every field of application, G-E selenium rectifiers are demonstrating their extremely slow aging.

OTHER APPLICATIONS for G-E selenium rectifiers include supplying power to operate d-c relays in various control circuits and as components in electronic equipment. A complete range of ratings is available in either open stacks or various types of sealed cases to meet special operating conditions. Contact your nearest G-E Apparatus Sales Office for complete information, or write Section 461-33, General Electric Company, Schenectady 5, New York.

You can put your confidence in—

GENERAL ELECTRIC

METALLIC RECTIFIER FACTS FOR ENGINEERS

Quality

by C. E. Hamann

One of the most overworked terms used in the selenium rectifier industry is "high quality." Every manufacturer claims "high quality" for his product. Every user wants "high quality" in the selenium components he buys because the quality of the end device can be no higher than that of the components assembled into it.

There are many yardsticks for measuring the quality of a selenium stack. Electrical characteristics, for example: low forward drop and low reverse leakage. Often one is sacrificed in favor of the other.

LOW FORWARD DROP

LOW LEAKAGE

UNIFORMITY

STABILITY

RELIABILITY

Which "yardstick" measures quality?

Real quality insures that both the forward and the reverse characteristics are good.

Uniformity of characteristics is another yardstick. If the characteristics vary from stack to stack the performance of the end equipment will be questionable.

Stability is another important standard in determining quality. The initial characteristics must be good, but they must stay good and not deteriorate with time and use.

Reliability is still another measure of quality. No matter how liberal the manufacturers replacement policy, frequent failures in the field are costly to the equipment manufacturer, and annoying to the equipment user.

All of these yardsticks must be considered carefully in determining quality. To really earn the title of "high quality" a selenium stack must measure up to a high standard of performance by every one of these yardsticks.

C. E. Hamann

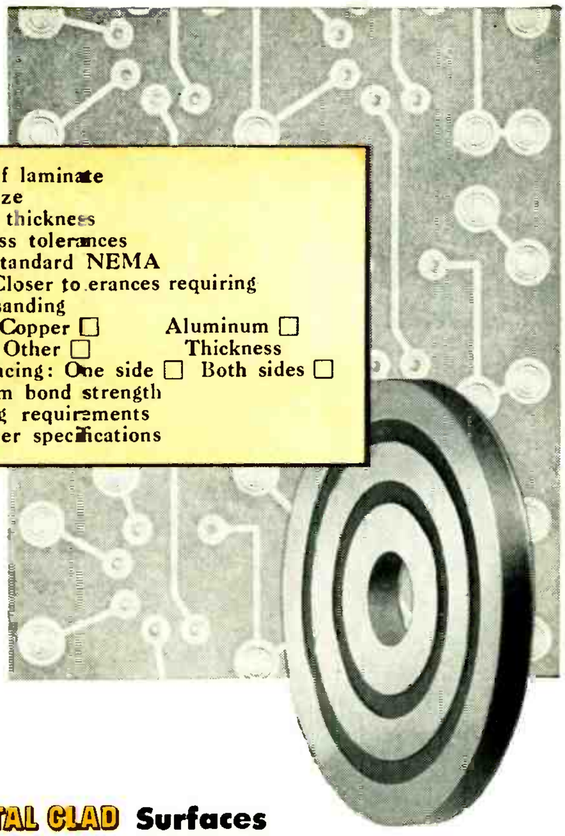
General Electric Company

Want more information? Use post card on last page.

Information Wanted...

about your uses for

C-D-F METAL CLADS



- Grade of laminate
- Sheet size
- Overall thickness
- Thickness tolerances
  - a. Standard NEMA
  - b. Closer tolerances requiring sanding
- Metal: Copper ☐ Aluminum ☐ Other ☐ Thickness
- Metal facing: One side ☐ Both sides ☐
- Minimum bond strength
- Punching requirements
- Any other specifications

Did you know that C-D-F supplies a full range of metal clad laminates in both Dilecto and Teflon grades? With mounting interest in printed circuits it pays to consider the respective advantages of these new C-D-F materials . . . it also pays to line up all the Information Wanted facts and discuss your specific application with your C-D-F sales engineer (Offices in principal cities). He's a good man to know!

Dilecto METAL CLADS

Printed circuits depend upon stable, uniform core material and Dilecto has years of proven insulation service (Dilecto is a laminated thermosetting plastic made only by C-D-F from paper, cotton, glass or asbestos fabric base, or a mat base). Normally phenolic or melamine impregnating resins are used for METAL CLAD sheet stock. There are many grades of Dilecto, but only the better electrical grades are supplied with metal foil surfaces. Outstanding is C-D-F grade XXXP-26, a hot punching grade with high insulation resistance, low and stable dielectric losses and excellent moisture resistance. Green color. New C-D-F Catalog GF-53 gives complete data on Dilecto grades. Write for your copy today.

Teflon* METAL CLADS

Glass fiber cloth is first coated with Teflon resin and laminated into C-D-F GB-112T sheet stock. This base withstands high heat (200°C. maximum operating temperature) with the dissipation factor and dielectric constant extremely low over a wide frequency range. No adhesive film is needed to bond metal to the Teflon laminate, thus the inherently good electrical properties of the core material are maintained. GB-112T has practically zero water absorption, so a METAL CLAD with this core offers consistent high insulation resistance with excellent stability of dielectric loss properties.

METAL CLAD Surfaces

Copper foil (usually .00135" or .0027" thick) is bonded on one or both faces of the sheet grade of Dilecto selected. The foil used is a special grade of electrolytic deposition copper particularly adaptable for cementing onto laminated materials. An adhesive film is placed between the metal and the Dilecto, and cemented during the pressing and curing cycle. When closer tolerances are required C-D-F sands the Dilecto to the required thickness before bonding. Aluminum, silver, or other alloys of various metals may be supplied.

Better Bond Strengths

One of the most important physical properties of a metal clad product is its peel strength, the pounds pull required to separate the foil surface from the core material. Working with years of laminating know-how, C-D-F has been successful in obtaining the following average test values for its METAL CLAD sheet stocks:

	Lbs. pull per 1" width
XXXP-26 plus .00135" copper	5 to 8
XXXP-26 plus .0027" copper	7 to 10
XXXP-26 plus .0015" aluminum ..	9 to 12
GB-112 Teflon plus .00135" copper ..	6 to 9

Sheet sizes: Dilecto grades — 38 x 38", 38 x 42"
Teflon grades — 16 x 36"

THE NAME TO REMEMBER . . . FOR PRINTED CIRCUIT METAL CLAD STOCK

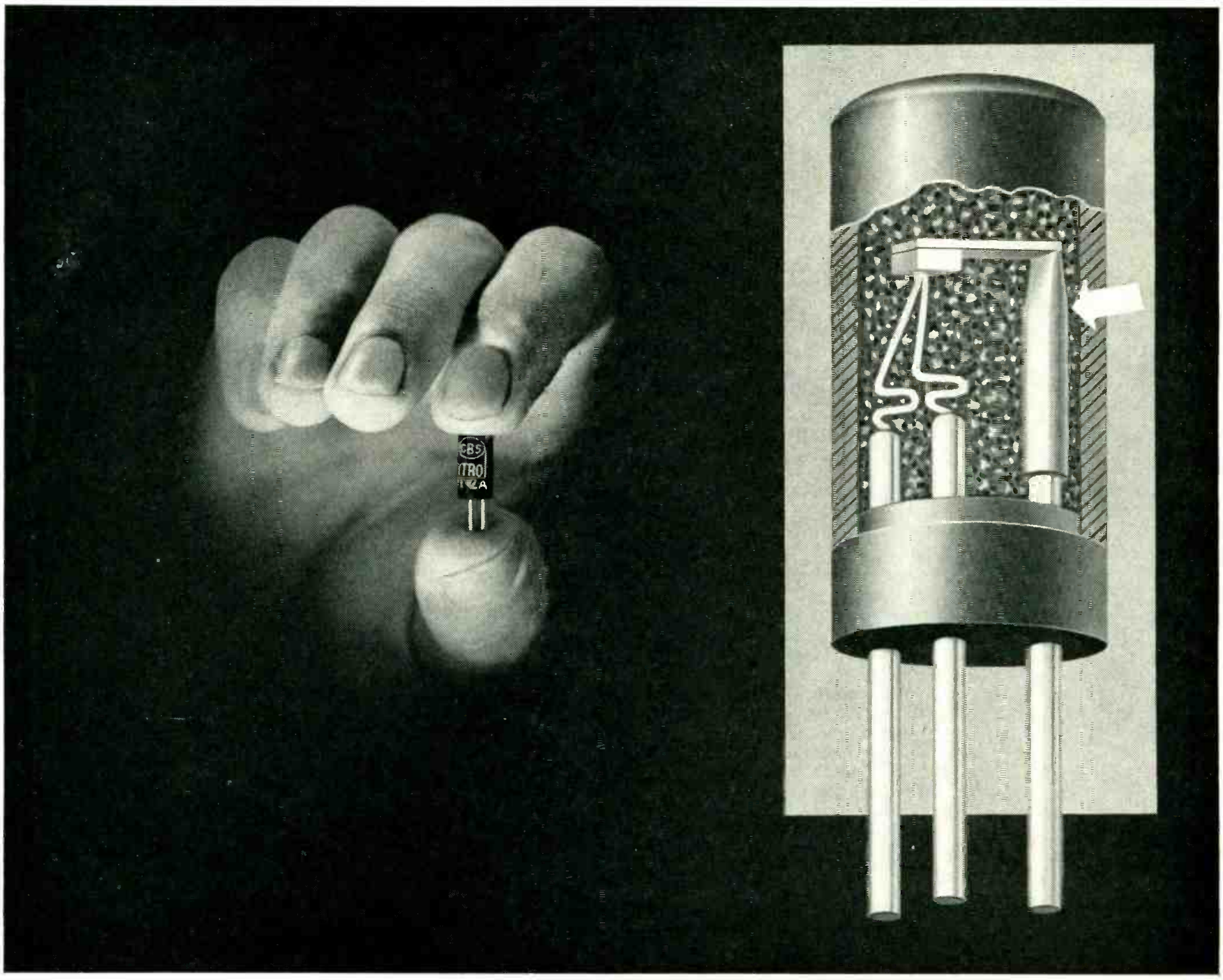
Continental-Diamond Fibre Company
NEWARK 16, DELAWARE

*DU PONT TRADE MARK

Write for new C-D-F General Catalog GF-53, new C-D-F Teflon folder T-52, and talk METAL CLADS with your C-D-F sales engineer.

Want more information? Use post card on last page.

Look what's happened to the "cat's whiskers"

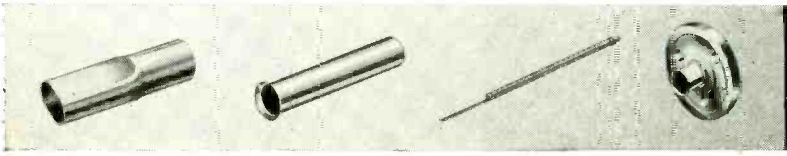


A miracle that can hide behind your thumb-nail is the hottest electronics news in years. Modernized descendant of the Twenties' crystal diode with its cat's whisker, the transistor threatens to send many vacuum tubes the way of old head sets.

No matter which ultimately gets the nod—tube or transistor—Superior will be in there pitching. Superior seamless and Lockseam* nickel cathodes, anodes and grid cups are familiar to you in vacuum tubes. Now Superior tubing is going into transistors.

CBS-Hytron, a division of Columbia Broadcasting System, Inc., uses Superior tubing for the L-shaped bracket that holds the germanium crystal in their PT-2A point-contact transistor. For this purpose they purchase tiny tubes—.032" I.D. x .003" wall. .193" long, drawn from seamless nickel. Added to the good welding, soldering and formability characteristics of the metal, Superior manufactures the brackets to the close tolerances CBS-Hytron must have.

Whether you are for the old or new order in electronics, if you need an idea or an analysis in small tubing, Superior is the first place to look. Superior Tube Company, Electronics Division, 2500 Germantown Ave., Norristown, Pa.



Superior
THE BIG NAME IN SMALL TUBING

All analyses .010" to 5/8" O.D.
Certain analyses in Light Walls up to 2½" O.D.

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

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

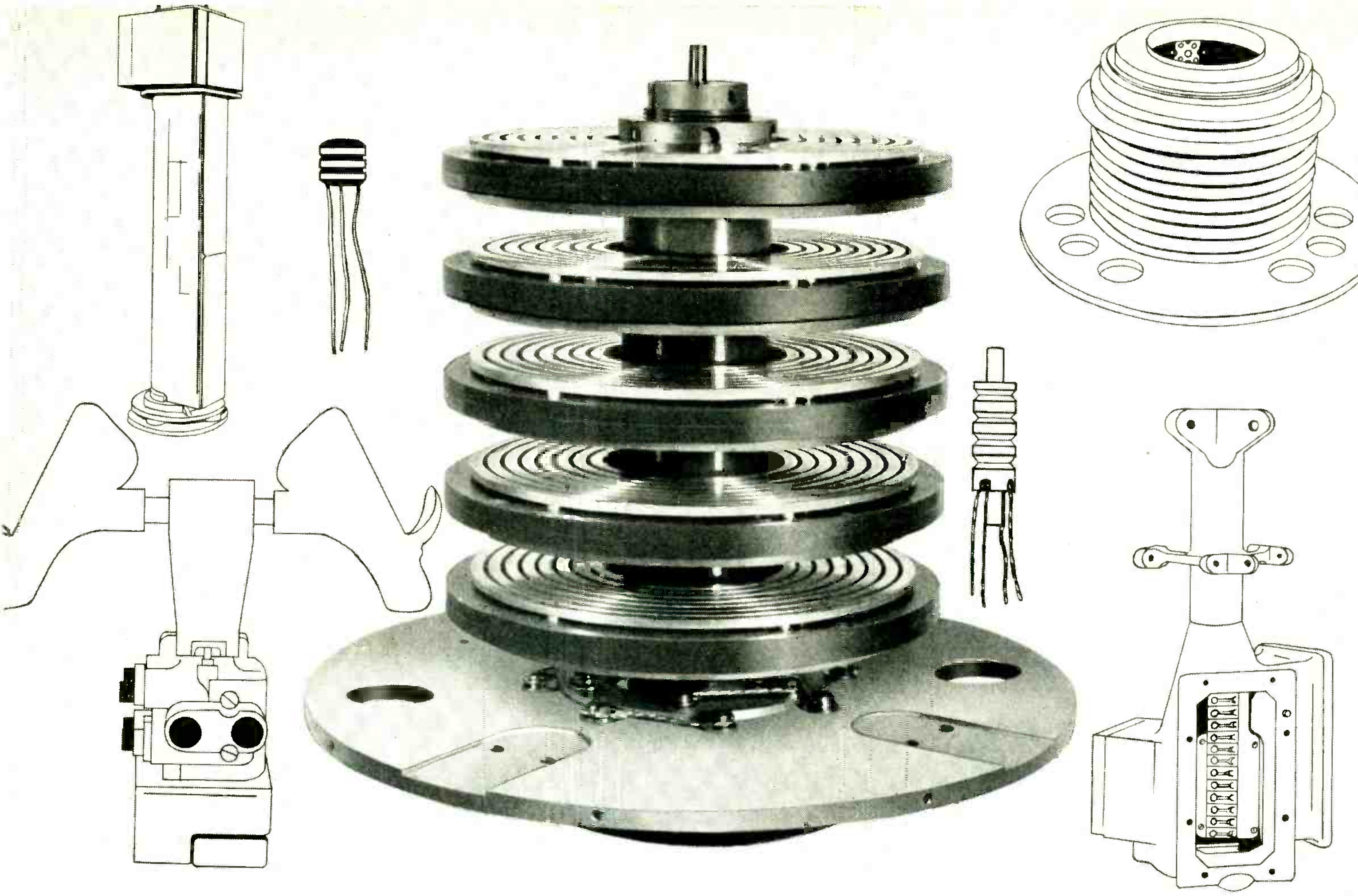
Lockseam* Nickel Cathode. Round, tabbed, single bead, .045" O.D. x .0021" Wall. 27 mm long.

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

Many types of nickel cathodes—made in Seamless and 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.

*Manufactured under U.S. Patents.


ELECTRICAL
CORDS
KEEP YOUR APPLIANCES
IN SERVICE
Belden
MANUFACTURERS AND SERVICE MEN WHO SERVE BEST
Specify Belden
WIREMAKER FOR INDUSTRY



PMI for ELECTROMECHANICAL INSTRUMENT COMPONENTS

For more than 12 years, P M Industries has specialized in designing, developing, and producing electromechanical instrument components of widely divergent natures. The principal concern has been with slip ring assemblies (from 8-foot, 500-ring assemblies down to miniatures for synchros, gyros, and resolvers), but PMI also maintains a contract manufacturing service, producing such devices as operator control assemblies for anti-aircraft directors, electrical winches, guided missile components.

The years spent solving problems imposed by a diversity of customer specifications have abundantly endowed PMI with experienced engineers and skilled technicians, backed up by complete laboratory and factory facilities. The combination may well be of value to you in helping solve troublesome component problems. Your inquires are invited and will receive prompt attention.

PMI **P M Industries, Inc., *Stamford, Conn.***

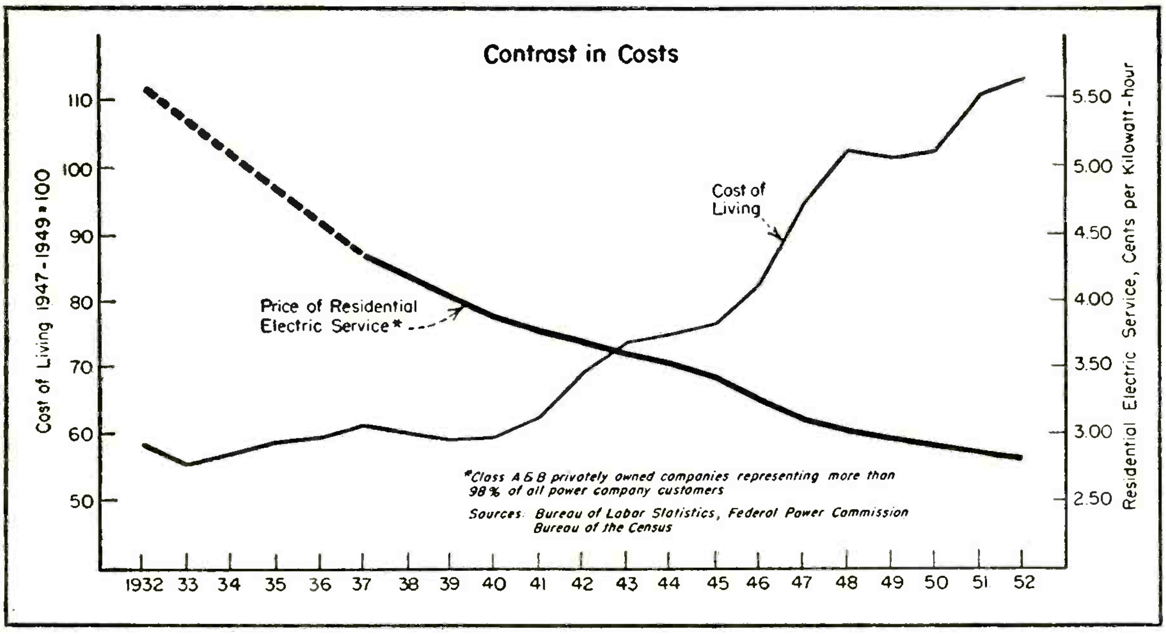
Design - Development - Production • Electro-mechanical Assemblies

Selenium Rectifiers
INTERNATIONAL RECTIFIER CORPORATION
EL SEGUNDO CALIFORNIA
Largest Range in the Industry
T 1/16"
U 1/8"
V 1/4"
Y 3/8"
Z 1/2"
X 3/4"
W 1"
A-1"x 1"
B-1.2"x 1.2"
C-1.5"x 1.5"
L-2"x 2"
D-3"x 3"
E-4 3/8"x 4 3/8"
N-5"x 5"
J-4 1/4"x 6"
F-5"x 6"
H-6 1/4"x 7 1/4"
Selenium Diodes Send for Bulletin SD-1
Germanium Diodes Send for Bulletin GD-1
Hermetically Sealed Selenium Rectifiers
Metal Enclosed Selenium Rectifiers
Encapsulated Selenium Rectifiers
B2
A5
B5
A10
B10
A15
INTERNATIONAL RECTIFIER CORP.
PHOTOELECTRIC CELL
B-10-M
PHOTOELECTRIC CELLS
Send for Bulletin PC-649
Pigtail Terminals
Ferrule Terminals
INTERNATIONAL RECTIFIER CORP. EL SEGUNDO, CALIF.
Stud Terminals
Selenium Rectifier
TYPE W7SH S
INTERNATIONAL RECTIFIER CORP.
CARTRIDGE TYPES
1.5 ma to 60 ma
20 volts to 10,000 volts
Send for Bulletin H-1
POWER RECTIFIERS
Single Stack Ratings:
125 ma to 2300 Amperes
Single Plate Ratings:
22 volts to 40 volts rms
Send for Bulletin C-349
INTERNATIONAL RECTIFIER CORPORATION
1521 E. GRAND AVE. EL SEGUNDO, CALIFORNIA, PHONE: OREGON 8-3778
CHICAGO: 205 W. WACKER DRIVE, PHONE: FRANKLIN 2-3889
NEW YORK: 501 MADISON AVENUE, PHONE: PLAZA 5-8665

A 20-YEAR RECORD...

The Electric Power Companies' Case for Public Confidence

An economic study of the record of the investor-owned electric power companies of the United States over the past twenty years underwrites their claim to public confidence today. A key factor of this record is set forth by the chart in the middle of this page. This shows that while the cost of living as a whole has almost doubled, the average price of electric energy for residential use in the United States has been cut in half.



The average prices of industrial and commercial power also are much lower than they were twenty years ago.

Such a study confirms the record on other key accomplishments of the electric power companies during the past two decades.

They have not failed, either in peace or war, to meet the nation's rapidly expanding electric power requirements. In paying tribute to the performance of these companies during World War II, J. A. Krug, Director of the Office of War Utilities, said, "Power has never been too little or too late." The same can be said for the entire period of the past twenty years.

To be ready with enough power — on time — the electric power companies have expanded their production fourfold since 1933. This has required an investment of over $17 billion in new facilities. To raise the funds for this investment they have enlisted the participation of about 3 million direct stockholders. Through life insurance companies, banks and similar institutions, about 90 million Americans — more than half of the nation's total population — have become investors in electric power companies. By thus relying on private investment for their expansion, the power companies have provided their *plant and operating equipment without burden on the taxpayer.*

In addition, the investor-owned companies have paid about $12 billion in taxes to various governments — national, state and local — over the past twenty years. Unlike government-owned and -operated systems, they have received no public subsidies. When taxes and subsidies are taken into account, the rates for electricity charged by the investor-owned companies have been as low as, or lower than, those charged by government-owned and -operated systems.

Many Americans do not appreciate the job that the power companies have done over the past two decades. That is due, in part, to the public memory of financial abuses by some utility holding companies during the 1920's. This memory obscures a clear and unprejudiced view of the progress since those days. And some of the all-out advocates of reliance on government rather than on regulated private enterprise for the development of our power resources do their best to keep this memory of the past alive in the present.

An Impressive Case

Some special cases of electric power development may involve problems for which the investor-owned companies are unable to provide full solutions. This may be true, for example, of some large multiple-purpose projects that combine electric power generation with related developments such as the improvement of navigation, flood control and the irrigation of arid lands. Some of the economic and administrative problems imposed by such projects are not well adapted to effective handling by private enterprise. Flood control and the improvement of navigation, for example, usually involve the provision of much costly service over and above the cost of producing power.

It is true, however, that in some cases development of the electric power side of multiple-purpose projects by private enterprise may well be more feasible than would appear from statements by some government power advocates. And the record indicates that even in those projects on which both the power generation and the other services are handled by public authority, it may well be desirable to have the investor-owned companies assume the transmission and distribution functions.

Our study of the record of the investor-owned and -operated companies over the past twenty years has led us, of course, behind the statistics that bear on the wisdom of giving them a priority in the development of our power resources. It reveals that these enterprises are manned by people who, through lifetime experience, are peculiarly conversant with the needs of the communities they serve. They have given the consumer notably good service while conforming to standards set and enforced by public regulatory commissions. They have won the confidence of the investing public. By their nature and their experience they are competent to handle any power program that can be demonstrated to be economically sound.

The Paramount Public Interest

By their economic performance during the last twenty years, the electric power companies have earned the confidence of the public. By relying on these companies to meet its electric power requirements the public will fully protect its economic interest in ample and efficient service at fair prices.

That is where our study comes out. Our findings do not touch the political consideration that private operation of electric utilities under public regulation is a safeguard against further concentration of both political and economic power in a federal government that already commands too great a concentration. But if these findings make an economic case for preferring power development by tax-paying business as against power development by governmental agencies, they clear the way for an appeal to the paramount public interest in safeguarding our personal and political freedoms against the further encroachment of government.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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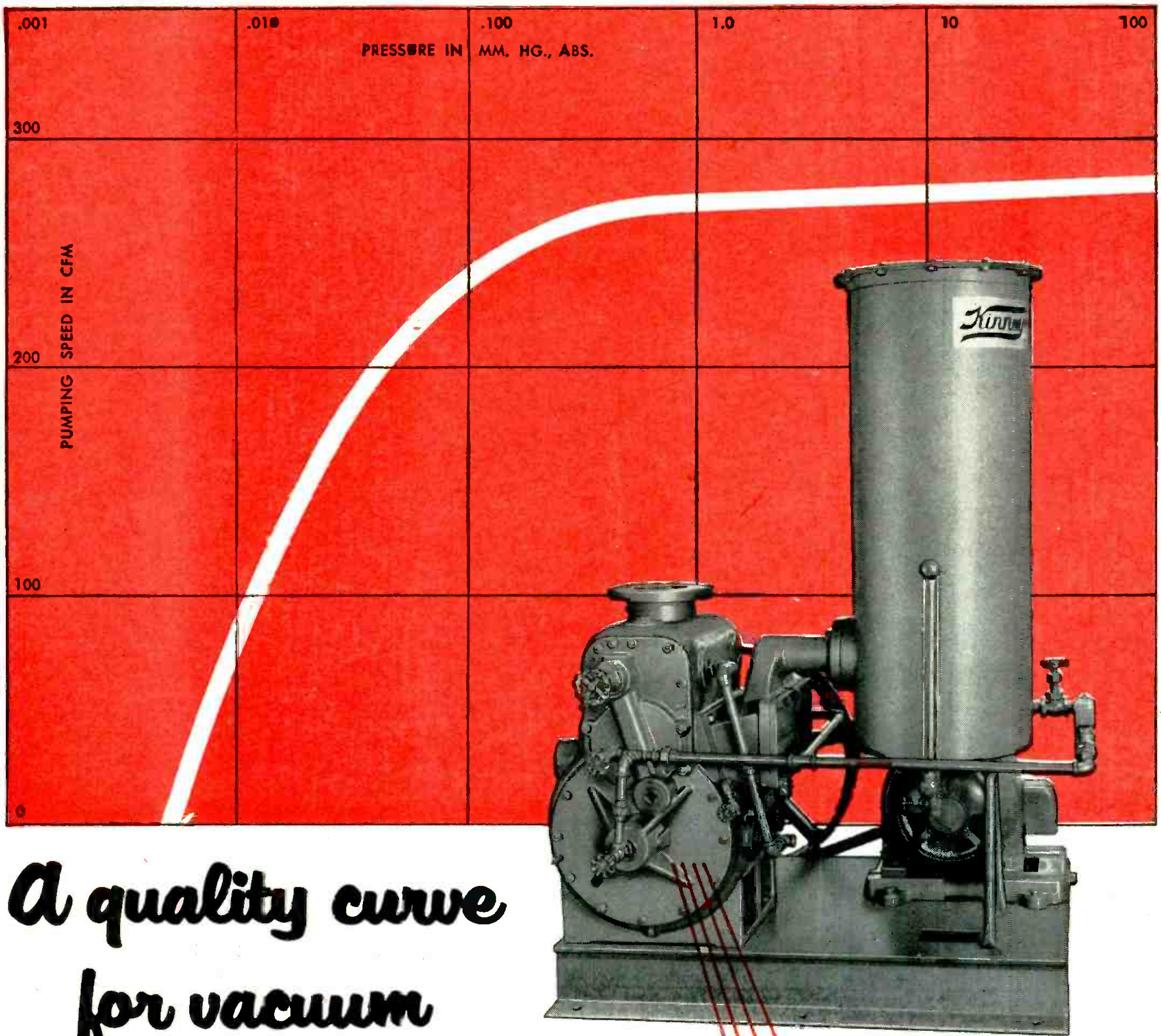

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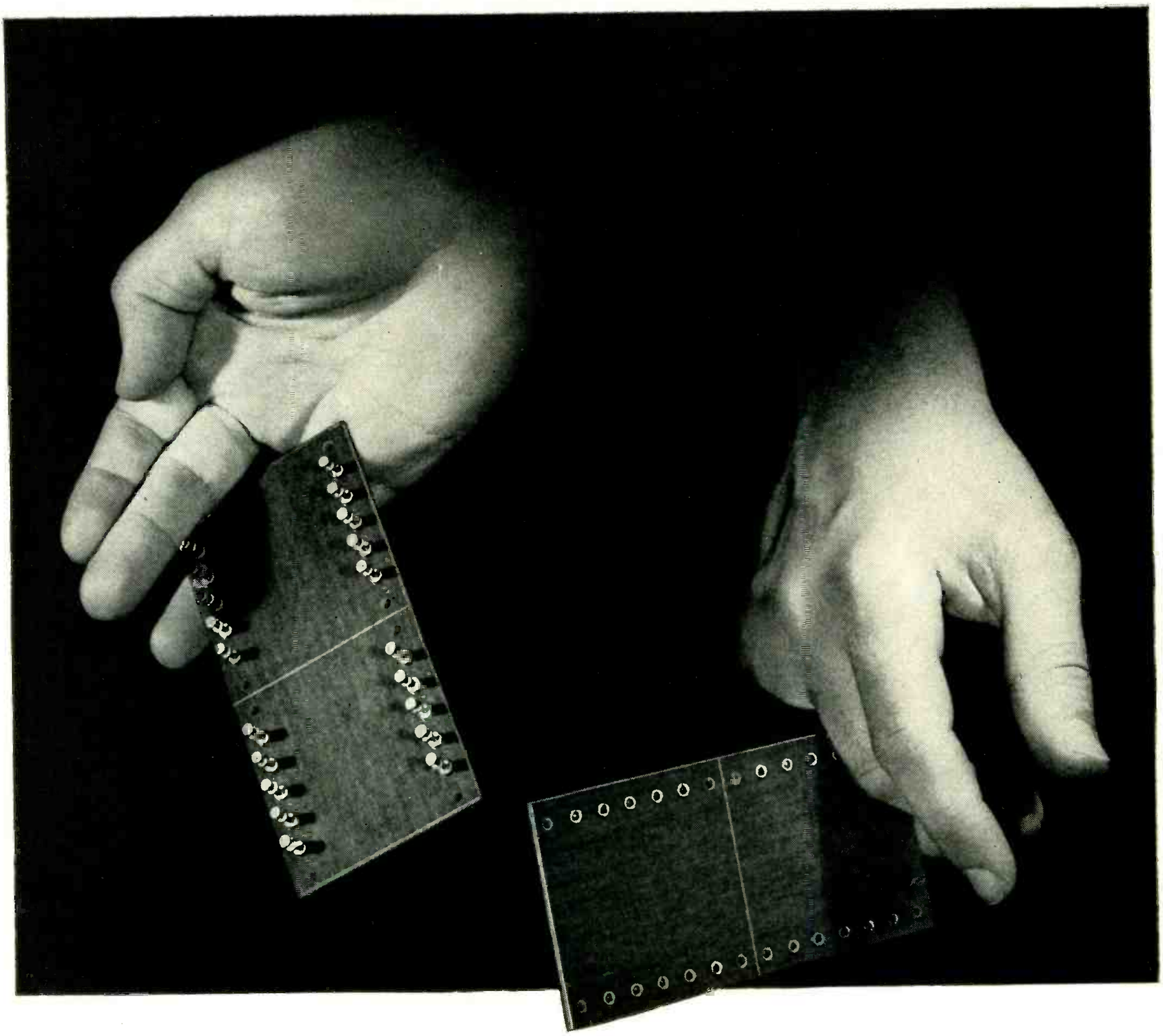

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You'll find no radial cracks in C.T.C. terminal boards, or "cracked" rivet shanks on terminals. And there's a good reason for this.

Our swaging machines use tools that we designed ourselves in order to prevent just such damage. Terminals are fastened securely — *and carefully*. You benefit from a board that has no "weak spots" — that can give you the service you have a right to expect. And, of course, you also benefit from all the other quality control details that enable us to offer our customers *guaranteed* components — custom or standard. Coatings are smoothly applied — no wrinkles, no heavy deposits. C.T.C. terminals are made from certified stock that is free from defects. And the terminals themselves are guaranteed, even to the thickness of the coatings.

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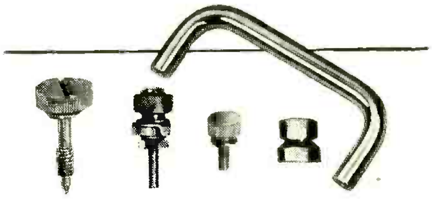
Terminal Board Data. C.T.C. makes both standard boards and to your own specifications. Standard boards in cotton fabric phenolic, nylon phenolic or grade L-5 silicone impregnated ceramic. Custom made in cloth, paper phenolic, melamine, epoxy or silicone fibreglas laminates, imprinted as required and lacquered or varnished to specifications MIL-V-173 and JAN-T-152.



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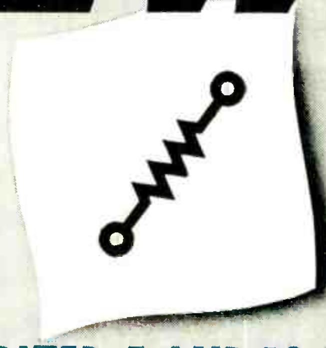

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Here are two *truly miniaturized* self-mounting wire-wound power resistors to simplify your TV and industrial electronic production where space is a factor. They're ideal for point-to-point wiring, terminal board mounting, and processed wiring boards, where they fit in admirably in dip-soldered subassemblies.

Axial lead Blue Jackets are rugged vitreous enamel power resistors built to withstand the severest humidity performance requirements As for *economy*, these newest members of the Sprague Blue Jacket family are low in cost . . . eliminate need for extra hardware . . . save time and labor in mounting!

You can get these outstanding new Blue Jacket Resistors without delay in any quantity you require. Sprague Engineering Bulletin 111 gives full data on these and all other commercial Blue Jacket Resistors. Send for your copy.

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35 Marshall Street, North Adams, Mass.

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
27E	5	1⅛	5/16	17,500 Ω
28E	10	1⅞	5/16	35,000 Ω

Standard Resistance Tolerance: ±5%

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

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A NEW HIGH Q, LOW LOSS, HIGH FREQUENCY CORE MATERIAL WITH STABLE CHARACTERISTICS

An ideal Core Material for Antenna Rods, Filter Inductances, Loading Coils, RF Coils and all other Applications Requiring High Performance up to 30 Megacycles.

Ferramic "Q" is an exclusive development of General Ceramics Corp. It was created to overcome the instabilities that characterized previous high performance ferrites. Exhaustive tests prove that Ferramic "Q" is completely stable in respect to age, shock, vibration, temperature. In addition this new material features higher Q and lower losses than former materials at all frequencies up to 30 Megacycles. Cost-wise, Ferramic "Q" offers extremely favorable comparison with competitive materials. For complete details, call, write or wire today.

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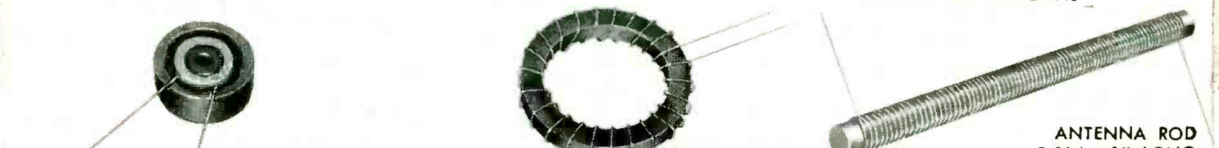

CUP CORE F-261

	L	C	Q
Ferramic J	154	165	50
Ferramic N	120	210	65
Ferramic Q	73	350	175

Coil consists of 20 turns #28 AWG S.F. wire random wound. Cup cores mating surfaces ground (no air gap). Inductance measured in micro-henries, capacitance measured in micro-micro-farads on Boonton Model 260-A Q-Meter. Frequency 1000 Kcs.

RING CORE F-108

	L	C	Q
Ferramic J	90	280	60
Ferramic N	60	425	100
Ferramic Q	35	725	400

Coil consists of 25 turns #20 AWG S.F. wire wound uniformly on toroid. Inductance measured in micro-henries, capacitance measured in micro-micro-farads on Boonton Model 260-A Q Meter. Frequency 1000 Kcs.

ANTENNA ROD F-214 — 8" LONG

	L	C	Q
Ferramic J	340	75	120
Ferramic N	270	95	160
Ferramic Q	210	120	350

Coil consists of solenoid of 85 turns #26 AWG S.F. wire. Space wound along approx. 80% of rod length and centered on rod. Inductance measured in micro-henries, capacitance measured in micro-micro-farads on Boonton 260-A Q meter. Frequency 1000 Kcs.

BASIC TOROIDAL MEASUREMENTS

Initial Permeability μ_0 (1Mc)	125
Figure of Merit Q (1Mc)	400 approx.
Loss Factor $\frac{1}{\mu_0 Q}$ (1Mc)	.000020 approx.
(5Mc)	.000031
(10Mc)	.000050
(20Mc)	.000097
μ_0 vs Frequency Characteristics	Good to over 30 Mc
Q vs Frequency Characteristics	Good to over 30 Mc
Curie Temperature (°C)	250
Temp. Coeff. of μ_0 (1Mc) %/°C (25°C to 70°C)	+0.08 approx.
Temp. Coeff. of Q (Same units as above)	−0.75
Saturation Flux Density B_s (gauss) at H_{dc} = 25 oersteds	2900
Max. Permeability μ max	400
Coercive Force H_c (oersteds)	1.90
Residual Magnetism B_r	1050

TYPICAL ANTENNA ROD MEASUREMENTS

FREQUENCY	Q	C = mmf.
0.6	334	344
0.8	350	189
1.0	350	120
1.2	338	83
1.4	318	60

TEMPERATURE COEFFICIENTS

Antenna Rod No. F-214 (.330 x 8"). Standard Test Coil — Space wound solenoid 85 turns #26 AWG. Formex copper, occupying approx. 80% of length of rod and centered on rod. (Resonates at 1 Mc. with 120 mmf.)

$$TC = \frac{\% \Delta \mu_0}{\mu_0} (25° \text{ to } 75°C)$$

Temp. Coeff. of Rod +1.0 to +2.0
Temp. Coeff. of Coil only = 0

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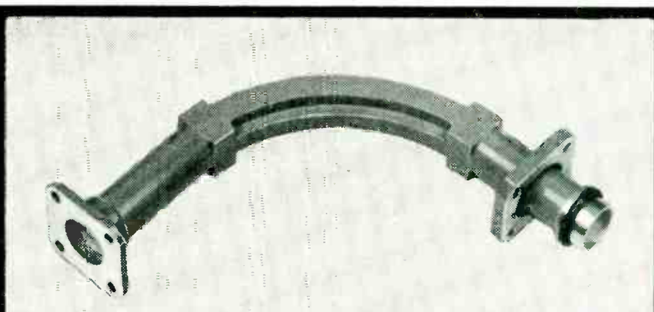
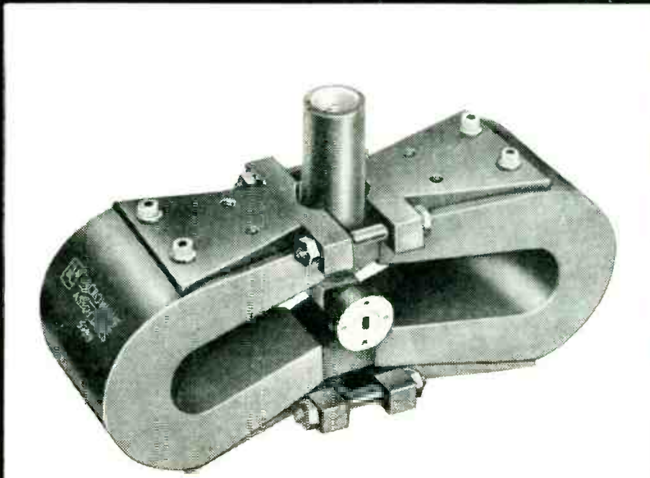
WAVEGUIDE BEND #557
WAVEGUIDE BEND #556



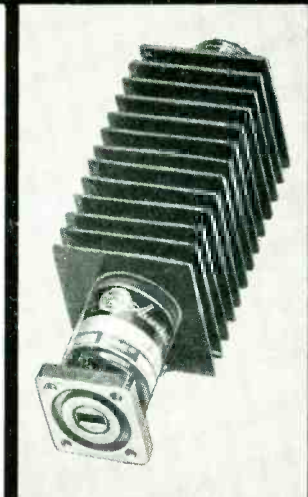
CIRCULAR WAVE GUIDE BEND #P600

LOW POWER TERMINATION #P540A
WAVEGUIDE 90° TWIST #558

MAGIC "T" TUNER #P559



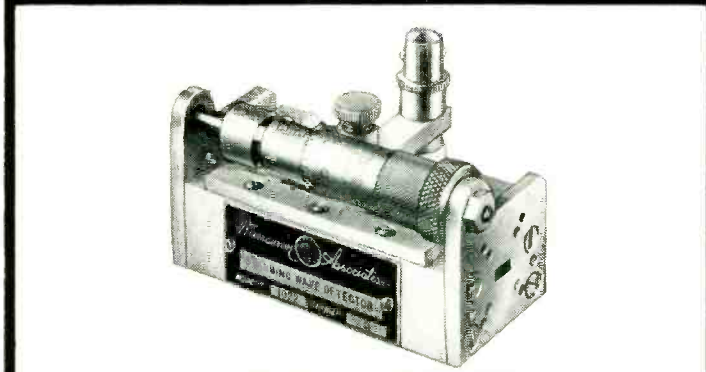
MAGNETRON #5789



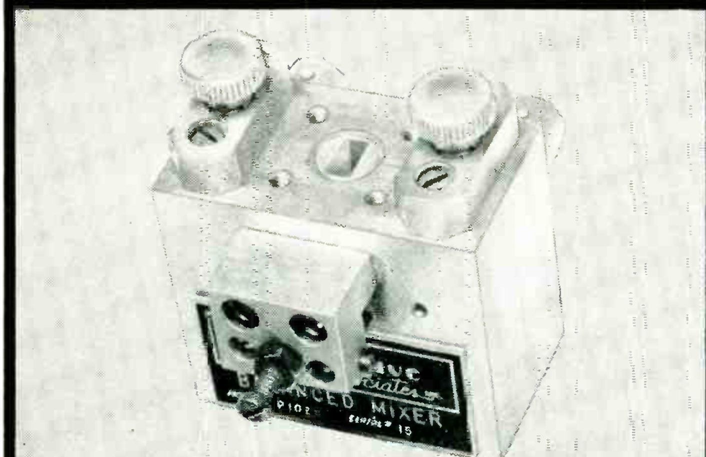
DUMMY LOAD #P537

FREQUENCY METER #P518

PLANNING MILLIMETER WAVE OPERATIONS?



STANDING WAVE DETECTOR #1022



BALANCED MIXER #P1026

If you are working in the millimeter region — or are exploring it — you may be able to save considerable design and production time by acquainting yourself with our extensive experience, facilities and products in this field.

Available to you right now are over 40 items — components and test equipment — ready for you to incorporate in your designs and benches. Components for use in the 35 kmcs. band include slotted lines, frequency meters, loads and a spectrum analyzer adapter. If you are working with high resolution radar systems, we can furnish the long-life 40 KW 5789 magnetron, the 1N53 diode, complete duplexers, balanced mixers, echo boxes and many other components such as bends and transitions for operating circular wave guide in the low attenuation TE_{01} mode.

SEND FOR DATA **Write for detailed specifications and catalog literature describing our millimeter components, magnetrons, TR and ATR tubes and silicon diodes.**

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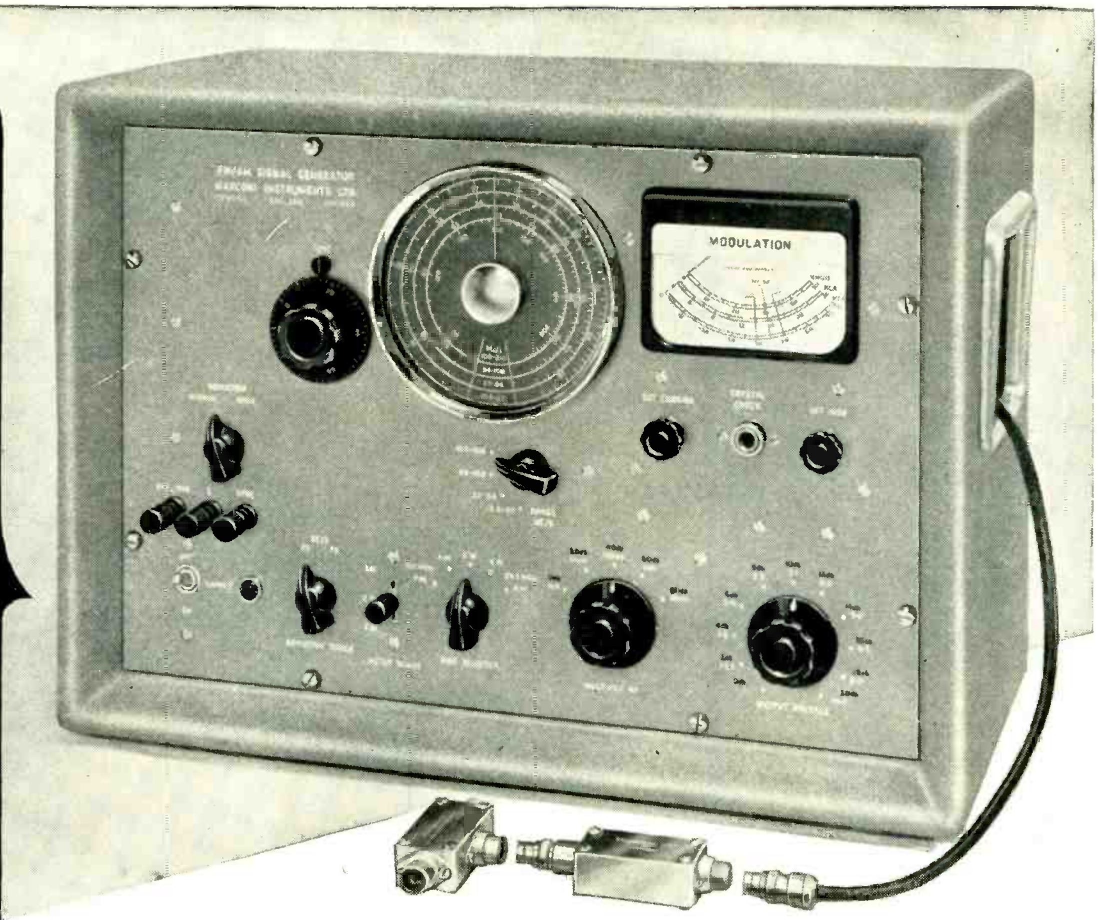
A.M.

SIMULTANEOUS F.M. and A.M.



F.M./A.M. SIGNAL GENERATOR TF 995A

The Marconi Signal Generator Type TF 995A is a compact, transportable, a.c. operated instrument covering from 13.5 to 216 megacycles in four crystal-standardized ranges. It has an open-circuit output level variable, in 1-db steps, from a minimum of 0.1 microvolts to a maximum of 100 millivolts at 52 ohms, and 200 millivolts at 75 ohms. The output may be c.w., frequency modulated, amplitude modulated, or simultaneously both frequency and amplitude modulated. The modulation, obtained either from an internal 1000-cps oscillator or from an external source, is variable to maximum frequency deviations ranging from 25 to 600 kc for f.m., and to depths up to 50% for a.m.

Full data and prices of any of the items listed below will be mailed immediately on request:
FM/AM SIGNAL GENERATOR TF 995A · UNIVERSAL BRIDGE TF 868
FM DEVIATION METER TF 934 · STANDARD SIGNAL GENERATOR TF 867
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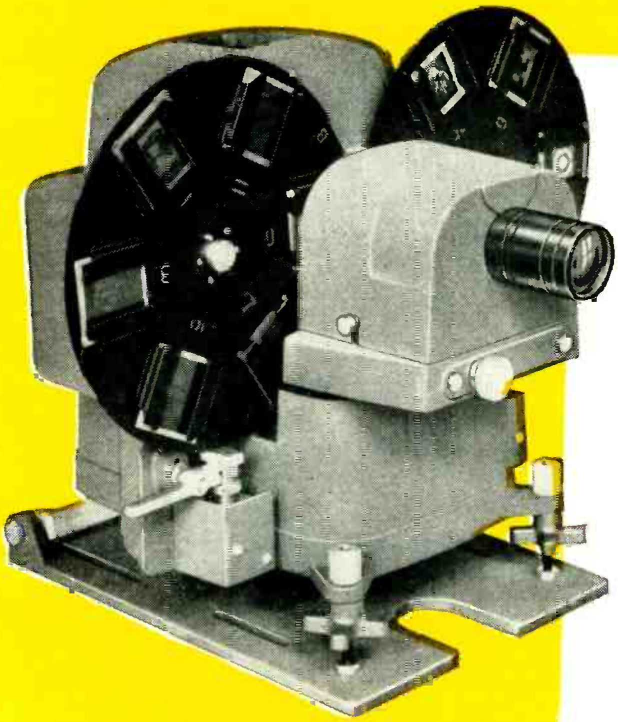
TF 995A

NEW SINGLE LENS

GRAY TELOJECTOR

STAR PERFORMER....



for TV commercials

Precision Projection

BETTER Commercials at LOWER COST

Yes . . . **now** you can use better 2″ x 2″ transparencies in uninterrupted sequence at lower cost. Important too, Gray Telojector is low in initial cost . . . ideal for budget-minded program directors. Telojector is compact, light weight, trouble-free. Two turrets take up to 12 slides at one loading. Additional loaded turrets are substituted in a matter of a few seconds . . . providing unlimited continual sequence. Controlled locally at the unit or remotely at the master video console. Also, can be used with the Gray 35B Manual Control Box to produce superposition, laps, fades and slide changes at any desired rate.

Complete Projection System

The New Gray 3B Telojector (2″ x 2″ Transparency Slide Projector) utilizes a single lens —permits superposing of two images on an optical axis . . . eliminates any need for external registration adjustment. The improved unit provides positive focusing of images on the camera tube with an uninterrupted sequence of slides for television commercials, news flashes and photographs or station and sponsors' identification.

YOU ARE INVITED:

See the NEW, SINGLE lens Gray Telojector and complete line of TV—Broadcasting Equipment at Booth 297, I.R.E. Show, March 22nd–25th, Kingsbridge Armory, New York. If unable to visit I.R.E. Show write for illustrated, detailed information on the NEW, SINGLE LENS GRAY TELOJECTOR.

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AND DEVELOPMENT CO., Inc., Hilliard St., Manchester, Conn.
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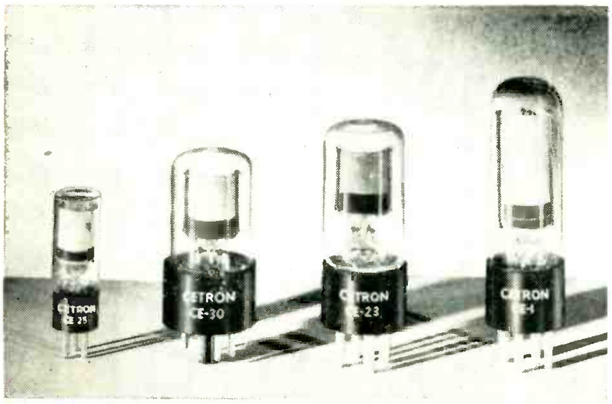
FOR LONG LIFE, UNEQUALLED PERFORMANCE AND LOW COST

The superb quality of Continental Electric Co. special purpose electronic tubes for industry, the armed services, and for the replacement market is the result of nearly a quarter century of development and production.

Through research, CETRON Tubes are opening new fields of application and improving efficiency in traditional circuitry at the lowest cost per operating hour.

Data sheets for all or any family of types are immediately available for your selection of applicable tubes. We welcome comparative tests in your own equipment. You may discover surprising improvements in performance at substantial savings in cost.



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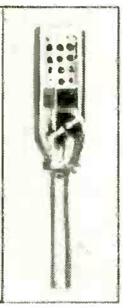
Especially designed for automobile headlight dimming. New. Low Priced. Low microphonic noise levels. High sensitivity.



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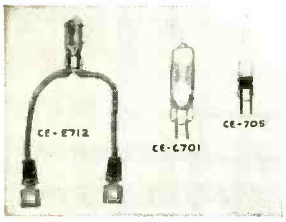
Continental manufactures a type for practically every electronic application. Makes more different types of photocells and special purpose photocells than any other manufacturer in the world.

Chart of Types

CE-1-C	CE-B25V-C	CE-918
CE-1P23	CE-29-R	CE-919
CE-1P30	CE-30-C	CE-920
CE-1P32	CE-30V-C	CE-927
CE-1P37	CE-31V-C	CE-929
CE-1P39	CE-34-R	CE-930
CE-1P40	CE-B36-C	CE-934
CE-1V-C	CE-64-R	CE-5581
CE-B22-C	CE-73-R	CE-5583
CE-B25-C	CE-91-R	CE-5653

LEAD SULFIDE



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3. Burglar Alarms, door-openers, etc., especially using infra-red radiation.
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CE-228/JAN3B28

Filament Volts	2.5
Filament Amperes	5.0
DC Ampere Output	0.25
Peak Inverse Volts	10000

CE-235A
Flexible Lead

Filament Volts	2.5
Filament Amperes	25.0
DC Ampere Output	15.0
Nom. DC Voltage	60
Peak Inverse Volts	230
(E235 Stiff Lead)	

CE-329C

Heater Volts	14.0
Heater Amperes	2.55
DC Ampere Output	3.0
Operating Inverse Volts	500
Surge Inverse Volts	3000

Send for our 1954 catalog; contains complete technical data covering our complete line.

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CE-393A/JAN393A
Mercury and Gas

Filament Volts	2.5
Filament Amperes	7.0
DC Ampere Output	1.5
Peak Inverse Volts	1250
Peak Forward Volts	1250

CE-872A

Filament Volts	5.0
Filament Amperes	7.1
DC Ampere Output	1.25
Nom. DC Voltage	2700
Peak Inverse Volts	10000

C1A

Filament Volts	2.5
Filament Amperes	6.5
DC Ampere Output	0.64
Peak Inverse Volts	340
Peak Forward Volts	170

CE-304
Mercury Vapo

Filament Volts	2.5
Filament Amperes	23.0
DC Ampere Output	12.5
Peak Inverse Volts	1000
Peak Forward Volts	1000

CE-311/JAN3C23

Filament Volts	2.5
Filament Amperes	7.0
DC Ampere Output	1.5
Peak Inverse Volts	1250
Peak Forward Volts	1250

CE-309/FG17
Mercury Vapor

Filament Volts	2.5
Filament Amperes	5.0
DC Ampere Output	5.0
Nom. DC Voltage	1250
Peak Inverse Volts	5000

CE-323B/JAN323B

Filament Volts	2.5
Filament Amperes	7.0
DC Ampere Output	1.5
Peak Inverse Volts	1250
Peak Forward Volts	1250

C6J

Filament Volts	2.5
Filament Amperes	20.0
DC Ampere Output	6.4
Peak Inverse Volts	1250
Peak Forward Volts	750

CE-210A

Filament Volts	2.5
Filament Amperes	6.5
DC Ampere Output	2.0
Nom. DC Voltage	230
Peak Inverse Volts	800

CE-203

Filament Volts	2.5
Filament Amperes	20.0
DC Ampere Output	15.0
Nom. DC Voltage	150
Peak Inverse Volts	500

CE-2W2
TV Color Circuits

Filament Volts	2.5
Filament Amperes	5.0
DC Ampere Output	0.65
Nom. DC Voltage	750
Peak Inverse Volts	2500

CE-206

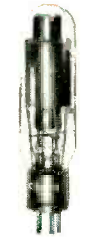
Filament Volts	2.0
Filament Amperes	12.0
DC Ampere Output	6.0
Nom. DC Voltage	90
Peak Inverse Volts	300

CE-220

Filament Volts	2.5
Filament Amperes	3.1
DC Ampere Output	.020
Peak Inverse Volts	20000

CE-205

Filament Volts	2.0
Filament Amperes	12.0
DC Ampere Output	5.0
Nom. DC Voltage	250
Peak Inverse Volts	900



CE-221/4B25

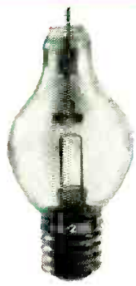
Filament Volts	2.5
Filament Amperes	17.0
DC Ampere Output	6.4
Nom. DC Voltage	200
Peak Inverse Volts	725

CR-5

Filament Volts	2.0
Filament Amperes	12.0
DC Ampere Output	5.0
Nom. DC Voltage	150
Peak Inverse Volts	900

CE 249C/JAN249C

Filament Volts	2.5
Filament Amperes	7.5
DC Ampere Output	0.64
Nom. DC Voltage	2000
Peak Inverse Volts	7500



CE-226/JAN4B26

Filament Volts	2.2
Filament Amperes	17.0
DC Ampere Output	6.0
Nom. DC Voltage	90
Peak Inverse Volts	375

CE-202B

Filament Volts	2.5
Filament Amperes	20.0
DC Ampere Output	15.0
Nom. DC Voltage	250
Peak Inverse Volts	900

CE-213A

Filament Volts	2.5
Filament Amperes	7.0
DC Ampere Output	2.5
Nom. DC Voltage	1500
Peak Inverse Volts	5000

IF YOU HAVE A TUBE PROBLEM . . . CONSULT CONTINENTAL

Air Sea Rescue?

The "Princess Victoria" was lost just over a year ago and with her, 133 lives. This disaster occurred only 20 miles from land but search aircraft found the location too late because there was no ship-to-air communication. Further tragedies may well be avoided by ships being able to talk direct to each other and to aircraft. The RM.200 V.H.F. transmitter and receiver has been developed to meet this need.

TYPE RM.200 Multi-spot channel marine V.H.F. radio-telephone operating from A.C. Mains and/or Batteries. Amplitude Modulation.

Range: Ship-to-ship 25 miles; Ship-to-air over 100 miles.

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Price £210 Delivery, 4 months

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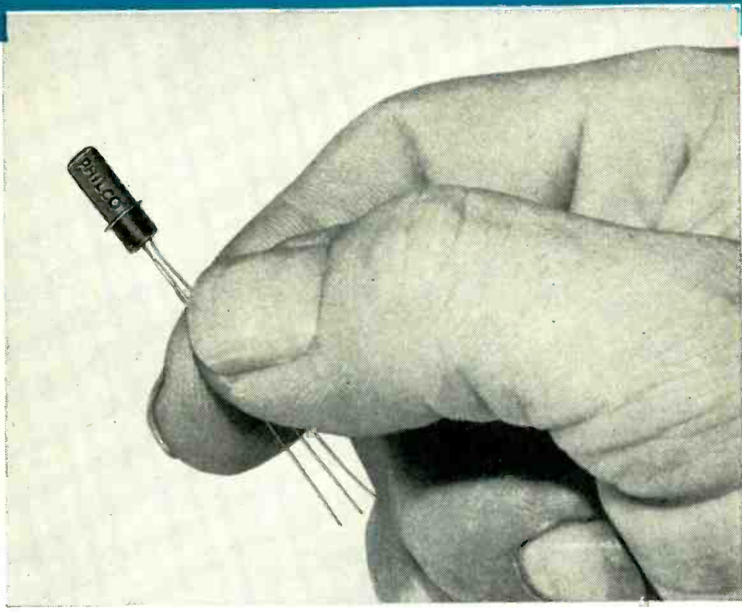
PHILCO ANNOUNCES A REVOLUTIONARY NEW TRANSISTOR



New Diffused Alloy Junction Type Has Amazing Advantages...

Philco now presents to industry a new diffused alloy junction transistor with uniformity of characteristics never before attained in production.

Design engineers will welcome the predictable performance of circuits incorporating this superior transistor.

At last, here is a transistor that will operate with the same high degree of excellence in mass-produced units as in laboratory models—*eliminating the need for individual selection of transistors or associated components to meet equipment specifications!*

Now in production at Philco, this new transistor meets the high standards required for production applications. It is one of the smallest transistors ever produced. Leads are fused in glass—the entire transistor is enclosed in a metal envelope—an instantaneous resistance weld hermetically seals the complete unit. Advanced processing techniques and new mechanical design features assure excellent characteristics and uniformity throughout the life of the transistor. Phone, write or wire Philco today for descriptive literature and specifications on this revolutionary transistor.

- **Minimum size.**
- **Hermetically sealed, resistance-welded metal case . . . leads sealed in glass.**
- **Uniform characteristics.**
- **Designed to meet typical military environmental conditions.**

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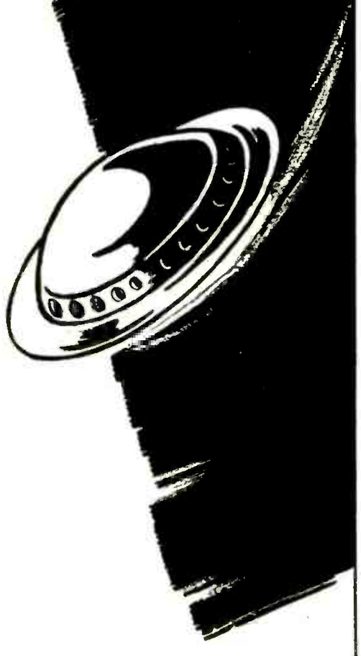
PHILCO CORPORATION

GOVERNMENT & INDUSTRIAL DIVISION • PHILADELPHIA 44, PA.

Want more information? Use post card on last page.

There may be some doubt about flying saucers

But none about Victoreen Current Regulator Tubes



More than 40 different Current Regulator Tube types are produced by Victoreen. Each tube type is designed to regulate the current at a definite value. A tube maintains its rated current within narrow limits after the threshold voltage is reached. From the great variety of tube types, with threshold voltages ranging from 1.5 to 35 volts and current ratings from 80 to 4200 ma, you may readily select just the tubes suited to your applications.

These top-quality Current Regulator Tubes will give many hours of low-cost, dependable regulation when used as recommended.

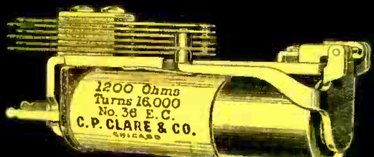
Write for brochure listing Current Regulator Tubes with complete technical information about them.

The Victoreen Instrument Co.

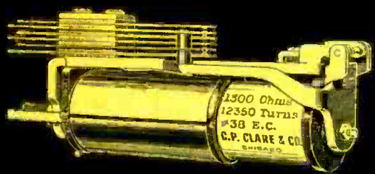
COMPONENTS DIVISION: 3800 PERKINS AVE. • CLEVELAND 14, OHIO

IS YOUR RELAY REQUIREMENT DIFFERENT?

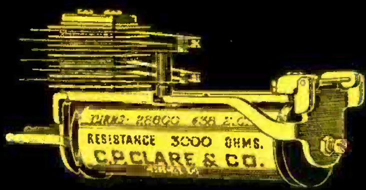
FAST OPERATE—FAST RELEASE—The Clare Type C relay will operate in from 0.005 to 0.04 second, depending on voltage applied, coil resistance, and contact assembly. Release time is from 0.006 to 0.020 second.



SLOW OPERATE—The Clare Type D Relay uses a low resistance copper slug to delay its operation. Operate time can be varied, from 0.01 to 0.1 second, by coil selection. Release time can be held low by heavy spring pressures and large residual settings.



SLOW RELEASE—The Clare Type E Relay uses a copper slug on the heel end of the coil to hold circuits operated from 0.05 to 0.3 second after the coil circuit has been broken. Operate time is from 0.01 to 0.04 second.



SLOW ACTING—The Clare Type H Relay uses dead-soft copper sleeve over coil core to delay buildup of magnetic flux so as to retard operation and release. Operate time may be from 0.01 to 0.05 second; and release time, from 0.03 to 0.3 second.

SNAP ACTION—The Clare Type CMS relay has enclosed snap-action switch contacts, rated at 10 amperes, 125 volts a-c

These five CLARE RELAYS have successfully met thousands of difficult applications

• CLARE RELAYS are built to render the utmost satisfaction to the user whose relay requirements are above the average—where extremely long life, and precise, reliable operation under severe conditions may be required.

Relays illustrated are all developments of the famous Clare Type C d-c Relay whose precision and dependability has been proved in thousands of military and industrial applications. They permit wide flexibility in design and construction to meet the most exacting requirements.

For full information on Clare relays, contact your nearest Clare sales engineer or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY

• *Write for Engineering Data Book*

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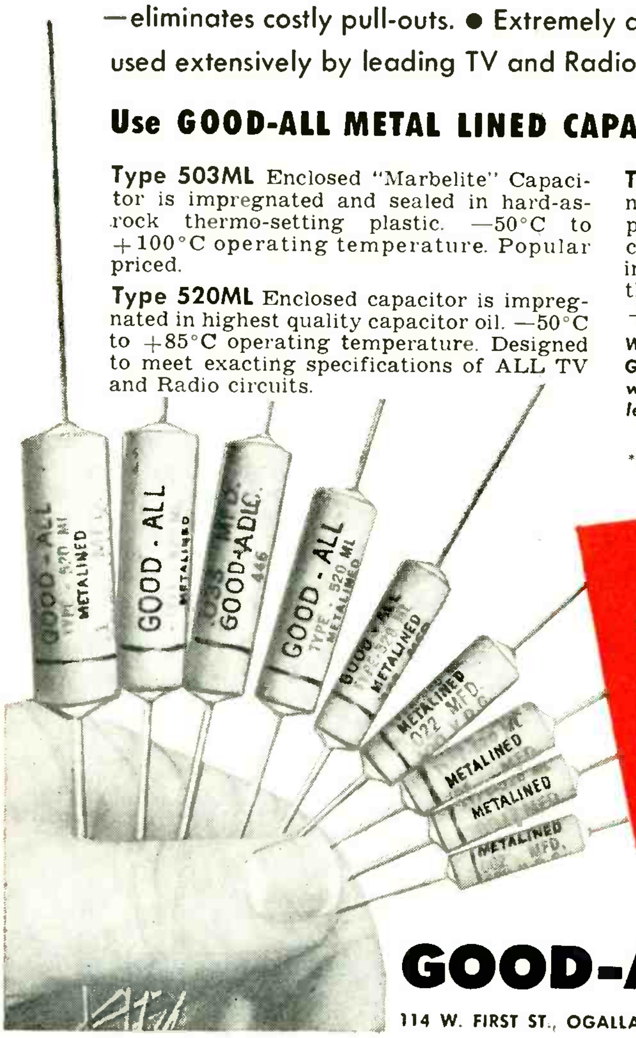
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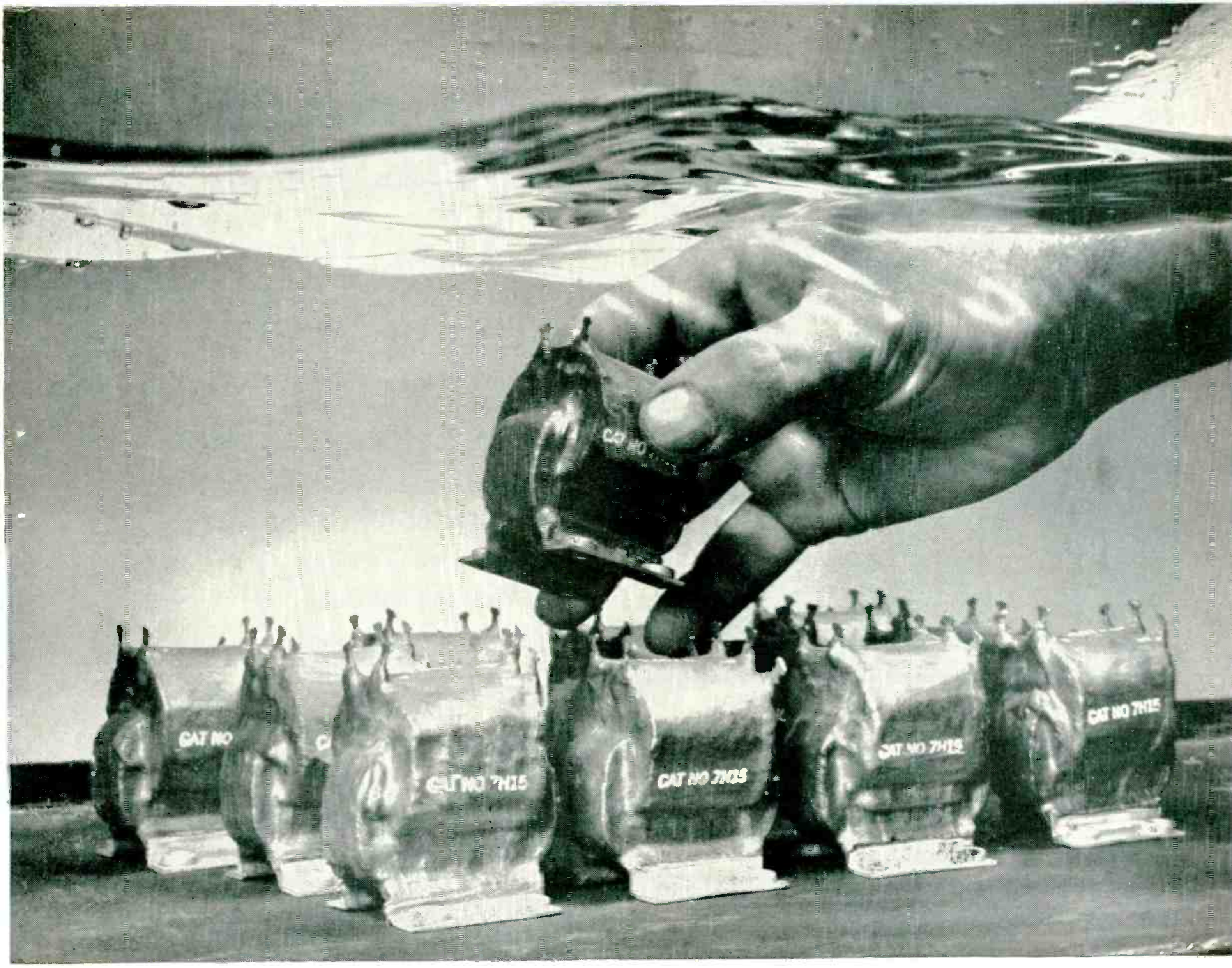

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If you're looking for a small, open-type transformer, fully protected against moisture, check the line of Westinghouse Fosterite impregnated transformers. This four-hour underwater test proves the point:

All Fosterite-treated transformers are completely submerged in hot water at 60° Centigrade for two hours, after which they are "thermal-shocked" in cold tap water, and soaked there for an additional two hours. An electrical test is then applied, in which each transformer must show an insulation resistance reading of at least 2000 megohms. Fosterite has to be good!

This is just one of many severe tests to which Westinghouse specialty transformers are subjected. They assure you of quality that will meet your requirements exactly . . . quality that stands up under extreme conditions.

Fosterite impregnated and coated transformers can be made available to meet your most stringent specifications. In addition to moisture protection, Fosterite makes drastic weight reductions possible . . . as much as 30 to 50%, when compared to enclosed types.

Call your Westinghouse representative for further information, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-70678

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

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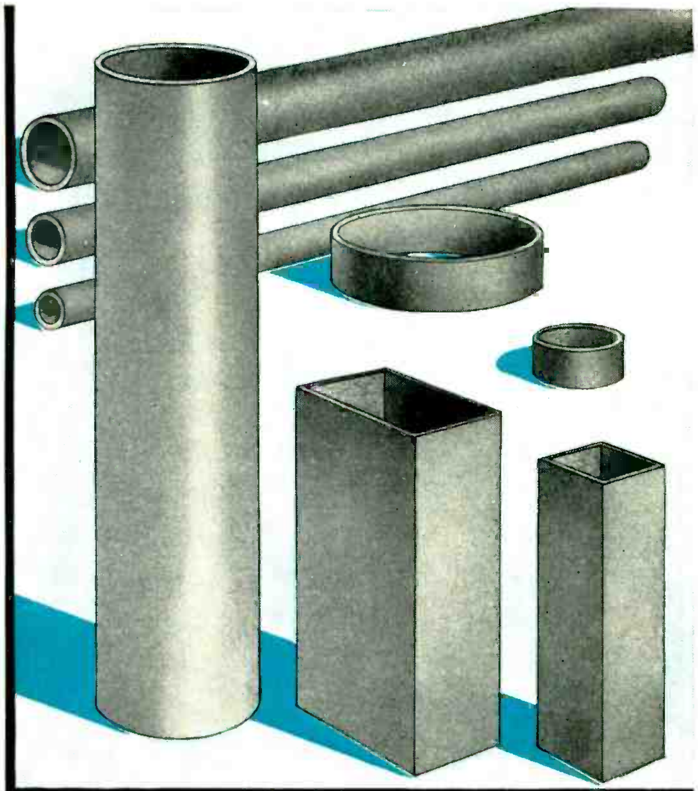

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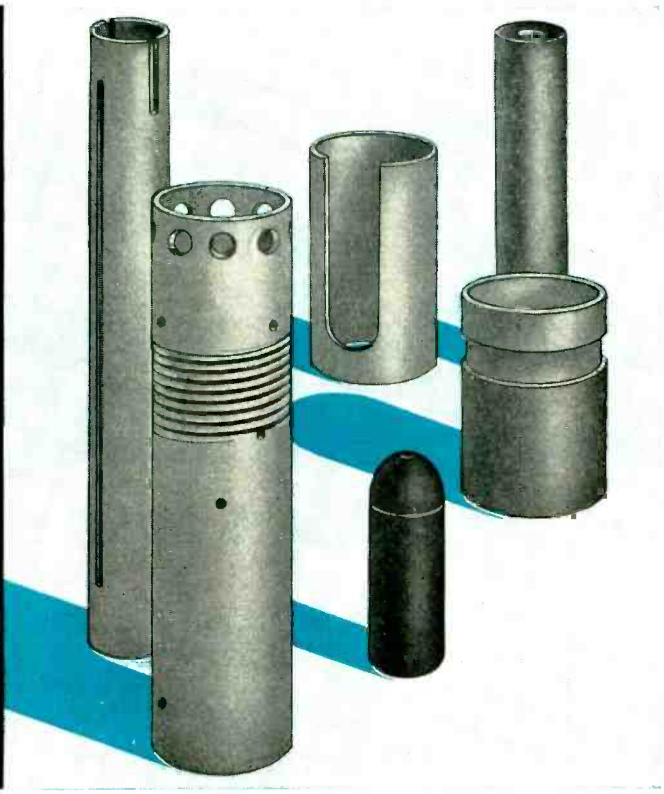

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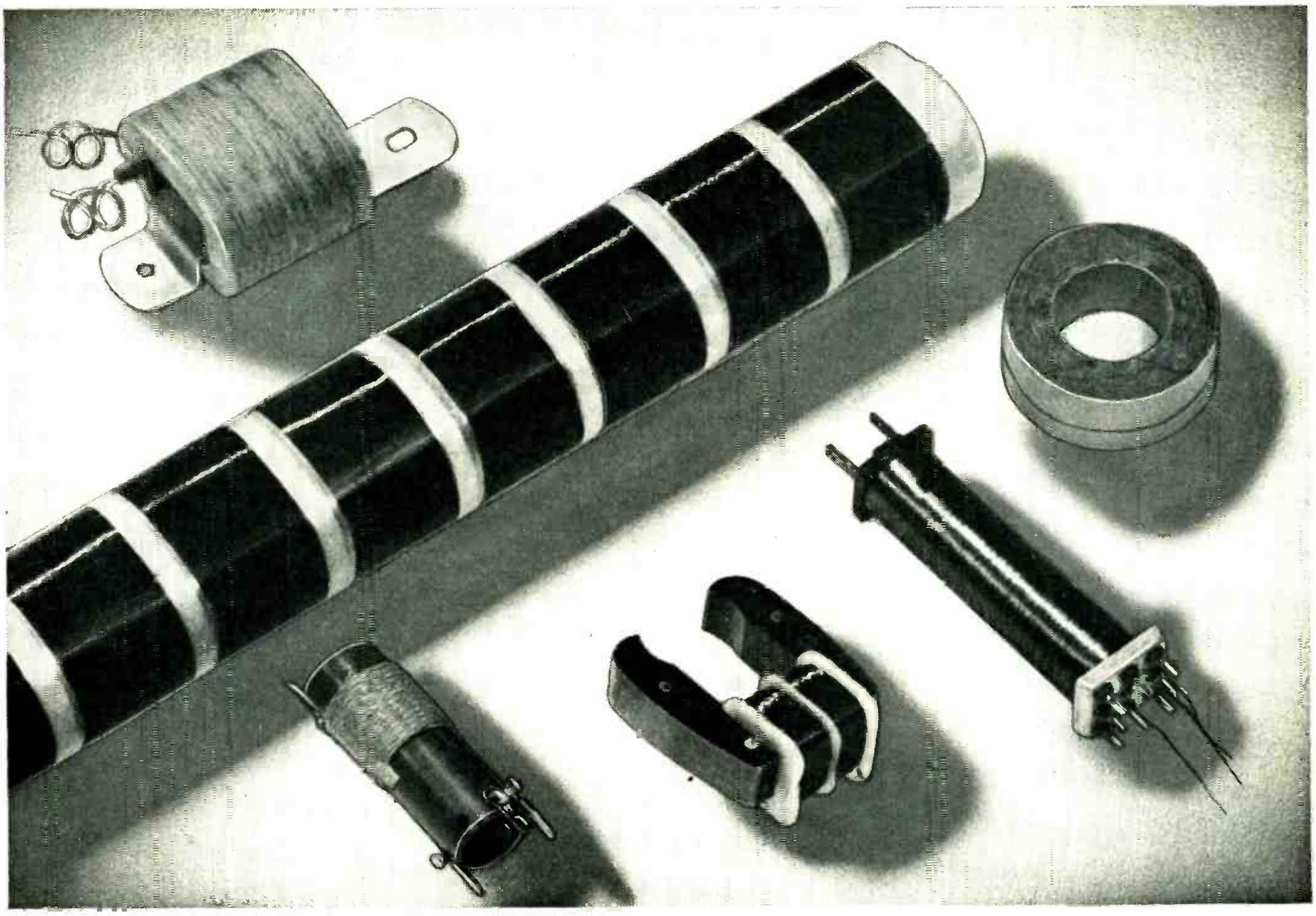

These coils saved winding costs

Each of these coils represents a sizable saving on coil winding costs because it was wound on Universal Coil Winders.

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Also: be sure to visit the Universal Demonstration Room nearest you — in Cranston, R. I. or Chicago, Ill. You'll see winders in operation and have a chance to talk over your coil winding problems with a Universal sales engineer.

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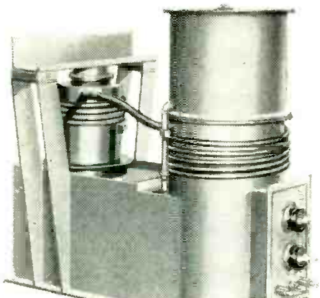

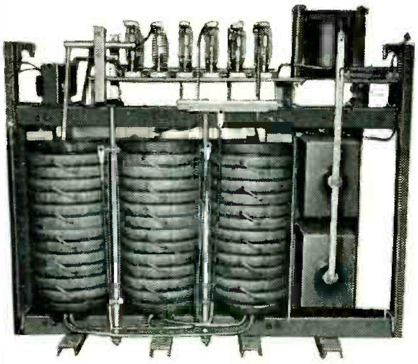

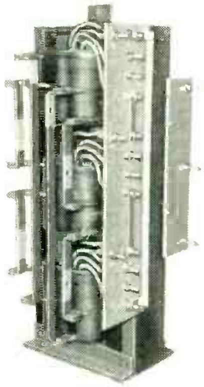

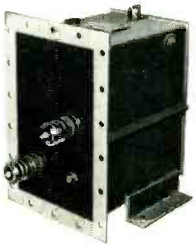

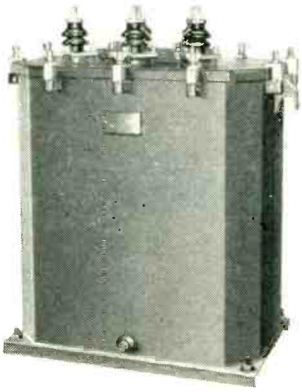

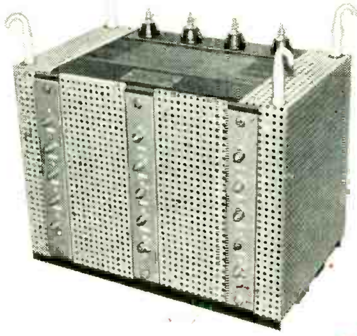

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Moloney HiperCore Electronic Cores are available to manufacturers in any quantity in more than 1000 stock sizes or to your own special specifications.

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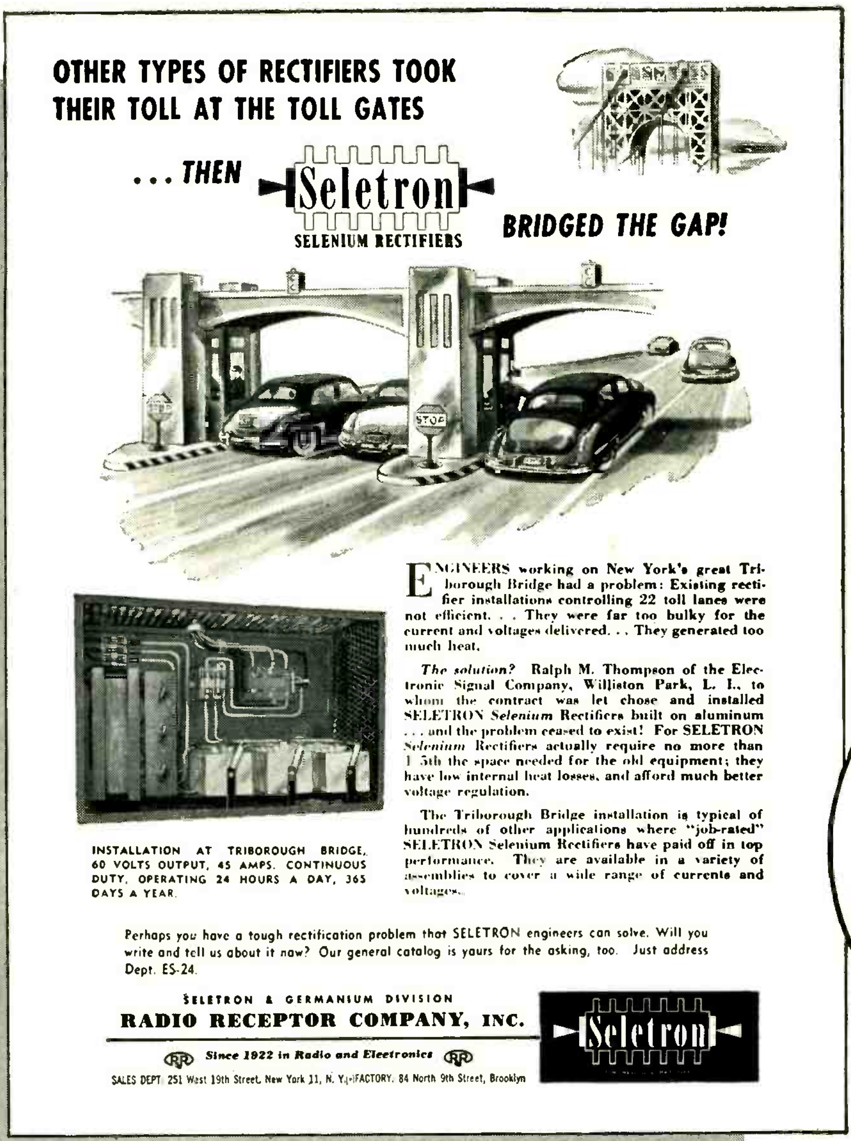
OTHER TYPES OF RECTIFIERS TOOK THEIR TOLL AT THE TOLL GATES

... THEN Seletron SELENIUM RECTIFIERS BRIDGED THE GAP!

ENGINEERS working on New York's great Triborough Bridge had a problem: Existing rectifier installations controlling 22 toll lanes were not efficient. . . They were far too bulky for the current and voltages delivered. . . They generated too much heat.

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Seletron

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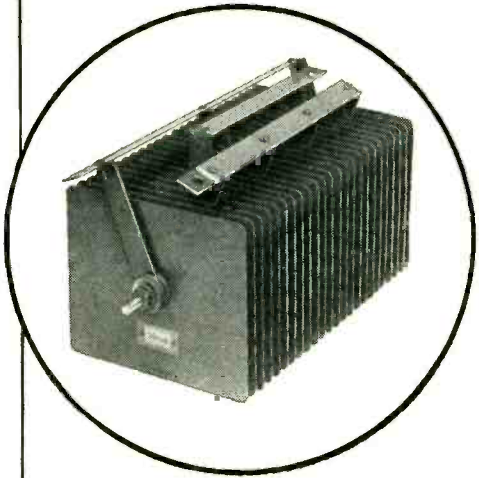

How's this for continuous performance!

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SELENIUM RECTIFIERS

Back in 1948 an ad we ran told how SELETRON Selenium Rectifiers were operating successfully in a new installation on the toll lanes of New York's great Triborough Bridge.

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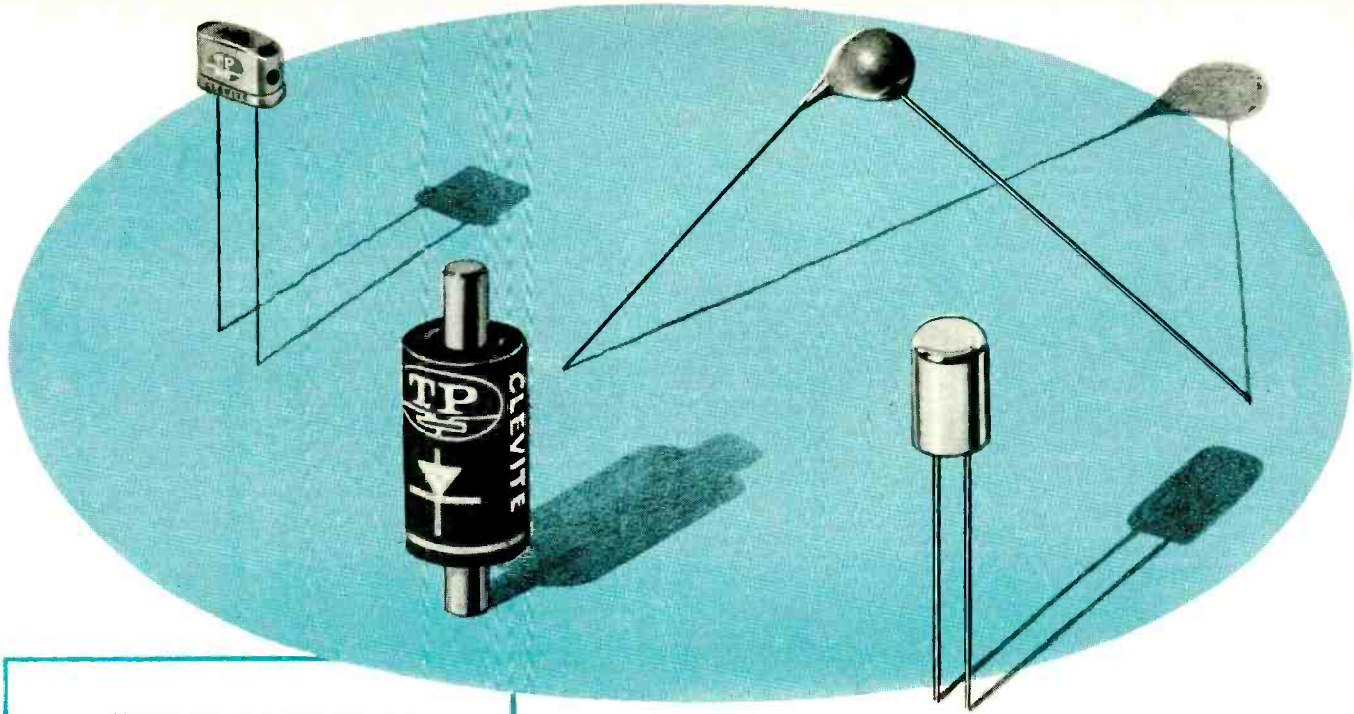

Clevite Germanium Diodes

CARTRIDGE TYPE

1N34	1N65	1N98	1N147
1N34A	1N66	1N99	1N174
1N38	1N67	1N100	1N190
1N38A	1N67A	1N105	4A
1N48	1N68	1N107	4B
1N51	1N68A	1N108	4C
1N52	1N69	1N109	4D
1N54	1N70	1N110	4E
1N54A	1N72	1N111	4F
1N55	1N75	1N112	4G
1N55A	1N81	1N113	4H
1N55B	1N86	1N114	4I
1N56	1N87	1N115	4J
1N56A	1N88	1N116	4K
1N58	1N89	1N117	4L
1N58A	1N90	1N118	4M
1N60	1N95	1N124	4N
1N63	1N96	1N132	
1N64	1N97	1N133	

"DIOMITE" BEAD TYPE

D1N34	D1N65	D1N108	1C
D1N34A	D1N69	D1N109	1D
D1N48	D1N86	D1N116	1E
D1N51	D1N88	D1N117	1F
D1N54	D1N90	D1N118	1G
D1N54A	D1N95	D1N174	1H
D1N56	D1N96	1A	1J
D1N56A	D1N107	1B	

"MICROTEMP" DIODES

M1N38	M1N55B	M1N68A	M1N108
M1N38A	M1N58	M1N70	6A
M1N54A	M1N58A	M1N75	6B
M1N55	M1N63	M1N81	
M1N55A	M1N67	M1N107	

SPECIAL CASE TYPES

S1N39	1N188	1N189	5B

For data sheets and complete information on CLEVITE transistors, diodes and transistor test sets, write Dept. E4.

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Can't

is a word ADLAKE engineers don't understand!

Often, a problem that "can't be solved" is merely one which hasn't yet been brought to the right people. When such problems come in to ADLAKE relay engineers...problems requiring special relays for unusual installations...they promptly drop the "can't". For, if there is no ADLAKE Relay to answer a specific need, one will be designed and manufactured to fill it.

ADLAKE Mercury Relays have proved their ability to stand up under the most adverse conditions of temperature and moisture. Their time delay characteristics are fixed and non-adjustable...normal line voltage fluctuations or ambient temperatures from −38° to 200° F. have no material effect on these characteristics.

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Type 1045 Quick-Acting Relay contact either normally open or normally closed.

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EQUIPMENTS FOR COMMERCIAL AND NAVAL USE

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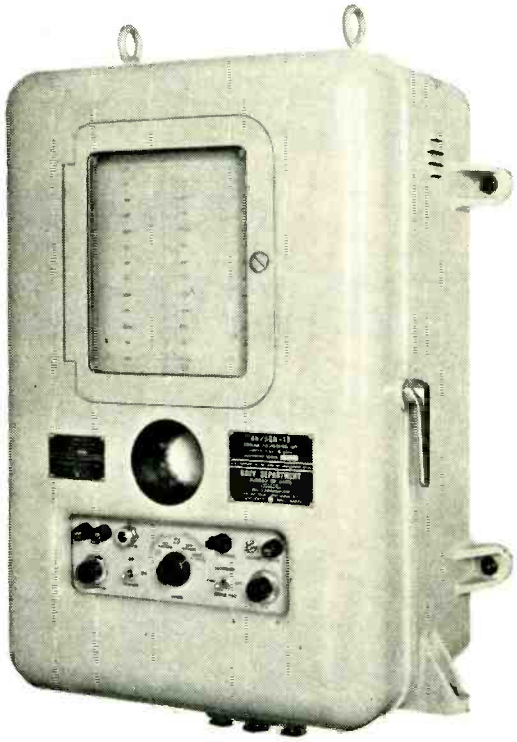
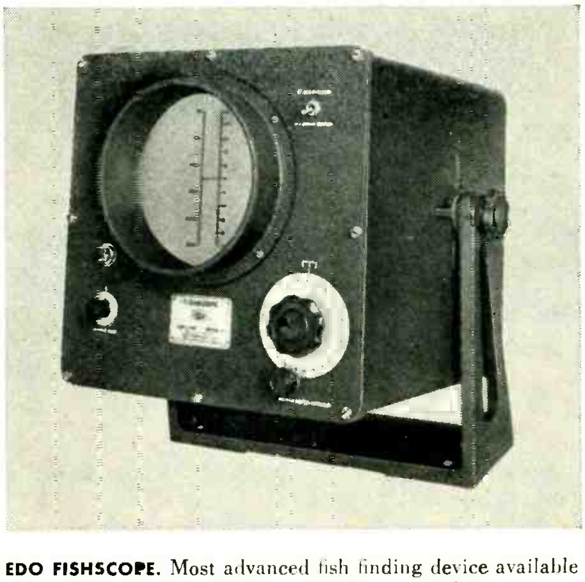


0 TO 6000 FATHOM DEEP DEPTH SOUNDER in wide use with U. S. Navy (AN/UQN-lb) now available commercially (Model 185). Gives clear indication of depth on cathode-ray tube in two scales: 0 – 100 feet; 0 – 100 fathoms. Records continuously in three scales: 0 – 600 feet: 0 – 600 fathoms; 0–6000 fathoms. The finest deep depth sounder available. For complete details send for Model 185 brochure.

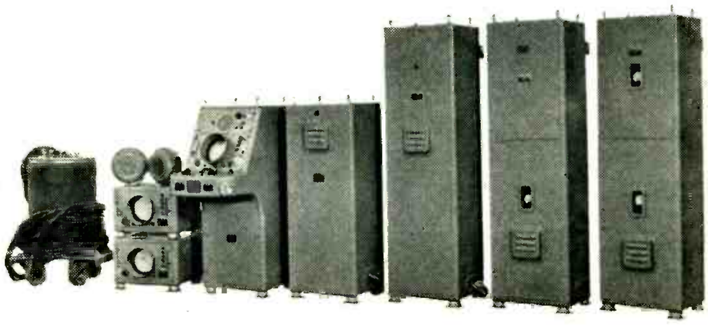
Ingenuity of design, proven performance and superior range with accuracy are the main reasons why EDO is now regarded and recognized as the outstanding leader in the development of echo-ranging equipment.

From deep depth sounders for navigation, survey, and ocean bottom exploration to a wide variety of under water detection systems, Edo equipment has made its mark and proven its superiority.

That's why when you see the Edo flying fish emblem on a sonar equipment you can confidently recognize it as a product of brilliant engineering and masterful workmanship—reliable beyond question.



EDO FISHSCOPE. Most advanced fish finding device available today. Spots fish on cathode-ray tube in 0 – 250 fathom range, then magnifies any 10-fathom sector 25 times for clearer view. Commercial fishing boats equipped with the Fishscope report better than average hauls in far less time thanks to this Edo development. For full details send for Fishscope brochure.



EDO SCANNING SONAR a typical example of a complex naval sonar system, developed and built for the U. S. Navy by Edo.

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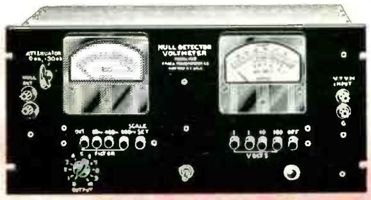

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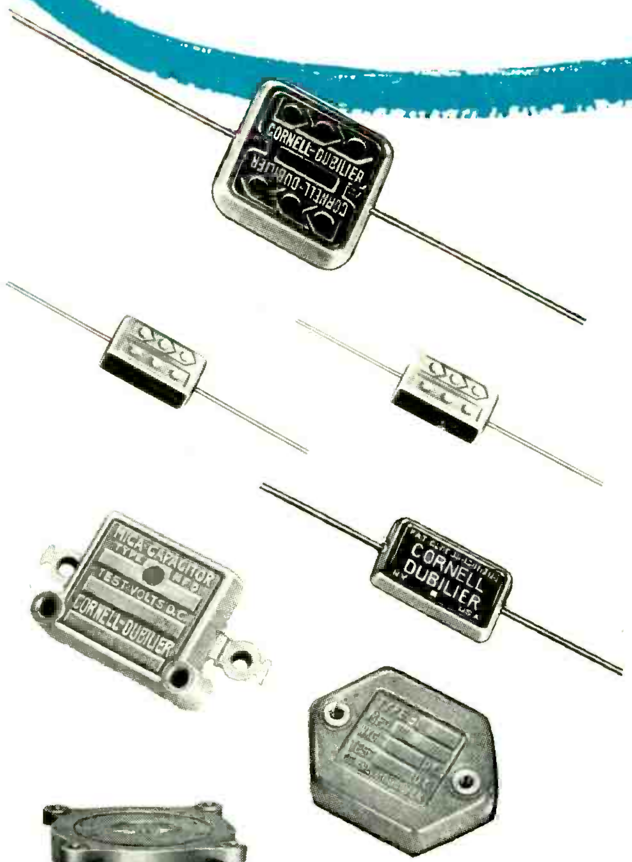

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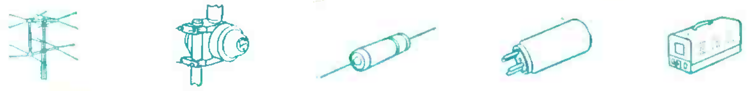

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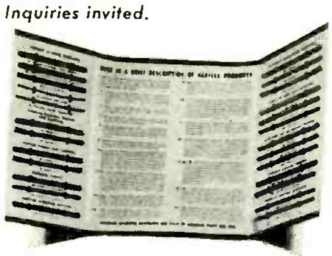

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CROSS TALK

► **TWO SPRINGS** . . . This report is written in California, where spring came early, with San Francisco singularly free of fog and Los Angeles temperatures well up in the eighties. By the time it goes to press we will be back in New York, and thus will see two springs for the price of one.

Most noticeable thing about far-western industry in the past six months is a healthy tendency toward stabilization. Not so many new firms. Some consolidations. Subcontractors are suffering a little, principally because some prime contractors deem it desirable on many counts to do more of their own work. Business in general is good.

There is an air of urgency in the development of commercial electronic products by Coast manufacturers heretofore concerned chiefly with government business. Many have excellent pipelines into local aircraft, guided-missile and college research laboratories, so the result should be more of the highly specialized and only moderately competitive products for which the area is noted.

► **DIP-SOLDER WIRING** . . . Where mechanized wiring seems desirable, but production runs are short, extension of dip-soldering techniques may solve the problem. We saw some wiring just the other day that consisted exclusively of solder flowed in thin streams onto an insulating base and it seemed to fill the bill experimentally.

► **CAGEY COLOR** . . . In our travels the impression is growing that tube makers in general are playing it safe on color-television picture tubes, producing just enough 15-inchers to keep a foot in the door while at the same time watching the other fellow for evidence of larger sizes.

No one wants to be caught without color tubes if the market suddenly blossoms. Nor does anyone wish to be committed in production if competition finds a practical way to provide sizes comparable with monochrome types.

Guessing is complicated by the fact that one suggested tube type does not appear to lend itself too well to the larger sizes and presents some problems in brightness. Another, that does not seem to be too difficult to produce in larger sizes and presents a bright picture, is still in process of refinement. Some engineers feel that there may be still a third type somewhere in the woodpile but, if there is, it is well-shrouded in industrial secrecy.

► **TAPE TRENDS** . . . The market for magnetic recording tape is expanding rapidly, with new applications showing up around every corner.

Movie producers have used a lot of it for some time, but the real news at the moment is the rate at which theater orders for stereophonic playback equipment are coming in. It is also becoming evident that tape recorders go nicely with home hi-fi equipment. Watch for new models aimed at this market by firms that have in the past concentrated upon professional users.

Doctors are digesting technical papers on tape, keeping up to date by listening instead of reading. (McGraw-Hill has done similar work in other fields.)

Tape is one of the keys to industrial automation. Several new firms have recently been set up to engineer automatic control into everything from "a peanut stand to a bank," and appear to be counting heavily upon it for programming.

Even in the geophysical field, where engineers are most reticent about divulging advanced techniques, there is evidence that the usefulness of conventional oscillographs is being extended through the use of magnetic tape.

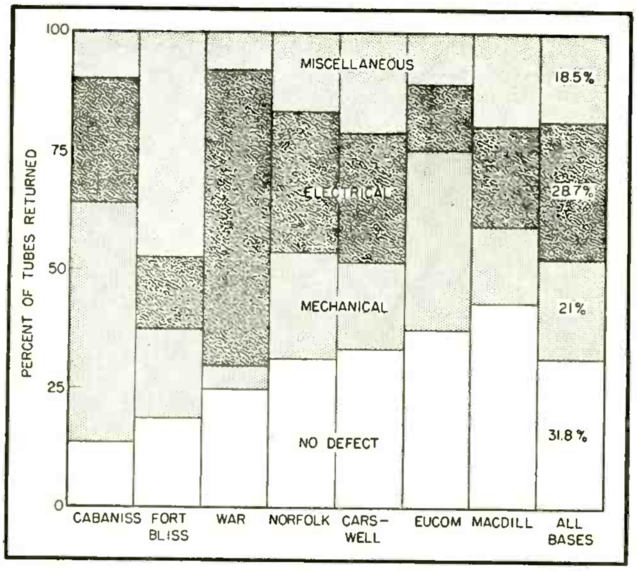

FIG. 1—Tubes returned fall into four defect classes: mechanical, electrical, miscellaneous including breakage and no defect

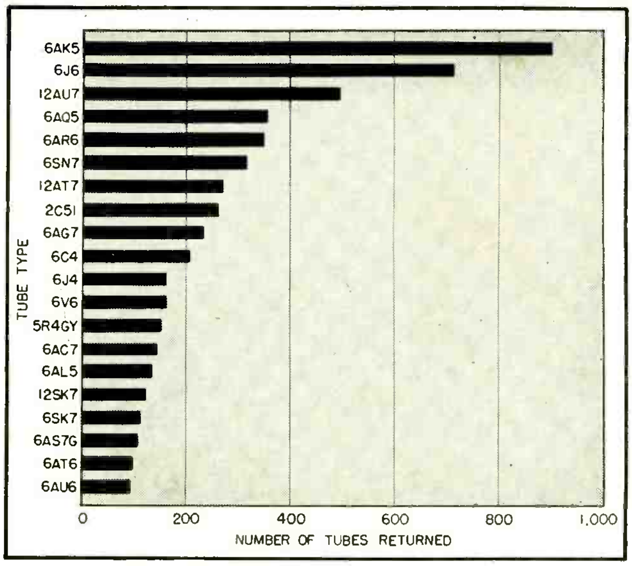

FIG. 2—Tube types 6AK5 and 6J6 lead the twenty tube types ranking highest in total number of returns for first quarter, 1953

Military Reliability of

Study of over 150,000 electron tubes used in military equipment reveals types most likely to fail and discusses common kinds of failure. Tells what equipment designers and tube manufacturers can do to increase electron-tube reliability

By E. R. JERVIS and J. SWAUGER

Aeronautical Radio, Inc.
Washington, D. C.

SEVERAL long-term programs have been launched by the armed services with a view to improving the reliability of more than 30 tube types. These types will be usable in more than ⅔ of all sockets in present-day military equipment. The improved types are being developed to reach a goal of 95-percent survival in 1,000 hours operation in contrast with 80-percent in 500 hours for presently available tubes.

A large-scale surveillance project is under way to determine the status of military electron tube reliability before and after use of improved tube types, to discover causes of unsatisfactory performance and to suggest measures for improving reliability. Field stations at eight military bases collect rejected tubes from military equipment. The tubes, with available failure data, are forwarded to Washington and subjected to both engineering and statistical analyses.

In two years, 88,500 tubes removed as defective by military technicians have been collected. Over 62,000 tubes have been installed in controlled tests. Tubes under test include over 14,000 of the 22 improved tube types as well as many thousands of their JAN prototypes.

Most of the information to be discussed concerns performance of JAN tube types since the improved versions have been used only in limited numbers during the last two years. This article covers from Sept. 1951 through March 1953 and includes data from over 44,000 tubes collected from 44 general equipment types.

Types of Defects

Tube returns have been classified in four general defect categories. Electrical defects include tubes rejected because of deterioration of performance caused by faulty processing during tube manufacture, end of normal tube life and environmental or operating conditions. Mechanical defects are physical defects in the structure caused by environmental conditions or weaknesses of tube construction. Miscellaneous defects include broken glass, noise, microphonism and defects caused by unusual environmental conditions or mishandling by main-

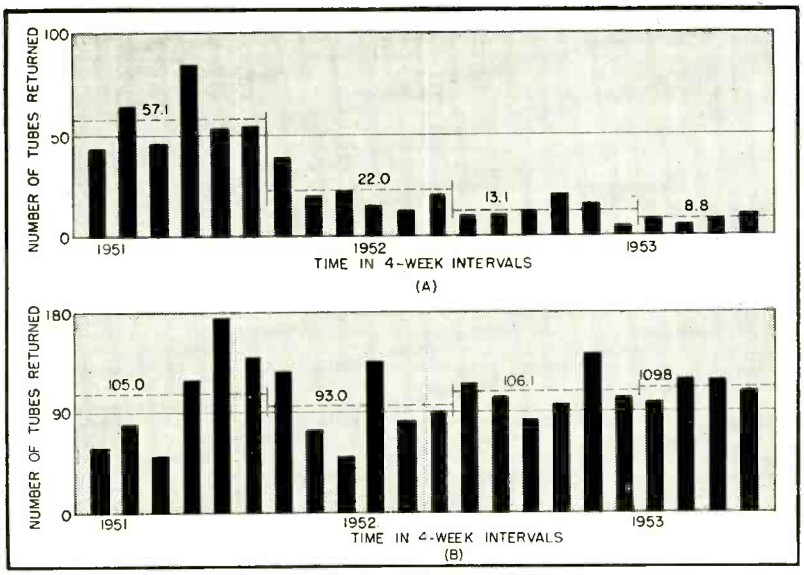

FIG. 3—Returns of 6AR6's from power supply of radar bombing system (A) and from complete system (B). Reduced failures are due to better ventilation

Electron Tubes

tenance personnel. The no-defect category includes tubes removed by maintenance personnel yet found upon laboratory examination to contain no mechanical or electrical defects.

As shown in Fig. 1, one third of all the tubes rejected from military equipment are not defective at all. An additional one sixth of the tubes were probably damaged during installation or maintenance. The remaining 50 percent are truly defective. However, ⅔ of these failed only after progressive deterioration; they could have been located and removed before causing trouble. Therefore, only one out of every six tubes represents a failure such as would cause unpredictable equipment malfunction.

The equipment types installed at the different bases are similar. However, each base has a characteristic defect distribution pattern. These patterns reflect local operating procedure and maintenance practices.

Figure 2 is a ranking of the 20 tube types contributing the highest number of returns during the first quarter of 1953. While these tube types constitute only about 10 percent of the types collected, they represent nearly half the total returns. Type 6AK5 alone contributed almost 10 percent.

Some tube types are numerous among those returned due to the large number in use. This group consists of old types such as the 6SN7, 6AC7, 6V6 and 6AG7 used in well-established equipment or newer tube types having wide application such as the 6AL5, 5R4GY and 6C4.

A second category includes tubes whose large return is due mainly to abnormal removals from some or all of the sockets in use. These include types 6AR6, 6AT6, 6J4, 12SK7, 6AQ5, 6AU6 and 2C51. With the exception of the 12SK7 these types are of relatively recent design and critical application.

Tubes in the third category—types 6AK5, 6J6, 12AT7, 6AS7 and 12AU7—show large returns due both to large socket populations and to abnormal removal from some of the sockets in use. The military services have already begun improvement projects on 17 of the 20 types listed in Fig. 2.

Type 6AK5

The only outstanding weakness revealed in the 6AK5 is the heater. Table I gives a quantitative comparison of the reliability of the 6AK5 and its improved versions, types 5654 and 6096. Comparison is made of mean removals from 100 sockets during 100 hours of operation when the tubes are replaced with new ones upon failure. The fourth column gives number of failures if all no-defect removals are eliminated; in column five, eliminating both no-defect and electrical-defect removals indicates unpredictable failures causing equipment malfunction.

Information was also obtained from commercial airlines on a number of 5654's made by different manufacturers.

Type 6J6

Tube type 6J6 is even more widely used than 6AK5 although the number of sockets under present surveillance is slightly less. Table II shows the defect distribution of all returns of this type and its improved versions during the first quarter of 1953. The no-defect category is larger for this type than for the overall average of all tubes from all bases. In returns of the improved type, electrical defects

SIX WAYS TO INCREASE ELECTRON-TUBE RELIABILITY

- Limit power dissipation in soft-glass tubes to keep bulb temperature below 200 C.
- Limit cathode temperature to values minimizing interface formation and sublimation of nickel material.
- Limit heater temperature to 1,400 K to prevent heater-cathode trouble and heater burnout during cycling surges.
- Control metallic deposits on insulating surfaces by proper design of parts and insulators and proper shielding and coating of insulating parts.
- Control dimensions to obtain proper fit of parts and reduce vibration.
- Control fabrication and assembly to reduce operational failures due to faulty workmanship

lead mechanical by two to one. A breakdown of the electrical defects is also given.

A common electrical defect is heater-to-cathode leakage, probably due to the unusual physical layout of the tube. A large amount of power—as much as eight watts—is dissipated between the cathode and plates, and the grids have a tendency to expand, usually toward the cathode.

A comparison of results obtained in some controlled tests is given in Table III. The figures are of the same order of magnitude as those for type 6AK5 and the improvement of the premium versions over the prototype is also similar. However, the 6J6 appears to be overrated. To improve its reliability, it may be necessary either to decrease its maximum rating or to redesign radically its mechanical structure.

A double triode such as the 6J6 has almost twice as many chances of failure as a single tube but the returns do not show double the number of failures. This indicates that double triodes, performing the function of two tubes, have higher reliability than two single tubes.

Double Triodes

Other double triodes, such as the 6SN7, 12AU7, 12AT7, 2C51 and their improved counterparts also show higher reliability than comparable single tubes.

The 12AU7 compares favorably with the 6SN7 if the most recent design of the 12AU7 is considered, Type 12AT7, on the other hand, shows high-temperature operation in its heater and cathode. This is indicated by the large percentage of returns for heater-cathode leakage and insulation failures. The 12AT7 has had wide acceptance among circuit designers because of its high transconductance and low heater requirements in spite of the extreme design features used to obtain such characteristics. These design features are responsible for the defects mentioned and should outweigh the performance characteristics if reliability is considered.

The 2C51 is similar to the 12AT7, but except for some insulation failures does not show the same weaknesses to as great an extent. The 2C51 has an improved version in the type 5670.

Types 6V6 and 6AQ5

Tube type 6AQ5 has been studied in comparison with type 6V6 of which it is the miniature counterpart. Table IV represents the defect distribution for these two types and their reliable counterparts.

The 6V6 exhibits a larger percentage of electrical defects than of other defects and is much higher in this category than the 6AQ5. The 6V6 shows a larger proportion of returns with interface resistance while the 6AQ5 evidences a greater tendency to fail because of emission degradation.

The temperature of the 6AQ5 has been estimated to be 100 C above that of the 6V6 at maximum rating. The higher operating temperature may explain the faster emission deterioration of this type, resulting from evolution of gas and poisoning of the emitting surface by ion bombardment.

Failures may occur either due to loss of emission properties of the cathode, interface formation, evaporation of materials, vibration or a combination of any of these, and by catastrophic changes such as gas discharge within the bulb, glass strains, and shorts and opens.

Deterioration Failures

The rate of decay of cathode emission is related to the residual gas in the envelope at the beginning of tube life. As time passes, the cathode absorbs some of this gas and is gradually poisoned. This process may be accelerated if additional gas is developed as a result of electrical overloading or high ambient temperature.

Formation of interface resistance occurs most frequently in tubes that operate for long periods of time in circuits requiring low current densities. Composition of the nickel sleeve affects the speed of interface formation but exhaust schedules and operating temperatures are also important.

The evaporation of metal from hot elements in tubes produces gradual deterioration in the insulating properties of the tube structure and low-resistance paths between electrodes resulting in noise or irregular operation. Methods for minimizing this effect are coating smooth surfaces with rough insulating material to increase the length of the leakage

Table I—Removals of Tube Type 6AK5 and Improved Versions from 100 Sockets During 100 Hours

Source	Tube type	Mean removals	95-percent confidence interval	All failures	Catastrophic failures
Carswell AFB	6AK5	3.36	2.06–5.00	1.7	0.90
	6096	1.73	0.89–2.84	0.67	0.40
NOB Norfolk (air)	6AK5	4.87	3.24–5.45	3.08	2.05
	5654	1.90	1.69–3.14	0.71	0.47
	6AK5W	1.83	1.36–2.38	0.99	0.66
Commercial airlines					
Tube mfgr A, line E	5654	0.21	0.07–0.43	—	—
Tube mfgr A, line D	5654	0.33	0.12–0.60	—	—
Tube mfgr B, line E	5654	0.17	0.05–0.38	—	—
Tube mfgr B, line D	5654	0.29	0.10–0.60	—	—

Table II—Defect Distribution for Tube Type 6J6 and Improved Versions

Defect	6J6 number	6J6 percent	6J6W, 6096, 6101 number	6J6W, 6096, 6101 percent
Mechanical	107	20	20	16
Electrical	86	16	41	32
No defect	213	40	55	43
Miscellaneous	130	24	12	9
Total	536	100	123	100
Electrical defects only (6J6 and improved versions)				
Degradation	135	55	—	—
Unbalance	37	15	—	—
Heater-cathode leakage	76	30	—	—
Total	248	100	—	—

path, proper shielding of electrodes, elimination of getter material, use of nonevaporating getters and inactive alloys and limitation to minimum operating temperatures in all elements.

If tubes are operating under conditions of constant vibration and frequent shocks, gradual deterioration can occur as a result of the enlargement of the supporting holes in the mica spacers. Eventually the electrical output produced by mechanical movement of the parts will overcome the useful output of the tube. Corrective measures include anchoring all elements firmly, using close tolerances on the mica spacers, processing the tubes at low temperature to prevent extreme expansion, using synthetic mica, Terratex or ceramics for spacers and redesigning the structure to obtain shorter electrodes and higher resonant frequencies for the elements.

Some causes of destructive gas discharge pressures are over heating of an electrode until it releases sufficient gas to reach arc discharge pressures, heavy heater-cathode leakages and slow air leaks.

If the glass envelope is not annealed properly or is subjected to unusual mechanical or thermal stresses it may crack. However, glass defects are infrequent where tubes are carefully handled.

The electrode most subject to shorts and opens is the heater. The operating temperature is one of the major reasons for failure. Low operating temperature for the heater is important to avoid burnout and to reduce heater-cathode leakage.

Only about 12 percent of all tubes collected had definitely identifiable mechanical defects. Of these, more than half were attributable to the heater or heater-cathode circuit.

Table III—Removals of Tube Type 6J6 and Improved Versions from 100 Sockets During 100 Hours Operation

	Tube type	Mean removals	95-percent confidence interval	All failures	Catastrophic failures
Carswell AFB	6J6	7.0	5.2–9.1	2.8	0.67
	6099, 6101	1.4	0.56–2.6	0.74	0.38
NOB Norfolk (air)	6J6	4.46	3.4–5.6	3.22	2.12
NOB Norfolk (ships)	6J6	1.86	1.3–2.5	1.39	0.67
	6101	2.2	1.0–3.8	1.55	0.66

Table IV—Defect Distribution for Tube Types 6AQ5, 6V6 and Improved Versions

	6AQ5		6005, 6095		6V6, 6V6GT, 6V6Y, 6V6TY	
Defect	number	percent	number	percent	number	percent
No defect	152	49	4	17	45	41
Mechanical	28	9	6	26	3	3
Electrical	79	25	4	17	51	47
Miscellaneous	57	17	9	40	10	9
Total	316	100	23	100	109	100
Defective tubes only						
Mechanical	28	17	6	32	3	5
Electrical	79	49	4	21	51	80
Miscellaneous	57	34	9	47	10	15
Total	164	100	19	100	64	100

Environmental Effects

High ambient temperatures, vibration and shock and abnormal supply voltage contribute to unreliability. Returns of tube type 6AS7G, and its reliable version, the 6080, from a voltage regulator used in a van-mounted fire control system illustrate this.

Operation in hot climates with the cabinet closed resulted in poor reliability in both type 6AS7G and its reliable version, type 6080. Operation in hot climates with the cabinet open gave satisfactory results if improved type 6080 was used while operation in air-conditioned vans gave normal life expectancy for both improved and JAN tube types.

In the power supply of a radar bombing system, the power supply chassis was originally mounted in the nonpressurized part of the plane where there was inadequate ventilation; 6AR6 returns per socket were four or five times greater than the average for all other sockets of the system. During flights above 30,000 feet, bulb temperature reached 315 C.

The power supply chassis was transferred to the pressurized zone of the plane and more effective blowers installed. A temperature check in the relocated chassis showed an average bulb temperature of 181 C. Figure 3A shows the returns of tube types 6AR6 and 6098 for four-week intervals over a period of almost two years. The gradual decrease in returns from an average of 57.1 to 8.8 for each four-week period is readily noticeable. Figure 3B shows returns of all other tube types in the complete system during the same period, indicating that there was no comparable change in the aggregate returns.

Misapplications

Severe misapplications are readily detected and corrected and do not constitute serious reliability problems. More troublesome are misapplications that produce only slight hardships. These include use of a tube type at its maximum rating when there is available another type that could be operated at a more conservative rating; use of a type not actually designed for a particular application when a more suitable type is available; and use of several tubes in parallel to avoid the use of a larger tube.

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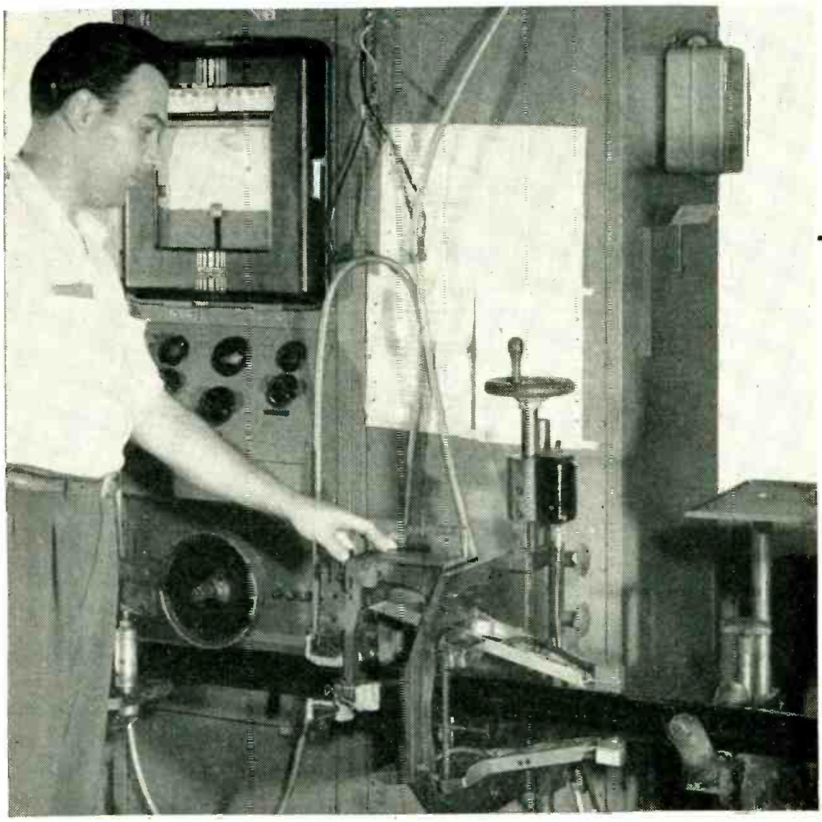
Capacitance Gage Checks



Measuring setup on cable production line. Toroid-shaped metal electrodes are in small blocks at right, held against sheath by metal arms mounted at angle to cable

By B. M. WOJCIECHOWSKI
Test Set Development Engineer
Western Electric Co.
Kearny, N. J.

POLYETHYLENE extruded over a metal jacket replaces the conventional lead sheath in a new telephone cable now in use by the Bell System. The cable core is covered with a metal jacket that may either be one thin layer of aluminum or layers of aluminum and steel.

To achieve the desired mechanical properties, the metal jacket is corrugated circumferentially. Between the metal layer and the plastic sheathing, a bonding viscous thermoplastic compound is applied to fill the depressions of the corrugations on the metal surface. The sheathed cable leaves the extruder at an essentially uniform speed, in the range from 30 to 80 feet per minute, under the pulling force of a capstan. After leaving the extruder, the cable is cooled in a trough of water and, before reaching the testing position, dried with compressed air.

Measurement Difficulties

Some of the problems encountered in the manufacture of the new cable were related directly to the lack of reliable methods for measuring thickness of the plastic sheathing. Under manufacturing conditions where sheath thickness cannot be adequately controlled, excess material must be used to assure meeting minimum thickness requirements.

Before the new method was introduced, measurements were made by destructive testing of end samples. One or two circumferential strips were taken from each cable length and micrometer measurements were made on each strip, at four to eight points. Unfortunately, the actual sheath thickness varies in a random way along the cable length, even between points only a few inches apart. A method based on a few point measurements, extrapolating long-cable properties which are describable in statistical terms only, thus left much to be desired.

Choice of Method

For practical reasons as well as for anticipated lack of accuracy, measurements involving use of an x-ray machine were rejected. The success of an ultrasonic echo method would be doubtful, the main reason being the presence of corrugations and of an irregular layer of the filling compound under the polyethylene sheathing, obscuring delimitation of the reflecting boundary surface.

The capacitance method, at first, also had discouraging aspects. Only grounded capacitance measurements are involved, since the metal core cannot possibly be insulated from the corrugating and forming machinery. The required long-time capacitance-to-ground stability and accuracy of the measuring system were estimated to be of the order of 0.001 $\mu\mu$f and 0.003 $\mu\mu$f, respectively. Meeting requirements of this order, even under controlled laboratory conditions, presents some difficulties—and yet these requirements had to be met on a production line, on moving cable in the climatic and operational conditions prevailing in a large cable plant.

It was evident, therefore, that conventional grounded-capacitance

Cable Sheath Thickness

Grounded direct-capacitance method utilizing shielded impedance bridge gives accuracy of 0.003 inch in measuring and recording thickness variations in polyethylene sheathing extruded over corrugated metal jacket of new telephone cable

measurements would not be practical. For instance, a shielded cable connecting the probes with the bridge circuit alone could produce wider random capacitance variations than the capacitance increments under measurement. A new method of grounded direct-capacitance measurement using an impedance bridge was therefore developed.

Impedance Bridge Circuit

The bridge circuit shown in Fig. 1 has equal ratio arms magnetically coupled. An application of this type of circuit for capacitance measurements has been known for some time. Such a circuit is capable of performing in one balancing operation direct-capacitance measurements if the center point B of the transformer ratio-arms winding is grounded. For cable this is impossible because corner D of the bridge consists of the metal covering of the cable core, which is at ground potential. However, by connecting to corner B a shield that surrounds the A-D and C-D measuring arms, including cables and probes, three desirable results are achieved.

First, admittances from the measuring electrodes to the shield at B are not critical. These admittances appear across the transformer arms. As a result of a close magnetic coupling realizable between these arms, any loading effects across any one of them are symmetrically reflected at the A and C corners of the bridge, thus essentially not affecting its balance.

Second, stray admittances from the shield to ground appear across the opposite corners of the bridge (detector diagonal). Therefore, they also have no essential effects on the circuit balance.

Third, as a result of the shield at B, stray admittances to ground from the measuring electrodes and from the connecting leads can be reduced to insignificant quantities.

Performance of Bridge

The bridge arrangement measures capacitance quantities equivalent to direct capacitance, in a particular case where one of two measuring electrodes is grounded.

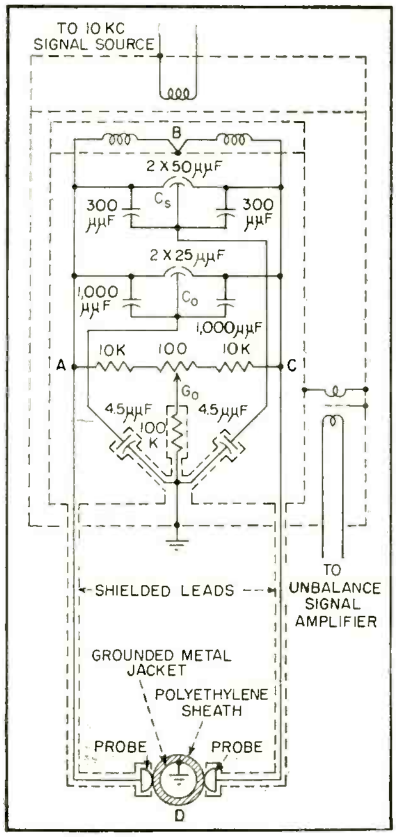


FIG. 1—Grounded direct-capacitance bridge circuit as used with two probes

Realization of the grounded direct-capacitance measurements is made possible by having within the measuring arrangement a three-electrode system in which stray admittances from the third (ungrounded) electrode to either of the measuring electrodes do not affect the fundamental balance condition of the bridge network.

Residual effective capacitances between the measuring electrodes and ground are reduced to a desirable minimum (actually below 1 $\mu\mu$f, including calibrating capacitor and balancing networks). Also, any adverse capacitance effects of the cables connecting the bridge to the measuring probes are practically eliminated, even though these cables are several feet long.

The calibrated grounded direct-capacitance range of the bridge extends over 0.32 $\mu\mu$f in either direction off the balanced center position. Any unbalances within the ± 0.25 $\mu\mu$f range can be read in increments of 0.005 $\mu\mu$f per division on the dial of capacitor C_s or on the recorder scale.

Covering such a limited capacitance range directly with an adjustable capacitor presents practical difficulties, hence a capacitor network was used to reduce electrically the range of the 2×50 $\mu\mu$f differential capacitor C_s to 2×0.32 $\mu\mu$f. Use of such a network facilitates calibration and adjustability and greatly reduces the effects of mechanical instability of the variable capacitor. Similar networks serve for capacitance C_o and conductance residual-balance control G_o.

Stationary unbalances of the bridge network can be measured directly in a conventional manner by rebalancing the circuit with C_s. For unbalances rapidly varying in time, however, this null method could not be applied simply. Therefore, a proportional off-balance deflection method had to be used.

The circuit shown in Fig. 2 assures overall linearity between incremental capacitance unbalances and indicator deflections, so that variations in linearity no larger than 0.4 db over periods of several days and 0.2 db over several hours have been observed in the actual operating conditions.

Measurements with the bridge depend essentially on the calibrated capacitor C_s. To avoid necessity for frequent and quite elaborate calibration checking (within a few thousandths of a $\mu\mu f$) of this capacitor in a laboratory, a set of supplementary high-stability auxiliary standards has been provided in the test-set assembly. The capacitance values (1.05 $\mu\mu f$, 1.20 $\mu\mu f$ and 1.35 $\mu\mu f$) of these capacitors are so chosen that differences between any pair of them can be compared directly with the calibrated capacitor in the bridge circuit.

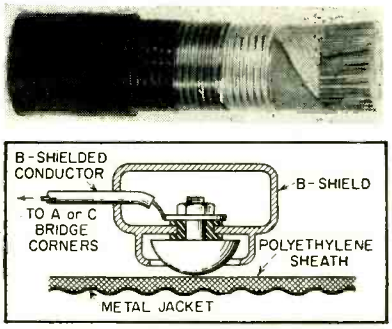
Reliability of this system is based on a reasonably high probability that change in the calibrated value of any single capacitor will be revealed in the process of mutually comparing all four capacitors. The sensitivity of this method of ascertaining calibration accuracy at the operating position is actually higher than the sensitivity of the usually available laboratory equipment.

Capacitance Unbalance Discriminator

For eccentricity measurements and control of the sheathing process it is essential to register the direction of incremental deviations from an arbitrary level. The phase-sensitive discriminator in Fig. 2 provides this indication. The unbalance signal from the bridge is fed through feedback amplifier V_1-V_4 and biased voltage limiter V_5 to the center tap of transformer T_1 in the discriminator circuit. The primary winding of this transformer is connected, through a continuously variable phase shifter, to the 10-kc signal source that also supplies the bridge circuit.

The d-c output from the balanced square-law discriminator stage is fed, through a time-delay network of approximately 50 milliseconds, to power amplifier stage V_7 and then through an attenuator to a zero-center recorder.

The voltage derived from the 10-kc power source across the secondary of T_1 is the reference potential which, by adjustment of the phase-shifter, can be oriented so as to be in phase with the signal resulting from the reactive unbalance of the bridge circuit. Since the bridge output signal resulting from small conductance unbalances is essentially perpendicular to the capacitance unbalance signal, in this condition the circuit is not sensitive to limited unbalances of the real component.



Cable construction and details of probe

At the operating sensitivity level, each of the 100 divisions of the recorder scale corresponds to 0.005 $\mu\mu f$, or approximately to 0.001 inch of the incremental sheath thickness. The role of the attenuator is two-fold; it provides control of the over-all sensitivity of the measurements (in steps of 0.2 db) and it introduces a substantial (over 20 db) attenuation into the d-c output signal path. This loss is compensated by an added gain within the feedback-controlled a-c amplifier preceding the phase discriminator. The net result of this a-c for d-c gain-trading is a considerable improvement of the over-all circuit stability since the range of random drifts, such as are usually generated within the phase-discriminator and its direct-coupled output stage, are materially reduced.

Measuring Probes

As has been mentioned above, two arms of the bridge circuit consist of a pair of admittances between the grounded metal core D of the cable and the probes sliding

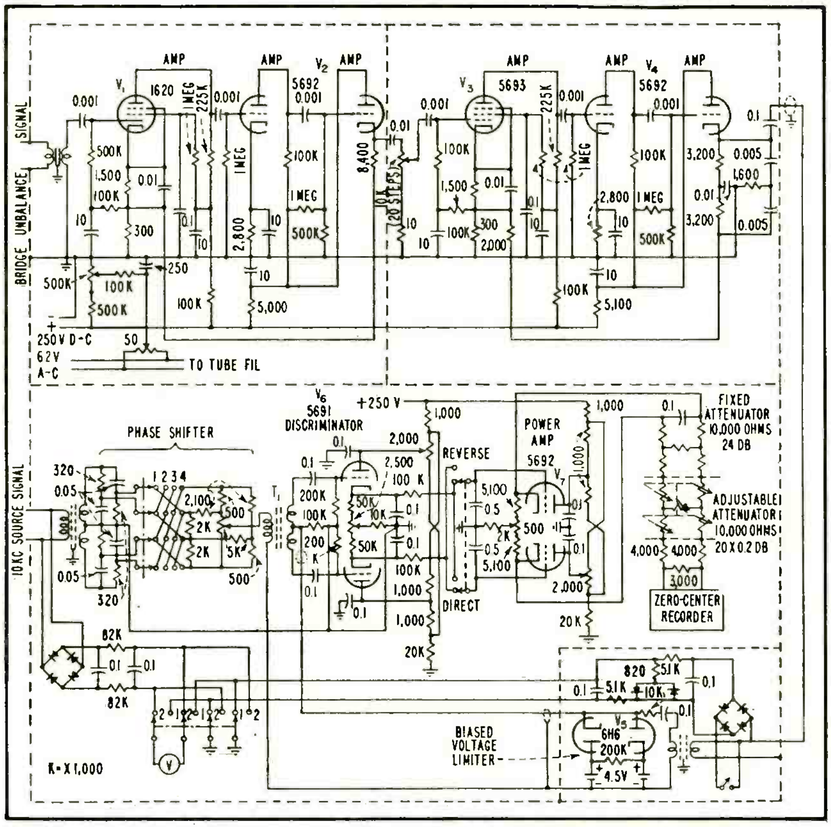


FIG. 2—Unbalance signal amplifier and capacitance unbalance discriminator

on the surface of the plastic cable sheathing. These probes are connected to the A and C corners of the bridge with two shielded flexible conductors (each about 10 feet long) and are maintained mechanically in the testing position by the probe assembly.

In the design of the probes and their assembly, various difficulties had to be overcome. The probes operate on cables subjected to some unavoidable swings and vibrations while moving with speeds up to 80 feet per minute. The capacitance from either of these probes to the metal cable core, in equivalent conditions, should match each other within approximately 0.001 μμf. This capacitance should not be appreciably affected by limited displacements of the probes with respect to the cable plane of symmetry, such as may occur in actual operating conditions.

Each of these probes is in the form of a cut-off segment of a toroid. This form of probe had various advantages, chief of which is that the capacitance from the probe to the cable core varies but little as a result of displacements and changes of position caused by the cable motion.

The probe electrodes, surrounded (except for the contacting face) by shielding, are mounted on mechanically balanced light aluminum arms. There may be one, two or four probes to an assembly, which can be turned over 360 deg around the cable axis. For eccentricity measurements two probes can be simultaneously used, having a spacing of 180 deg (for measurement of eccentricity across a diameter) or of 90 deg (for measurement of ellipsoidal eccentricity). Also, for eccentricity or direct thickness investigations and process settings one probe only may be used, with the other bridge measuring arm connected to an auxiliary standard.

Performance Data

The average capacitance from the probe element to the grounded metal core varies from 1.1 to 1.3 μμf for cables measured. Incremental capacitance sensitivity for grounded direct-capacitance measurements, in normal operating conditions with the probes in contact with a cable sample, is of the order of 0.001 μμf. Circuit stability and repeatability for periods over one hour duration is ±0.003 μμf.

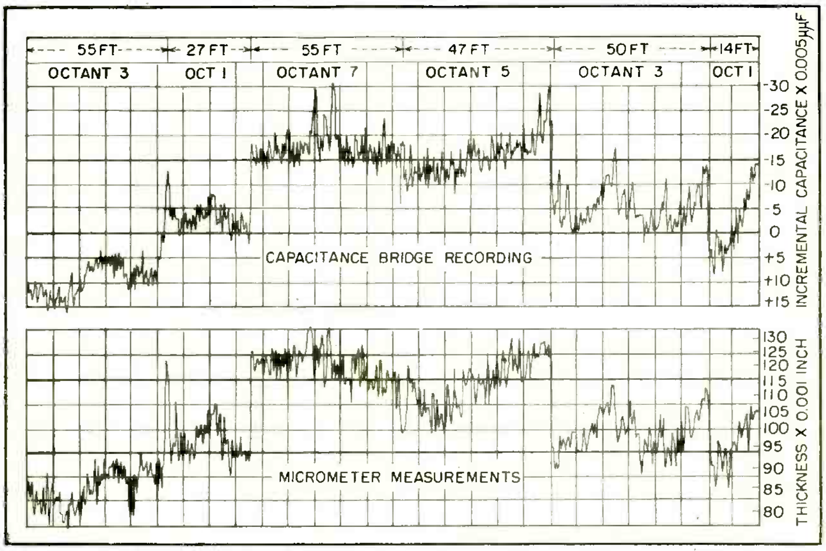


FIG. 3—Comparison of production-line recording with micrometer measurements of 248-ft length of Alpeth polyethylene-jacketed cable having 1.59-inch core thickness

Overall linearity of the unbalance indications, as read on the recorder scale within the range of ±0.25 μμf off center-balance position, is ±(3 percent + 0.003 μμf).

Moving or twisting the connecting leads has no effect on balance stability. Swinging of the cable under measurement, even beyond the limits encountered in actual working conditions, produces barely noticeable effects on the balance indication.

Production-Line Measurements

A typical example of a measurement performed on a cable section approximately 250-feet long is shown on Fig. 3. The upper curve represents a photograph of the recorder tracing. The lower curve was obtained by measuring actual thickness with a micrometer at 6-inch intervals, plotting them on the nonlinear vertical scale following the capacitance-versus-thickness function.

From comparison of these graphs a few observations can be made. The recorder indications are continuous average readings based on an area having a definite width and a length of a few corrugation spaces, while the micrometer readings are point measurements taken at discrete distances at the bottom of the corrugation valleys in the polyethylene jacket. Despite this fact, the statistical character of both graphical results is closely similar. Assuming an average translation factor of 0.005 μμf per 0.001 inch and discarding tracing errors, the agreement for incremental measurements between both methods can be estimated to be of the order of 0.003 inch. This accuracy is ample for any practical purpose of incremental thickness control of cable sheathing.

The author wishes to thank R. I. Neel, W. T. Eppler and D. T. Robb of the Western Electric Co. for assistance given in various phases of this work. Especial credit for checking accuracy of the new method belongs to J. L. O'Toole of the Bell Telephone Laboratories group at Kearny, N. J.

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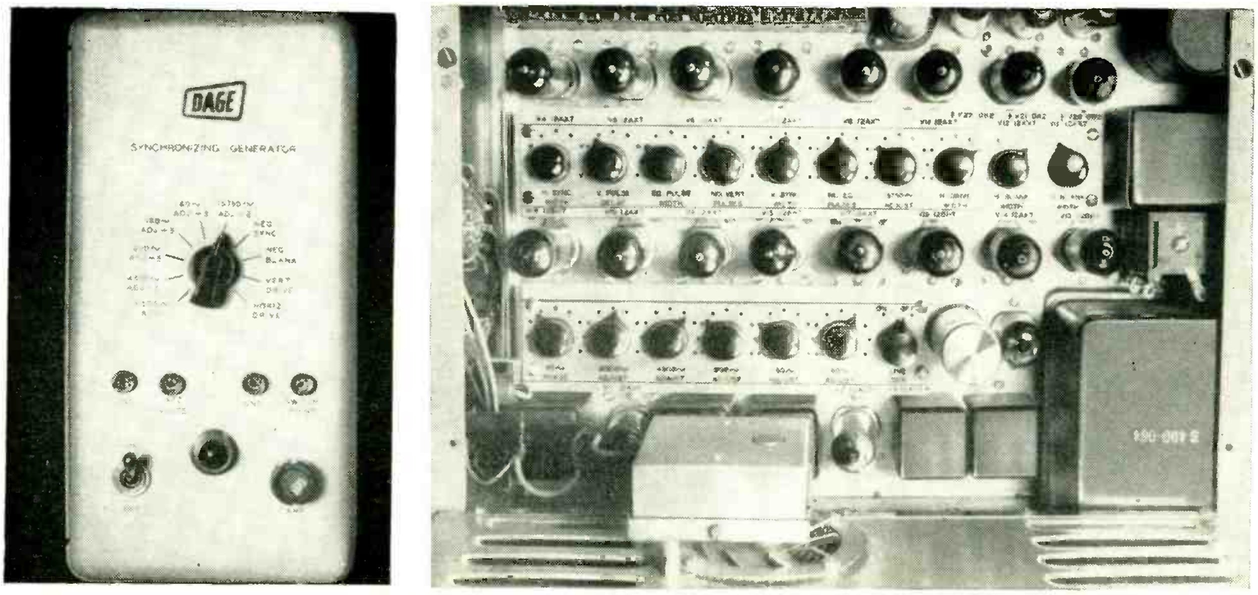

Rear-panel view of sync generator, left, and tube and adjustment side of chassis, right

Portable Sync Generator for TV Broadcasting

Miniaturized synchronizing pulse generator supplies standard RETMA signal at 4 volts negative peak to peak. Unit weighs only 20 lbs and is interchangeable with conventional television broadcast equipment. Built-in power supply is gas-tube regulated

PORTABILITY AND SIMPLIFICATION of television broadcast studio equipment may be achieved by use of the synchronizing pulse generator to be described.

The generator furnishes standard RETMA synchronizing signals at 4 volts negative peak to peak across 75 ohms. It is housed in a briefcase-sized cabinet that also contains its regulated power supply. The photographs illustrate the tube and adjustment side of the chassis and the rear panel of the generator. Figure 1 is a functional block diagram and Fig. 2 is the complete schematic.

Timer Section

The master oscillator and the 7-5-5-3 divider chain incorporate five blocking oscillators each isolated by 1N51 germanium diodes. The timer generates the 31.5-kc and 60-cps trigger pulses to time the gates and multivibrators in the shaper section. All grid circuits in the timer section are connected through their respective time-constant controls to a +150-volt bus that serves as the afc line-lock path.

Tuned circuit $C_1 - L_1$ in the master-oscillator grid circuit is a resonant stabilizer for maximum frequency stability. Shock excitation of this resonant circuit by the grid-current pulse produces added potential at the desired resonant frequency resulting in a high degree of grid stability.

Point J at the cathode of the master oscillator terminates at the rear-panel waveform selector switch providing a signal at the rear-panel switch point for scope observation. Points A, B, C and D in the grid circuits of the 7-5-5-3 divider provide the same function.

Line-Lock

The negative plate pulse and positive cathode pulses at V_{8A} are supplied to a balanced R-C network terminated in germanium diode clampers. The 6.3-volt 60-cycle reference from point Y in the power supply is injected at the junction, also designated Y.

When the 60-pps final divider output is in phase with the 60-cps line voltage, the equal-amplitude pulses occur at the instant the sine-

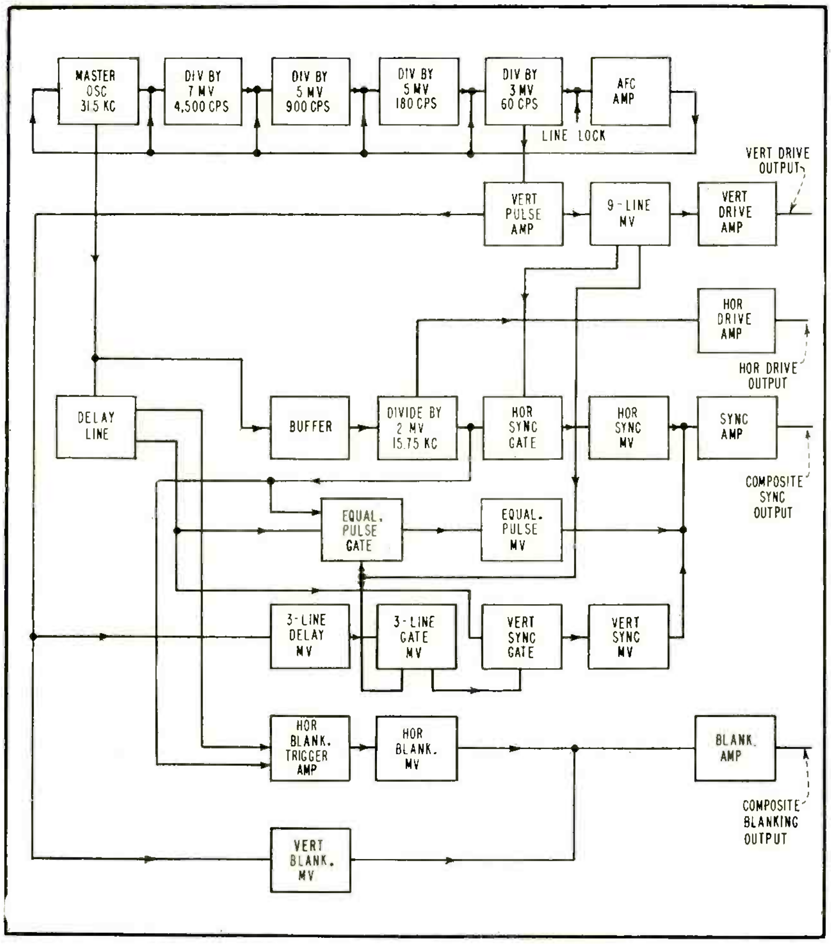

FIG. 1—Functional block diagram illustrates interconnection of stages

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wave reference is crossing its axis and the voltage appearing at the clamped grid of V_{3B} is zero.

If, however, the pulses occur early or late, the voltage rises or falls depending upon whether the positive or negative value of the a-c is clamped. Thus the pulses are caused to slide on the slopes of the sine-wave alternation until they coincide with the axis of the line voltage and the timer is locked with the line frequency.

Switch S_1 is open for the line-lock position and V_{8B} serves as a d-c amplifier for the afc voltage fed to all grids of the timer section. Filter $C_2 - R_1$ smooths out current variations. The circuit comprising R_2, C_3 and C_4 provides a time-constant for afc action to prevent instability from too-rapid action. With S_1 closed, automatic frequency control action is removed.

Synthesis of the output pulses is best described with the aid of the waveform diagram, Fig. 3. Italicized letters in text refer to waveforms shown in Fig. 3. All multivibrators are of the driven type and must receive enabling voltage from associated gate tubes.

Camera Drive

Camera driving pulses are delivered only to the camera chains and slightly precede the composite sync signal to compensate for interconnecting cable delay. Positive 31.5-kc trigger pulses *A* from V_{1A} cathode are fed to the horizontal-drive buffer amplifier V_{8B} and appear as amplified negative triggers at the grid of V_{16A}, the divide-by-two multivibrator. This section is driven to cutoff and drives V_{16B} into conduction.

This condition prevails in the absence of further triggering for an interval determined by the grid-potential adjustment and circuit time constant. Adjustment of R_3 determines within limits the potential and time-constant of V_{16B} grid. With proper adjustment, alternate 31.5-kc pulses occur when V_{16A} is cut off and have no effect. Thus only 15.75-kc pulses *B* appear at the output. Different values of resistance and capacitance in the two grid sections result in asymmetrical pulses; the on time is less than the off time. Resistor R_4 adjusts the width to system standards, ½ to 1 times blanking width. The 1N63 clamps the pulses on the grid of the horizontal drive amplifier V_{19} at 9 volts assuring flat-topped pulses in the plate circuit.

Vertical Drive

Positive 60-cycle pulses from V_{3A} cathode amplified by V_{11B} appear as negative triggers at the grid of the on section of the 9-line multivibrator, V_{17}. The NUMBER-OF-EQUALIZING-PULSES control R_5 in the V_{17B} grid circuit determines the gating-pulse width for the vertical-equalizing and sync interval and automatically sets the width of the vertical-drive pulse. The positive pulses from the plate of V_{17B} applied to the grid of the vertical-drive amplifier V_{15} appear as standard negative-polarity pulses *C* at the plate.

Horizontal Sync

The horizontal-sync multivibrator V_4 is gated by the horizontal-sync gate V_{5A}. The cathode of V_{5A} is tied to the cathode resistor of V_{17A}. In the period between fields when V_{17} is not triggered, V_{17A} is cut off and the cathode potential is negative.

The grid of V_{5A} receives delayed 31.5-kc trigger pulses from the delay line and 15.75-kc pulses from V_{16}. Since the grid of V_{5A} is biased to −108 volts by the regulated power supply, only the 31.5-kc *D* triggers occurring at horizontal-pulse time are of sufficient ampli-

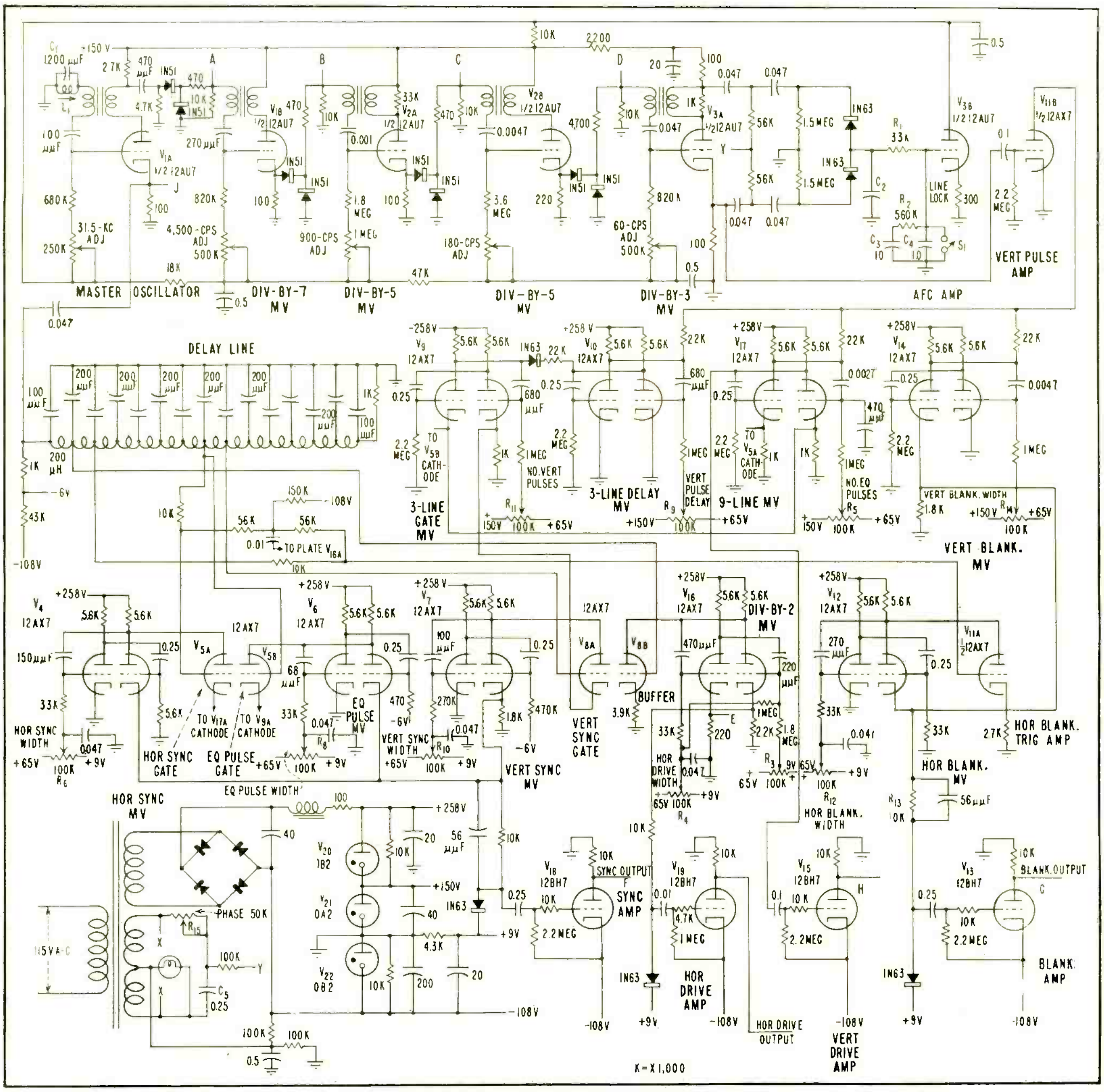


FIG. 2—Complete schematic shows how the 22 miniature tubes provide RETMA standard sync signal

tude to rise above cutoff level. The resultant negative 15.75-kc trigger pulses applied to the on section of the horizontal-sync multivibrator V_4 drive that section off and opposite section on. The narrow triggers are widened by the horizontal-sync control R_6 to standard horizontal-sync width. The cathode output pulses E feed through a common 10,000-ohm resistor to the sync amplifier stage V_{18}.

The horizontal sync multivibrator is gated off for the duration of the vertical interval. When the 9-line multivibrator V_{17} is triggered at the 60-cps field rate V_{17A} is driven on with its cathode going positive. With the horizontal-sync gate V_{5A} cathode also positive, the gate is closed at the start of the vertical interval. The gate remains closed for the 9-line duration of the vertical-sync interval.

Vertical Sync

When the 9-line multivibrator V_{17} is triggered by a 60-cycle pulse, the cathode potential of V_{17B} falls in the negative direction. This point is common to both V_{9A} the 3-line gate multivibrator and the equalizing-pulse gate V_{5B}. Since the cathode of V_{5B} is now negative, the gate is on, F. The delayed 31.5-kc trigger pulses on the grid of V_{5B} are transferred as negative triggers to the grid of equalizing-pulse multivibrator V_6. The on section of V_6 is driven to cutoff and triggers the other section on. The narrow triggers are widened to standard equalizing-pulse width by the EQUALIZING-PULSE-WIDTH control R_8. Cathode output pulses G are fed to the same common 10,000-ohm load resistor as the horizontal sync, and hence to the grid of sync amplifier V_{18}.

At this point the first 3-line interval containing six equalizing pulses is ended. Equalizing-pulse multivibrator V_6 is gated off, and the vertical-sync multivibrator V_7 gated on. This action involves four stages: the 3-line delay multivibrator V_{10}, the 3-line gate multivibrator V_9, the vertical-sync gate V_{8A} and also the vertical-sync multivibrator V_7.

The grid of the on section of 3-line delay multivibrator V_{10} receives a 60-pps negative trigger simultaneously with that applied to the 9-line multivibrator V_{17}. With V_{10B} driven to cutoff, the positive pulse on the plate holds the negative terminal of the 1N63 diode too far positive to allow conduction, hence prevents interaction between V_9 and V_{10}. During this time the cathode of V_{9B} (3-line gate multivibrator), being common to the cathode of the vertical-sync gate V_{8A}, is of positive polarity and gates off the vertical-sync multivibrator V_7. This is the first 3-line interval of the total 9-line interval.

With proper adjustment of the VERTICAL-PULSE-DELAY control R_9 in the V_{10} grid circuit, V_{10} returns to its nondriven state under control of its time-constant and grid potential. Tube V_{10B} returns to on, and the resultant negative plate pulse allows the 1N63 to conduct. The passed negative trigger drives multivibrator V_9. The V_{9A} cathode goes positive gating off V_{5B}, the equalizing-pulse gate, and the V_{9B} cathode goes negative gating on V_{8A}, the vertical sync gate.

Thus the equalizing pulses are shut off and vertical-sync pulses driven on. The 31.5-kc triggers on the grid of V_{8A} are passed as negative triggers to grid of the vertical-sync multivibrator V_7. The VERTICAL-SYNC-WIDTH control R_{10} widens the narrow triggers to standard vertical-sync width and the cathode output pulses H are combined in the common load and passed to the grid of sync amplifier V_{18}.

With proper adjustment of the NUMBER-OF-VERTICAL-PULSES control R_{11}, the 3-line gate multivibrator V_9 returns to its non-driven state at the end of 3 lines. The cathodes reverse their polarities. The vertical-sync multivibrator V_7 is gated off by V_{8A} gate and the equalizing-pulse multivibrator V_6 is again gated on by gate V_{5B}.

The 31.5-kc pulses on the grid of V_{5B} are amplified as negative triggers to the grid of equalizing-pulse multivibrator V_6 and the trailing six pulses are fed to sync amplifier V_{18}.

The 9-line multivibrator V_{17} is returned to its nondriven state gating off all vertical stages, and restoring horizontal-sync gate V_{5A} to on until the next 60-cycle vertical pulse.

The composite sync appears at the grid of sync amplifier V_{18} at positive polarity, is clamped at 9 volts by the 1N63 and the resultant clipped standard negative polarity composite sync I results at the output. Waveforms meet all RETMA specifications.

Composite Blanking

The blanking pulses must slightly precede their respective sync pulses to establish front porch.

Horizontal blanking pulses are derived as follows: 31.5-kc triggers from the delay line together with 15.75-kc triggers from the divide-by-two multivibrator V_{16} are applied to grid of the horizontal-blanking trigger tube V_{11A}. Note that the 31.5-kc triggers are fed from a tap on the delay line allowing camera driving pulses to precede composite blanking but delaying composite sync from the start of blanking. Since V_{11A} grid is biased to -108 volts, only those 31.5-kc triggers occurring at the time of the 15.75-kc pulses are of sufficient height to be passed as triggers for the horizontal-blanking multivibrator V_{12}. The cathode output pulses J adjusted in width by the HORIZONTAL-BLANKING-WIDTH control R_{12}, are fed to the common load resistor R_{13}, hence to the grid of blanking amplifier V_{13}.

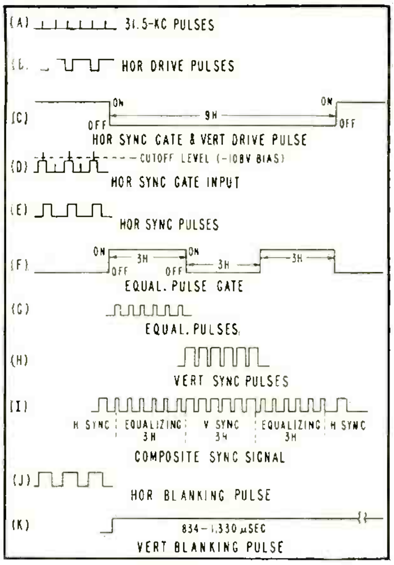


FIG. 3—Sync generator waveforms

For vertical blanking, 60-cps negative triggers from V_{11B} drive the vertical-blanking multivibrator V_{14}. The VERTICAL-BLANKING-WIDTH control R_{14} is adjusted for proper blanking width and the cathode output pulses are combined with horizontal-blanking pulses K in common load resistor R_{13} and passed to the grid of blanking amplifier V_{13}. The horizontal-blanking pulses occurring during the vertical interval stand atop the long vertical pulses and are clipped by the clamp action of the 1N63 diode in the V_{13} grid circuit.

Since the amplitude of the pulses is much higher than 9 volts at this point, a flat-topped composite blanking signal results.

The standard negative-polarity blanking pulses at the plate of V_{13} yield 4 volts peak to peak across 75 ohms at the output.

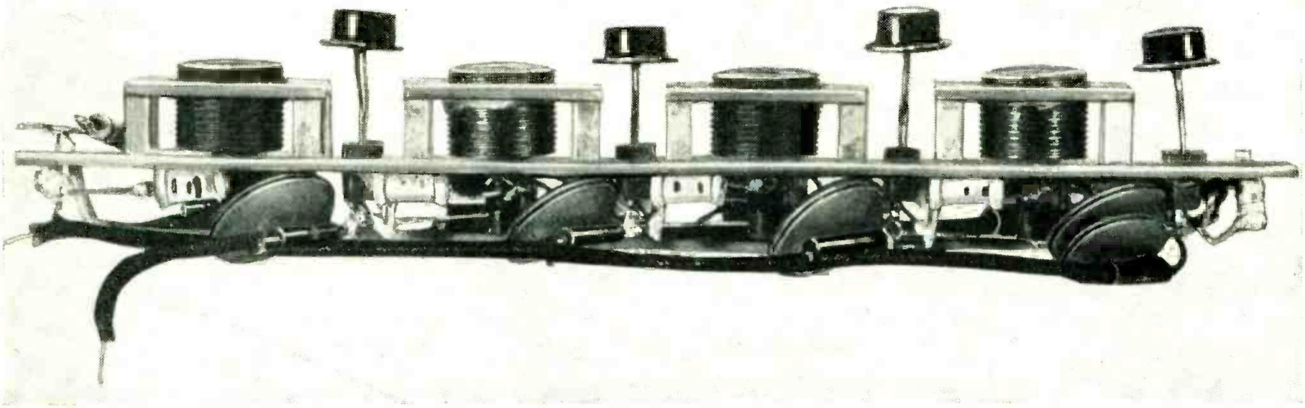
Power Supply

The rectified voltage from the bridge-type selenium rectifier is gas-tube regulated providing -108, $+9$, $+150$ and $+258$ volts. The 60-cps lock-in circuit that provides afc voltage to hold the master oscillator precisely 525 times the power-line frequency derives its line-frequency reference from the filament winding at point Y through the phasor control R_{15} and phase capacitor C_5.

This phasing adjustment properly times the system with shutter-type film projectors by phasing the sync pulses relative to the shutter synchronous motor so that shutter opening occurs well within the interval of the vertical blanking pulse. Resistor R_{15} is adjusted in practice for elimination of banding effects from any associated film chain.

The author congratulates G. Fathauer of Dage Electronics Corporation, upon the design of the camera chain and thanks Dage for permission to publish this article.

High-Frequency



Four-stage 455-kc intermediate-frequency amplifier uses rate-grown *npn* junction transistors in cascade

Design equations for getting optimum performance from video and radio-frequency amplifiers are presented. Sample design of four-transistor 455-kc i-f amplifier is described in detail; i-f gain is 18 db per stage with 14-kc bandwidth

IN THE APPLICATION of transistors to high-frequency circuits the low-frequency equivalent circuit must be modified since most of the parameters become complex. The finite input impedance of a transistor amplifier at high frequencies is an important factor along with the interaction between input and output.

The usual low-frequency equivalent-T circuit may be modified to apply at high frequency, as shown in Fig. 1, which shows the modified circuits for the grounded-base (A) and grounded-emitter (B) configurations. One important modification consists of the addition of the capacitor C_c across the collector resistance r_c. Additional important factors, not evident from these circuits, is that a is complex, and both r_c and C_c vary with frequency. To a lesser degree r_e and r_b are also frequency dependent. However, it is customarily assumed that these two parameters are constant and resistive up to about the alpha cutoff frequency $f_{\alpha o}$.

If operations at only one frequency were involved, it would obviously be adequate to take the proper values of the equivalent circuit parameters at that frequency and insert them in the usual mesh equations, using the proper vector additions, multiplications and so on. For wide-band use, such as video and pulse amplifiers, this method is inadequate, hence a great deal of analysis has gone into attempts to derive high-frequency equivalent circuits which adequately reproduce the transistor over a wide frequency range.

The variation of α with frequency is a hyperbolic secant function of the parameters of the physical construction. This function can be approximated by the short-circuit current equation of a R-C distributed transmission line. Thus the ratio of output short-circuited current to input current is

$$\frac{i_o}{i_i} = \operatorname{sech} \sqrt{j\,\omega\, RC} \qquad (1)$$

and $\omega_{\alpha o} RC = 2.43$.

A further approximation can be made by a low-pass R-C network. In this approximation, the expression for the variation of α with frequency becomes

$$\alpha = \frac{\alpha_o}{1 + j\,\omega\, RC} = \frac{\alpha_o}{1 + j\dfrac{\omega}{\omega_{\alpha o}}} \qquad (2)$$

since $\omega_{\alpha o}\, RC = 1$.

The variation of the effective value of collector admittance y_{22} can also be calculated by the following approximate equations

$$y_{22} \cong \frac{1}{r_c} + j\,\omega\, C_c + \sqrt{\frac{j\,\omega\, C}{R}} \tanh \sqrt{j\,\omega\, RC} \qquad (3)$$

$$y_{22} \cong \frac{1}{r_c} + j\,\omega\, C_c + \frac{\omega^2 C^2 R^2}{1 + (\omega\, CR)^2} + \frac{j\,\omega\, C}{1 + (\omega\, CR)^2} \qquad (4)$$

Of particular interest in the utilization of the grounded-emitter configuration, is the variation of b, the current ratio, with frequency. Recalling that $b = a/(1 - a)$, it is

Transistor Amplifiers

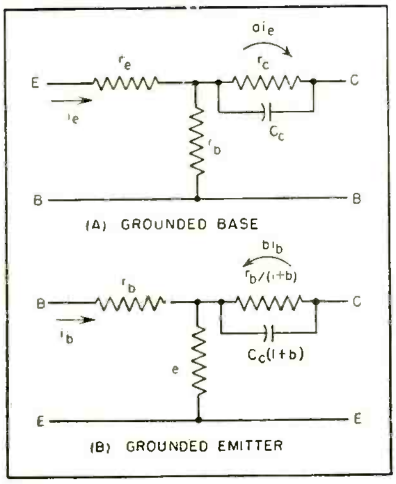


FIG. 1—Equivalent-T circuits

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evident that the variation of a (which is approximately equal to alpha) will be reflected as an even greater variation in b, particularly due to the phase angle of a. The b cutoff frequency is approximately equal to $(1 - a_o) f_{ao}$.

Single Stage Equations

Before going into the study of high-frequency amplifier design, it is necessary to study the equations for input and output impedances, and for power gain. Only equations for the grounded-base and the grounded-emitter configuration are studied, because the grounded-collector configuration has been found to be relatively less effective as a small-signal high-frequency amplifier.

Using the circuits of Fig. 1, the established equations for input and output impedances and power gain can be applied. In the following equations the collector impedance z_c includes both r_c and C_c.

The input impedance of the grounded-base amplifier is

$$z_i = r_e + r_b \left[\frac{z_c (1 - a) + z_L}{r_b + z_c + z_L} \right] \quad (5)$$

The output impedance is

$$z_o = z_c + r_b \left[\frac{r_e + z_g - a z_c}{r_e + z_g + r_b} \right] \quad (6)$$

where z_L and z_g are the load impedance and source impedance, respectively.

Due to the variation of z_c and a with frequency, the impedances z_i and z_o vary with frequency. For a constant z_L, the input impedance z_i of a junction transistor amplifier, as given by Eq. 5, will increase with frequency and appear as an inductive impedance. The effect of increasing the magnitude of z_L is to increase the magnitude of z_i and to decrease the phase angle.

For a point-contact transistor, the input impedance z_i will appear as an impedance having an imaginary term which increases with frequency, and a real term which can be either positive or negative depending upon the load resistance. When the load resistance is large enough the input impedance given by Eq. 5 will have a positive real term which will increase with frequency. When the load resistance is small the input impedance given by Eq. 5 will have a negative real term, but this negative resistance will decrease with frequency and eventually become positive as frequency increases.

The output impedance z_o for a given source resistance is in general capacitive because z_o is strongly capacitive. The magnitude of the output impedance decreases with increasing signal frequency.

The power gain of a grounded-base amplifier stage is given by

$$PG = \left| \frac{r_b + a z_c}{r_b + z_c + z_L} \right|^2 \frac{[z_L]_R}{[z_i]_R} \quad (7)$$

where $[z_i]_R$ and $[z_L]_R$ represent the real components of z_i and z_L respectively. The variation of power gain with frequency is approximately proportional to the square of the variation of a with frequency. Due to the change of input and output impedances, the actual power gain at high frequency is less than the approximate relation $[a]^2$.

The input impedance of a grounded-emitter amplifier is

$$z_i = r_b + r_e \left[\frac{z_L + z_c}{r_e + z_L + (1 - a) z_c} \right] \quad (8)$$

For a given load impedance, this input impedance decreases with increasing frequency and is capacitive. For a given frequency, z_i decreases as the ratio of z_L/z_c increases.

The output impedance of a grounded-emitter amplifier is

$$z_o = (1 - a) z_c + r_e \left[\frac{r_b + z_g + a z_c}{z_g + r_b + r_e} \right] \quad (9)$$

In general, the output impedance decreases with frequency due to the decrease of z_c with frequency.

The equation for the power gain of a grounded-emitter amplifier is

$$PG = \left| \frac{a z_c - r_e}{z_L + r_e + z_c (1 - a)} \right|^2 \frac{[z_L]_R}{[z_i]_R} \quad (10)$$

where $[z_L]_R$ and $[z_i]_R$ represent the real components of z_L and z_i. This power gain also varies with frequency and is approximately proportional to the square of the variation of b with frequency.

I-F and R-F Circuits

In the early application of point-contact transistors to high-frequency amplification, the grounded-base configuration was generally used. The principle of duality was applied and the single tuned vacuum-tube amplifier circuit was found to correspond to a transistor amplifier employing a series resonant circuit as the interstage network.

In using the series resonant cir-

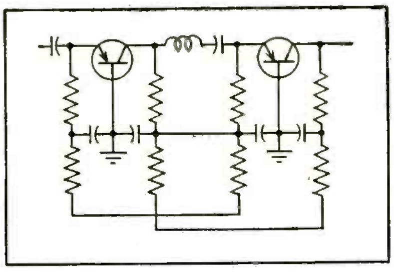

FIG. 2—Circuit showing series resonant coupling of transistors

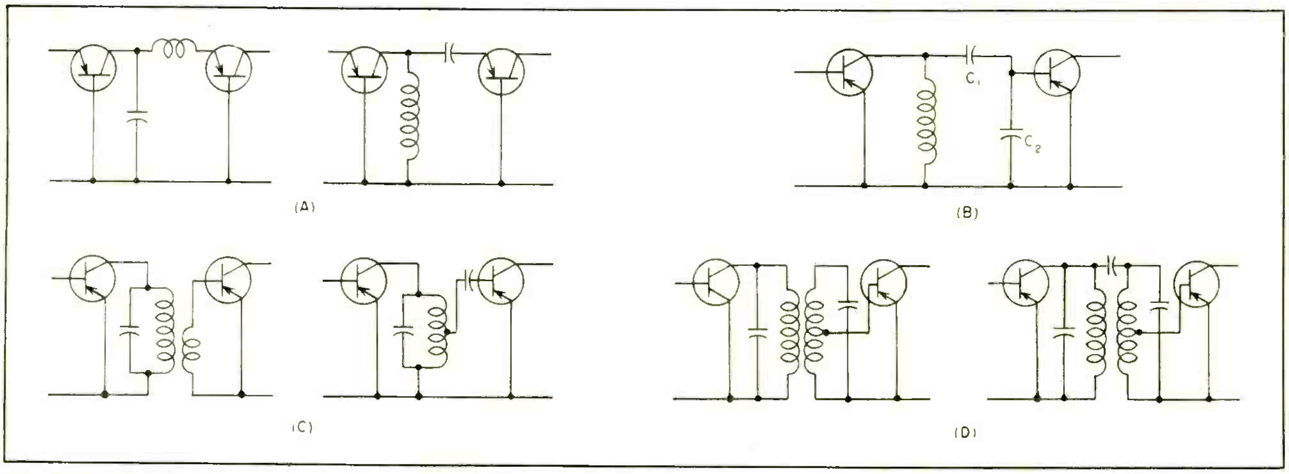

FIG. 3—Simplified circuits of available methods of coupling transistor stages

cuit as the interstage coupling network, the necessary condition is that the output short-circuit current amplification must be greater than unity. This implies that the point-contact transistor may be connected in either the grounded-base or the grounded-emitter connection, however, the junction transistor must be used in the grounded-emitter connection.

Figure 2 shows a series-resonant circuit used as the interstage coupling network between two point-contact transistor amplifiers. The input impedance z_i is in series with the tuned circuit and becomes the load of the preceding stage. For a given transistor and a given operating condition, the input impedance of this amplifier stage can be calculated from the impedance equation. Since the resonant circuit is in series with the input impedance, the effective Q of this amplifier stage will be modified by z_i. The power gain per stage will be approximately equal to A^2.

Besides the series-resonant circuit, the parallel-resonant circuit can be used as the interstage coupling network. However, when point-contact transistors are used with a parallel-tuned coupling network, the short-circuit instability problem arises. Unless the circuit is so designed that there are sufficient positive resistances in the circuit to compensate for the negative resistance component of the input impedance, the amplifier will oscillate. In practice, when point-contact transistors are used with parallel-resonant coupling circuits as the interstage coupling network, the transistors are usually selected for short-circuit stability. With proper control of the operating point, one can usually obtain a stable amplifier using point-contact transistors. A stable point-contact transistor amplifier can also be obtained by inserting a resistance in series with the emitter (the grounded-base configuration is generally used), with about 3 to 6 db sacrifice of gain.

There are several practical arrangements for coupling two amplifier stages using a parallel-resonant circuit. They can be grouped into several classes as follows:

Direct connection—In this group the second amplifier is directly connected into the parallel-resonant circuit, either in series with the inductance or in series with the capacitance as shown in Fig. 3A.

Capacitive-coupling—In this group the second stage is connected to the junction of two capacitors as shown in Fig. 3B. These two capacitors are also the elements of the parallel-tuned resonant circuit and serve as an impedance transforming device.

Inductive-coupling—In this group the second stage is inductively coupled to the resonant circuit as shown in Fig. 3C. The secondary is not tuned and an impedance step-down is normally provided to match the input impedance of the following amplifier stage.

Double-tuning—The above three groups use single-tuned circuits for the interstage coupling circuits. Double-tuned circuits employing either inductive coupling or capacitive coupling can also be employed, as shown in Fig. 3D. An impedance step-down is necessary where the input impedance is low.

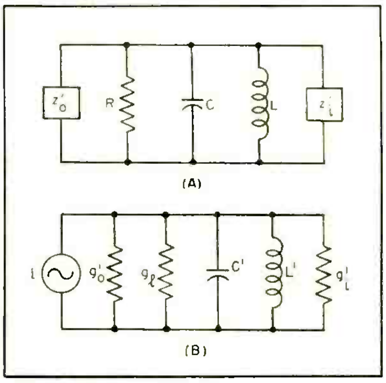

FIG. 4—High-frequency transistor equivalent circuits

In designing an interstage coupling network using parallel-resonant circuits, it is again necessary to consider the input and output impedances of each amplifier stage, since those impedances are in effect in parallel with the resonant circuit. Thus, the input impedance of the following amplifier stage will appear as the load of the preceding amplifier stage and the output impedance of the preceding amplifier stage will appear as the source impedance of the following stage. These impedance values will then be calculated by assuming that all the transistors used in this amplifier are practically identical.

In Fig. 4A a parallel-resonant $R\ C\ L$ circuit is shown which is shunted by the effective output impedance z_o' and the effective input impedance z_i'. These two effective

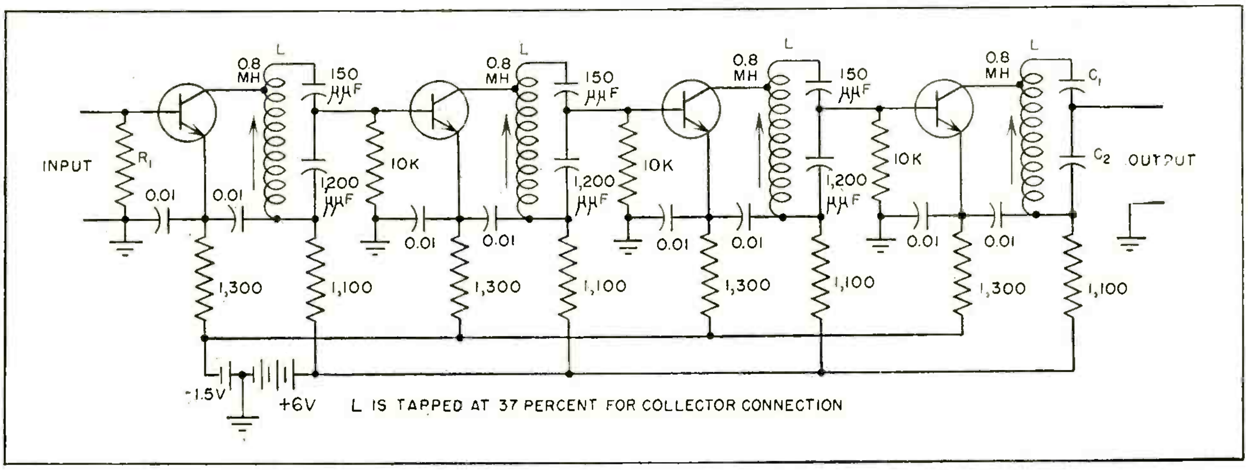

FIG. 5—Circuit diagram of 455-kc i-f amplifier having overall power gain of 58 db with 14-kc bandwidth. Battery current is 3.5 ma

impedances are the output impedance z_o and the input impedance z_i after the required impedance transformations. Let the reactive component of z_o' and z_i' be combined with the elements of the parallel-resonant circuit, as shown in Fig. 4B. The condition required for maximum power transfer from the preceding amplifier stage, through the interstage coupling network to the following amplifier stage, at resonant frequency is

$$g_i' = g_l + g_o' \quad (11)$$

where g_l corresponds to the loss in the interstage coupling network. If the ratio of available power (less the loss in the coupling network) to the available power is defined as the power loss factor F_p

$$F_p = \frac{g_o'}{g_o' + g_l} = \frac{1}{1 + \frac{g_l}{g_o'}} \quad (12)$$

The effective Q of such an amplifier stage will be determined by the total conductance and the inductance or the capacitance. Thus at resonant frequency $\omega_o = 2\pi f_o$

$$Q = \frac{\omega_o C'}{g_o' + g_l + g_i'} = \frac{\omega_o}{\Delta\omega} \quad (13)$$

where $\Delta\omega$ is the bandwidth at the half-power points on the selectivity curve of this amplifier stage. Let the original unloaded Q of the parallel-tuned circuit be Q_o

$$Q_o = \frac{\omega_o C}{g_l} = \frac{\omega_o}{\Delta\omega_o} \cong \frac{\omega_o C'}{g_l} \quad (14)$$

where $\Delta\omega_o$ is the bandwidth. Combining Eq. 11, 13 and 14 to obtain the required impedance matching conditions and at the same time obtain the required bandwidth yields

$$\Delta\omega = 2\left(\frac{g_o'}{C'} + \Delta\omega_o\right) \quad (15)$$

or solving for g_o'

$$g_o' = \left(\frac{\Delta\omega}{2} - \Delta\omega_o\right) C' \quad (16)$$

and

$$g_i' = \frac{\Delta\omega}{2} C' \quad (17)$$

From Eq. 16 and 17 the required impedance transformation ratios can be found for a given resonant-circuit unloaded Q and the required effective Q of the amplifier stage. It is found that normally both the output impedance of the preceding amplifier stage and the input impedance of the following amplifier stage must be stepped up in order to satisfy narrow band requirements.

Sample Design

An example of the design of an i-f amplifier will help to explain the principles discussed above. Assume that experimental *npn* rate-grown transistors are used, following average parameters; a equal to 0.9, r_e = 30 ohms, r_b about 100 ohms, r_c = 1 megohm and f_{ao} about 1 mc as measured at I_e = 1 ma and V_c = 5 volts. Average available power gain in the grounded-emitter configuration at 455 kc is 18 db per stage. The average input impedance of each stage is

$$z_i = 1/\left(\frac{1}{200} + j\omega\, 1{,}600 \times 10^{-12}\right) \text{ ohms} \quad (18)$$

and the average output impedance is

$$z_o = 1/(10^{-4} + j\omega\, 25 \times 10^{-12}) \text{ ohms} \quad (19)$$

Using an inductance of about 0.8 mh and a Q_o of about 90, the capacitance C' required is about 150 μμf, if the desired overall effective Q of a four-stage amplifier is about 30. Therefore, the required effective Q of each stage is about 15. Using Eq. 16 and 17 the value of g_o' and g_i' and the required output and input impedance transformation ratios are $g_o/g_o' = 7.3$ (20)
and $g_i/g_i' = 350$ (21)
The circuit of such an amplifier is shown in Fig. 5. The power loss in the coupling circuit is given by Eq. 12 and is approximately 1.74 db per stage.

If the inductance is reduced to 300 μh with the Q maintained at 90, the required C' is approximately 400 μμf. If the effective Q of the amplifier is maintained the same, the output and input impedance transformation ratio become $g_o/g_o' = 2.74$ and $g_i/_i' = 132$.

Using the circuit of Fig. 5 with 300-μh inductance, a 60-percent tap is required on the inductance, and the 1,200-μμf capacitance should be increased to 2,990-μμf. The power loss in the coupling circuit is about the same as before. In the actual experimental setup, a loss of 2 to 3 db per stage usually occurs. This is due to the nonuniformity of the experimental transistors and the mismatch in the actual circuit.

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Playing of game illustrates principles of modern warfare in which protection of own bases and industrial factories is as important as striking enemy targets

Electronic Air-War Game

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A SIMPLE ELECTRONICS game using a dozen vacuum tubes can hardly be called a computer—but it can nevertheless illustrate some of the basic principles of modern military tactics.

The device is an analog of two industrial nations at war, the two sides being alike initially as in a chess game. That part of each side that simulates industry, with factories producing war munitions, provides two electrical potentials for use in furtherance of air operations against the enemy. One potential determines the rate at which a player can attack his opponent. The other potential simulates defensive capability and can be used by the player to protect one region or another of his industry.

Each player is provided with a target selector switch, a strike launching switch and a defense potentiometer that controls the placement of interceptors.

Eight targets are provided on each side. Six of the targets represent factories producing war munitions such as aircraft engines, bomber assembly plants and oil refineries. These targets differ from each other either in location, in vulnerability, in speed of recovery after attack or in the logistic times between production of goods and use of the goods by the simulated offensive or defensive potential. The other two targets are a composite target representing bomber or missile launching bases and a composite target representing defensive bases, such as interceptor aircraft or guided missile bases.

Although this game is a simplified analog of a complex problem, that of two large nations at war, it does meet the following minimum characteristics as a simulator:

(a) A simulation of the effect of launching and striking particular enemy targets, military as well as industrial.

(b) A simulation of the effect of protecting one's own bases and industrial factories against enemy strikes.

(c) A time scale of operations fast enough so that the duration of the war is not excessive, but not so fast that significant decisions, such as choice of targets, rate of attack and disposition of defense cannot be logically made during the course of the war.

(d) Indications to the players as

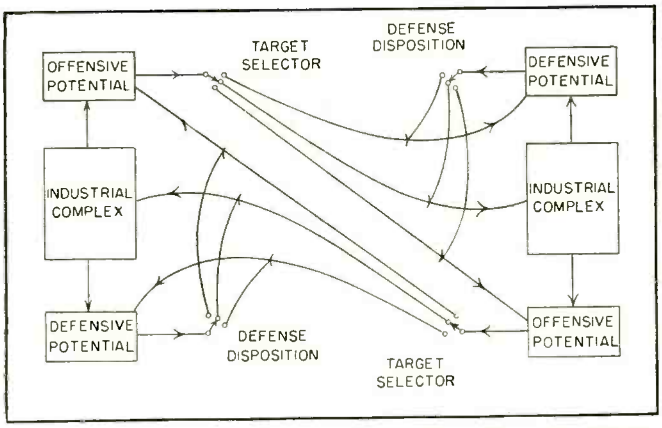


FIG. 1—Block diagram of game, illustrating strike and defense

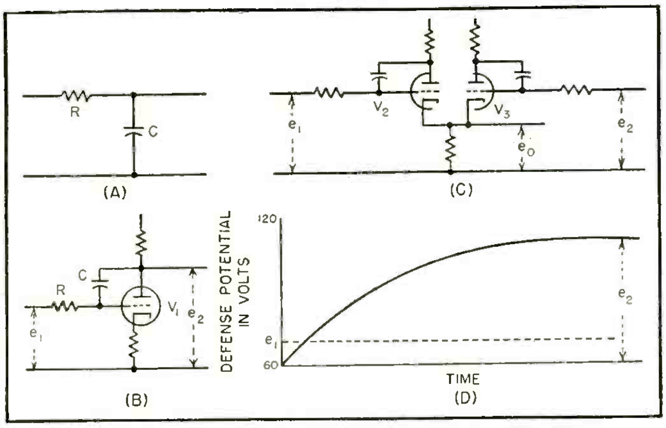


FIG. 2—Types of R-C charge and discharge circuits employed

Ten-tube circuit using multivibrators, R-C charge and discharge circuits and thyratrons simulates varying munitions-producing ability of an industrial complex during varying ratios of attack and defense chosen by players, who start with equal voltages. Meters and flashing neon lamps show progress of game and indicate winner

Simulates Missile Strikes

to the progress of the war in terms of strength of or damage to one's own forces, which strikes are intercepted, and which targets the enemy has attacked.

(e) A definite indication of the end of the conflict and its winner.

(f) Reliable operation, with a minimum of adjustment and maintenance.

General Design

The main elements of the game are shown in Fig. 1. The industrial complex produces two electrical potentials; one, which is called the offensive potential, determines the rate at which strikes can be launched at the enemy. These strikes can be directed at targets in the enemy industrial complex or against the enemy's force in being, such as his offensive bomber force, or his defensive interceptor force. In the latter case the targets are the bases that enemy bombers and interceptors must use.

The second electrical potential produced by the industrial complex is the defensive potential. This can be used to defend against enemy strikes. Controls are provided to shift defenses from one part of the industrial complex to another, with consequent change in the probability of penetration.

In this particular game the industrial complex produces munitions at a rate that varies according to the stage of the war. The two sides start with undisturbed industries producing war munitions at equal rates. Damage to the complex as a result of enemy strikes results in decreased production rates.

At the start, with all targets at ground potential, the rate is at a maximum and of a value that can sustain the size of the initial forces in being. As the war progresses, targets are attacked. Successive strikes charge the target capacitors to a level limited by the neon indicator bulbs. These attacks will cause the output potential to fall to zero at a rate determined by circuit time constants.

Several types of integrating or summing circuits are used to simulate the accumulation of goods as the result of production rates. The simple R-C circuit in Fig. 2A is adequate to represent the relation between production rate and goods on hand if the assumption is made that the goods on hand suffer depreciation or loss at a rate proportional to the amount on hand.

Longer characteristic times can be obtained by using a Miller integrating circuit as in Fig. 2B. Here the characteristic time is the product of RC and the stage gain of the tube. Scale factors must be applied to the voltages to obtain the production rates in terms of units per month, as well as to the final voltages to obtain goods on hand or forces in being.

It is unnecessary for the purpose of this game to assign specific numbers to the rates and quantities. Suffice it to say that ground potential at the target capacitors represents an industrial production rate that will maintain at constant level the defensive and offensive forces in being. Damage to specific elements of industry will reduce the force in being an amount proportional to the reduction in production rate.

Figure 2C illustrates how a single twin-triode such as a 6SL7 can take two voltages, delay them by means of plate-to-grid capacitors and input resistors and combine them through the common cathode to give an output in the same sense and proportional to the higher of the input values. If the inputs are the inverse of production rates, then the output corresponds to a combination that is limited by the lower rate. The output of the industrial complex could then rise with time as in Fig. 2D as it recovers from attack.

Circuit of Industrial Complex

Figure 3 gives the complete circuit diagram of the game. Eight targets are shown in the industrial complex, corresponding to the eight positions of the switch at the top of the diagram. Switch position 1 (Red side) provides a means of attacking the offensive potential or force in being. A strike consists of charging capacitor C_1 through neon indicating bulb N_1. This charge, conducted through R_1 to the grid side of the plate-to-grid capacitor of V_1, will produce a discrete and immediate effect on the plate voltage of V_1, which is the enemy's offensive potential. Attacks against target 8 will have the same effect on the plate voltage of V_6, which is the enemy defense potential.

Targets 2 and 7 represent factories producing munitions, such as aircraft engines. Strikes on target 2 charge C_2, which discharges through R_2 to C_3; eventually through R_{10} the voltage is combined in V_2 and V_3 with a voltage representing another munition. The output, limited to a level determined by the higher input grid of the combination, is fed to the final integrator through R_{26} and represents the rate at which aircraft and necessary gasoline and supplies are furnished to the bomber bases.

Targets 3 and 6, for bombers and interceptors respectively, are analogous to aircraft assembly plants. Targets 4 and 5 add together and combine with the output of the aircraft assembly plants. The circuit constants chosen give these targets rather short recovery times and, since they contribute to both offensive and defensive potentials, they might simulate gasoline and oil industry.

Figure 4 shows the effect of bombing target 3. As target capacitor C_3 is charged by the strikes, production rate Q_1 (complement of capacitor charge) falls rapidly to zero. If the production rate is kept at zero by repeated attacks, output of combining and limiting tube Q_2 will fall. The final output, the offensive potential, will fall as indicated by the curve for Q_3. Response is roughly second order, with time to the half-point about 180 seconds when bombed six times per minute. If a time scale is assumed such that 1 second represents 1 day, bombing target 3 will reduce the effectiveness of the enemy force in being by one-half in 6 months.

Launching Strikes

The voltage that represents offensive potential is used to control the rate at which strikes are launched at the enemy. By assuming uniformly potent unit strikes, the effect of the size of the force in being is simulated by making the strike launching rate proportional to the offensive potential. This approximation greatly simplifies the circuit design, because the plate potential of V_1 can be easily adjusted to 60 volts at the lower end of its excursion by cathode potentiometer P_1 in Fig. 3. This plate voltage, applied to a neon bulb through network R_{12}-C_{18}, produces a sawtooth wave form with a steep negative front. At the upper end of the plate excursion, about 120 volts, the bulb will fire about once a second. At the lower end, it won't fire at all, representing a loss of offensive potential.

The waveform, differentiated by the coupling capacitor-resistor combination, is applied to the cathode of a small thyratron. When the grid of the thyratron is at the proper level, this pulse will cause the thyratron tube to ionize or fire, discharging C_{21} through neon bulb N_{11} and the variable resistance P_6 to the target capacitor selected by switch S_{14}.

Capacitor C_{21} is charged to 210 volts from B plus through R_{41}. The neon bulb N_{11} serves to block the flow of current to and from the target capacitor except when the thyratron fires. Variable resistance P_6 serves to limit the current discharge and is used as a fine control on target damage per unit strike.

The launching switch or key can be placed before or after the combination of C_{18} and N_{10}. Placed before the combination, the time required to charge the capacitor simulates a delay between launching a strike and arrival at the target. Placed after the combination (between C_{18} and the cathode of V_9) the rate of flashing of N_{10} serves as a measure of the strength and readiness of the force in being. In most operations it will be desirable to launch at the maximum rate possible, in which case the key may be closed, leaving the hands free to manipulate fighter defenses and target selector switches.

Interception of Strikes

The grid of thyratron V_9 is driven by the plate of cathode-coupled multivibrator (V_7 and V_8 in Fig. 3) through voltage-dividing resistors R_{40} and R_{46}. The cathode of V_9 can be adjusted to the proper level by P_5. A negative pulse from the multivibrator drives the grid negative and prevents the negative pulse on the cathode from firing the thyratron. The negative signal on the grid represents interception of the strike and is accordingly controlled by the strength and dis-

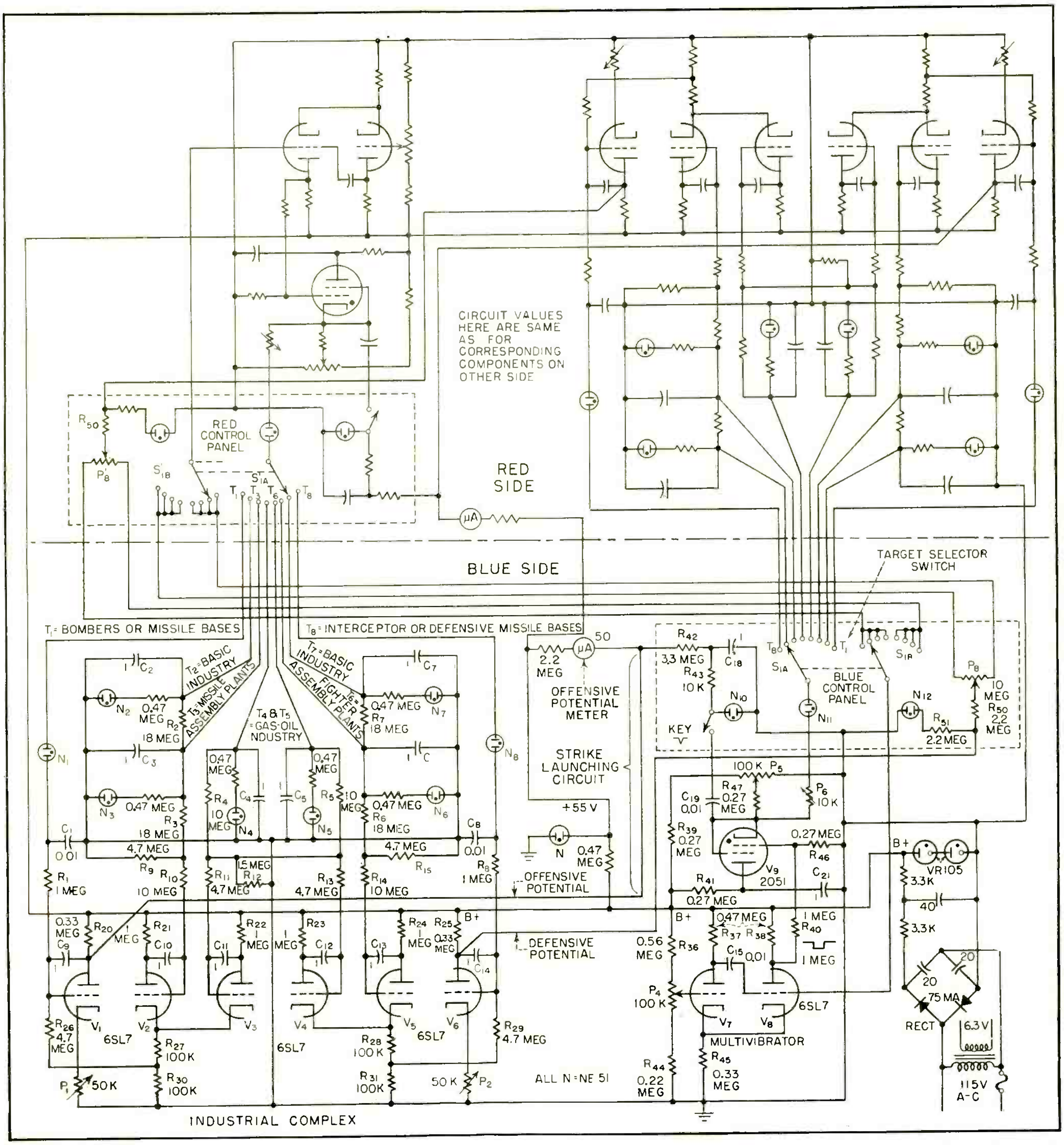


FIG. 3—Complete circuit of game. Since Red side uses identical components, order two of each identified part except those in power supply at lower right

position of enemy defenses.

The circuits that accomplish control of defenses are also shown in Fig. 3. Enemy defensive potential is applied to the moving arm of P'_8 on the enemy control panel through R'_{50}. The ends of P'_8 are connected to the second deck of gang switch S_{1B}, one side to the first four contacts and the other side to the other four.

The first deck of the gang switch is the target selector switch of the friendly team. Accordingly, selection of targets 1, 2, 3 or 4 picks up the end of the potentiometer and places a resistance in the circuit that is determined by the setting of P'_8. The enemy defensive potential is thus connected to the multivibrator (V_7 and V_8) through R'_{50} and P'_8. This circuit resistance affects the percentage of time that V_8 is conducting.

When V_8 is conducting, the plate is at the lower level and the grid of the thyratron is too low to allow the tube to fire. This, then, is the intercept condition. On the other hand, when the enemy defensive potential is low (60 volts), the grid of V_8 is below the cathode potential, and V_8 is cut off. Under this condition the plate remains at a high level and the voltage impressed on the grid of the thyratron is at such a level that a negative pulse on the cathode will cause it to fire.

The defensive potential furnished by the industrial complex varies between 60 and 120 volts. At 120 volts, with the circuit values indicated, the flip-flop will dwell about 50 percent of the time in the down or no-go position when the sole circuit resistance between defensive potential and multivibrator is R'_{50}. If the enemy guesses wrong and has placed his interceptors on the other side of the industrial complex (full potentiometer resistance in series with R'_{50}), the plate will dwell only about 15 percent of the time in the no-go position.

Element of Chance

For values of the defensive potential between 60 and 120 volts and for different settings of P'_8, the percentage of the time that the multivibrator will prevent the thyratron from firing is determined by the time required for the defensive potential to charge C_{15} through R'_{30} and P'_8. Here P_4 places the cathode of V_7 in the proper operating range and provides a fine control for adjusting the no-go dwell time. The multivibrator operates at about 20 cps as an average. This circuit provides a chance element that cannot be outguessed by manually closing the strike key.

Displaying Progress

Inasmuch as this is a game intended for the entertainment of the players, means for displaying the progress of the contest are important. The neon bulbs at the target capacitors glow when the target is charged to the destroyed condition.

Neon bulb N_{10} flashes at a high rate when the offense is at a high level, and barely flashes when the striking force is low. Bulb N_{12} serves to indicate by its brightness the level of the defensive potential. Bulb N_{11} in the discharge circuit glows with an arc-type discharge each time that a launched strike penetrates the enemy defense. In addition, meters are provided to indicate to each side the level of its own offensive potential. These are 50-microampere 4½-inch movements with red and green markings at the low and high levels. Less sensitive meters may be used with appropriate circuit changes.

Resetting Relays

Because of the long time constants, resetting of initial conditions would be lengthy but for the arrangement shown in Fig. 5. These relays were made up from four multicontact relays with 30-volt coils. Connecting the four in series across the 117-volt line gives positive action. The grounding contacts are used to ground target capacitors C_2 through C_7 and the grids of V_2 through V_5 of each side. The remaining pairs of contacts short integrating resistors R_{26} and R_{29} and their corresponding numbers on the other side. A tilt light is not necessary because the four relays with the 24 contacts close with considerable racket.

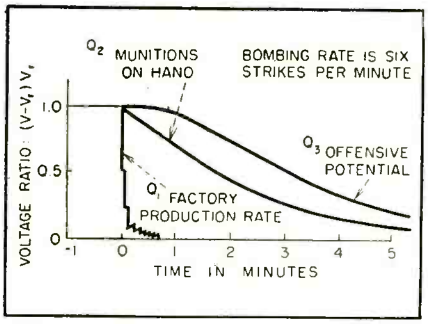


FIG. 4—Effect on offensive potential when attacked at bombing rate of six strikes per minute

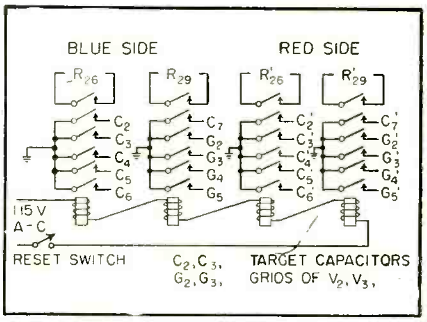


FIG. 5—Relay arrangement used to reset all capacitor potentials quickly for start of new game

The power supply is conventional. Selenium rectifiers supply about 280 volts to two VR 105 tubes that hold the B plus at 210 volts. The total drain is less than 10 ma, half of which is drawn by the VR tubes.

The panel arrangement used for the game is shown in Fig. 6 and in the photos. The two sides of the panel are identical except for facing meters and lettering in opposite directions.

Assembly Precautions

Balance and adjustment of a device of this type can be made simple by a few precautions and by logical steps in setting the potentiometers. First, although 10-percent resistors are used throughout, pairs of equal value should be selected for the corresponding circuit elements of the two sides. This is particularly important for plate load resistors R_{20} and R_{25}, for dividing networks $R_{27}R_{30}$ and $R_{28}R_{31}$ and for the attenuating networks between the target capacitors and the vacuum tubes.

It is not necessary or desirable that targets within a complex be alike, but attenuating ratios such as (R_8/R_9) should be within 2 or 3 percent of the corresponding ratio in the other system. Either 450-volt paper bathtub-type capacitors or 600-volt oil-filled types can be used for target and integrating capacitors.

Neon bulbs vary widely in flash point and regulating level. Connect a 500,000-ohm potentiometer from B plus to ground, with a voltmeter between one side and the moving terminal. Place each NE 51 bulb in turn across the voltmeter and pair up those that will flash and stabilize within 1 or 2 volts of each other.

Variations between targets on the same side are allowable, but the average effect should balance out. The two neon bulbs that determine launching rates (N_{10} and its mirror image) are critical and should be the best pair of the lot tested. The launching rate is a function not only of the input potential, resistance and capacitance, but also of the difference between the flash and stabilizing voltage of the neon bulb.

Another component that should be checked against its counterpart is target capacitor C_1. This can be done beforehand with a capacitance meter, or later by counting the number of strikes necessary to reduce the offensive potential from 120 to 60 volts. Another method is to use the neon tube and a resistor in a circuit similar to the strike launching circuit. Using the same resistance and bulb, different capacitors of the same nominal rating should cause the same discharge rate. If not, find a pair that do.

Adjustment Procedure

If the foregoing precautions are observed in construction, the main calibration and adjustment will proceed quickly. A vacuum-tube voltmeter is required and a cathode-ray oscilloscope is desirable but not absolutely necessary. A convenient source of about 60 volts reference level is useful and can be quickly obtained with a 0.47-megohm resistor and a neon bulb connected to B plus. Connect this voltage source

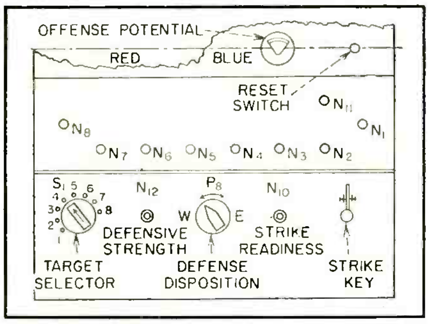


FIG. 6—Arrangement of controls, neon lamps and strike key on one half of front panel.

to the $S'A$ switch terminal for target T_3, charging capacitor C_3 to 60 volts. Short R_{10} and R_{26} with jumpers to eliminate the integration delays.

Adjust potentiometer P_1 to yield 60 volts on the plate of V_1. Remove jumpers and note the change in plate voltage due to grid current through R_{20}. One or two volts change is permissible. Readjust P_1 until the plate voltage is 60 volts. Repeat the procedure on target T_6, adjusting P_2 to get 60 volts output from the plate of V_6. Make the same adjustments on the other industrial complex. Next, ground the targets by using the reset switch and note the upper levels of plate voltages of V_1 and V_6 on each side. They should be pretty well paired and close to 120 volts.

Next, adjust the multivibrators that produce the square-wave blanking pulses to simulate interception of strikes. The cathode common to V_7 and V_8 should be very near 65 volts. Adjust P_4 so the tube does not oscillate when the enemy defense potential is at 60 volts, but does start to oscillate when the potential rises to 65 volts. This can be quickly checked with an oscilloscope. Lacking that instrument, a neon bulb or a voltmeter will show the state of the plate of V_8 and give a rough idea of the rate of oscillation.

Next, supply the multivibrator with 120 volts from the enemy defense potential. If the previous steps have been followed, this can be done by merely resetting the game. Turn P_8 so that it adds no resistance to the circuit, the direction of turning depending upon the position of the target selector switch. Under these conditions, the square wave generated by the multivibrator should be about balanced; the plate of V_8 should dwell in the high position as long as in the low position. Again a scope is desirable; but, after checking the two levels of the plate, a voltmeter can be used to determine the 50-percent-go/50-percent-no-go point. The ultimate test is to wait until all adjustments have been completed, then count the knockdowns per 100 strikes launched.

Thyratron Circuit Adjustment

To adjust the thyratrons with potentiometer P_5, connect the voltmeter to the cathode, open the strike launching key, raise the cathode potential until the thyratron is well above the ionization point, then lower it until the tube fires under grid action alone. Note this voltage. Now raise the cathode about 5 volts above the noted level. Close the strike launching key with the target selector switch on some enemy target, preferably T_1 since repeated bombing of that target will not affect the enemy defense potential. With fighter defenses (enemy) at 120 volts and the defense potentiometer providing maximum blanking width for the area of the target, N_{11} should flash only about half as often as N_{10}. Recheck the thyratron cathode by lowering its voltage until every strike pulse fires the thyratron, then by raising it until none get through. The proper setting is midway between the two values, which should be about 10 volts apart. Repeat all of the foregoing adjustments on the other side of the game. Set the series resistance P_6 in the strike circuit to 1,000 ohms.

Final Balancing

The two systems can now be placed in opposition for final balancing. First, press the reset button two or three times to insure equal initial conditions. Check the launching rates at which N_{10} and its image flash. If the offensive potentials are equal and the components are matched, the rates should be close together. The difference in rate is best measured by timing the beats as the flashes synchronize, then fall out of synchronization. One beat in 30 seconds should be satisfactory.

Next, remove interception probability by connecting the potentiometer side of R_{30} to a source of 60 volts; do this on both sides. Now attack enemy target 1 at maximum launching rate. Note the number of strikes and the time required to reduce the enemy offensive potential from 120 volts to 60 volts. Repeat the process the other way, after resetting. If there is a marked disparity, check the matching of components. If they are close, adjust P_6 or its image until the number of strikes required is within one of equality.

Now release the defenses, reset, set the defenses to protect target 1 on each side, and close the strike launching switches simultaneously. Try this two or three times; if one side wins all the time and in less than 3 minutes, recheck the multivibrator setting.

Potentiometer P_4 can be used to control the width of the blanking pulses generated by the multivibrator. If an oscilloscope is not available, adjust P_4 or its counterpart until the probability of penetration is the same for each side. This may require making 100 trials a side and keeping track of the interceptions. If the two sides are close, so that the contests last longer than three minutes but one side consistently wins, adjust series resistor P_6 until one side is as likely to win as the other.

This adjustment procedure may appear lengthy and the balance rather delicate, but it is essential because two systems are being placed in opposition and the difference between them integrated with respect to time. The two sides (when placed in opposition) produce a system that is as unstable as balancing a knife on its point. Any game of similar strategy on each side that lasts more than 6 minutes proves the game is well balanced.

Play of Complete Game

Assuming that adjustment and calibration have been completed, find a prospective opponent and start learning the game together. First, try the following three contests, resetting after each.

(1) Red attacks T_1 and Blue attacks T_3.

(2) Red attacks T_1 90 percent of the time and T_3 10 percent, while Blue attacks T_3.

(3) Red attacks T_1 90 percent of the time and T_3 10 percent, while Blue attacks T_4 50 percent and T_5 50 percent.

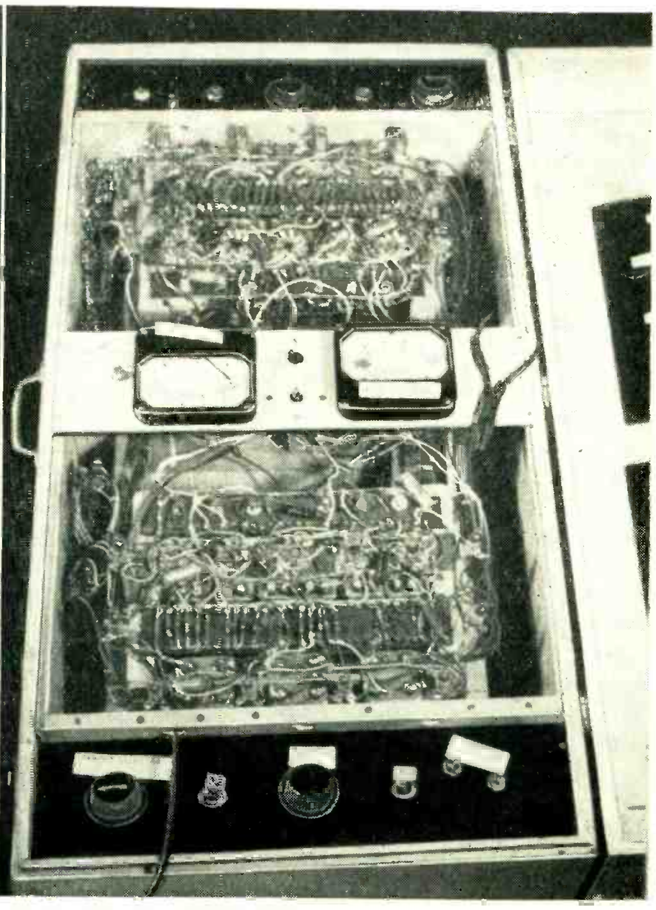
These plans of attack should illustrate that in this game the primary target to attack is the enemy offensive potential and the primary object to defend is your own offensive potential. By stretching the imagination, T_1 can be strategic bomber or missile bases; T_2, some element of basic industry, say aluminum or steel plant; T_3, bomber or missile assembly plants; T_4 and T_5, some essential commodity common to both offense and defense, such as gasoline and oil; T_6, fighter assembly plants; T_7, more basic industry; and T_8, interceptor or defensive missile bases.

Since some of the games may be long drawn out, it is useful to establish a criterion of winning. When one side is below 10 percent of its offensive potential and the other is twice as great and increasing, the contest can be declared at an end, the winner being the one with the greater offensive potential. Another criterion might be to declare as winner the side that can keep the opponent's strike and defense neon bulbs from flashing.

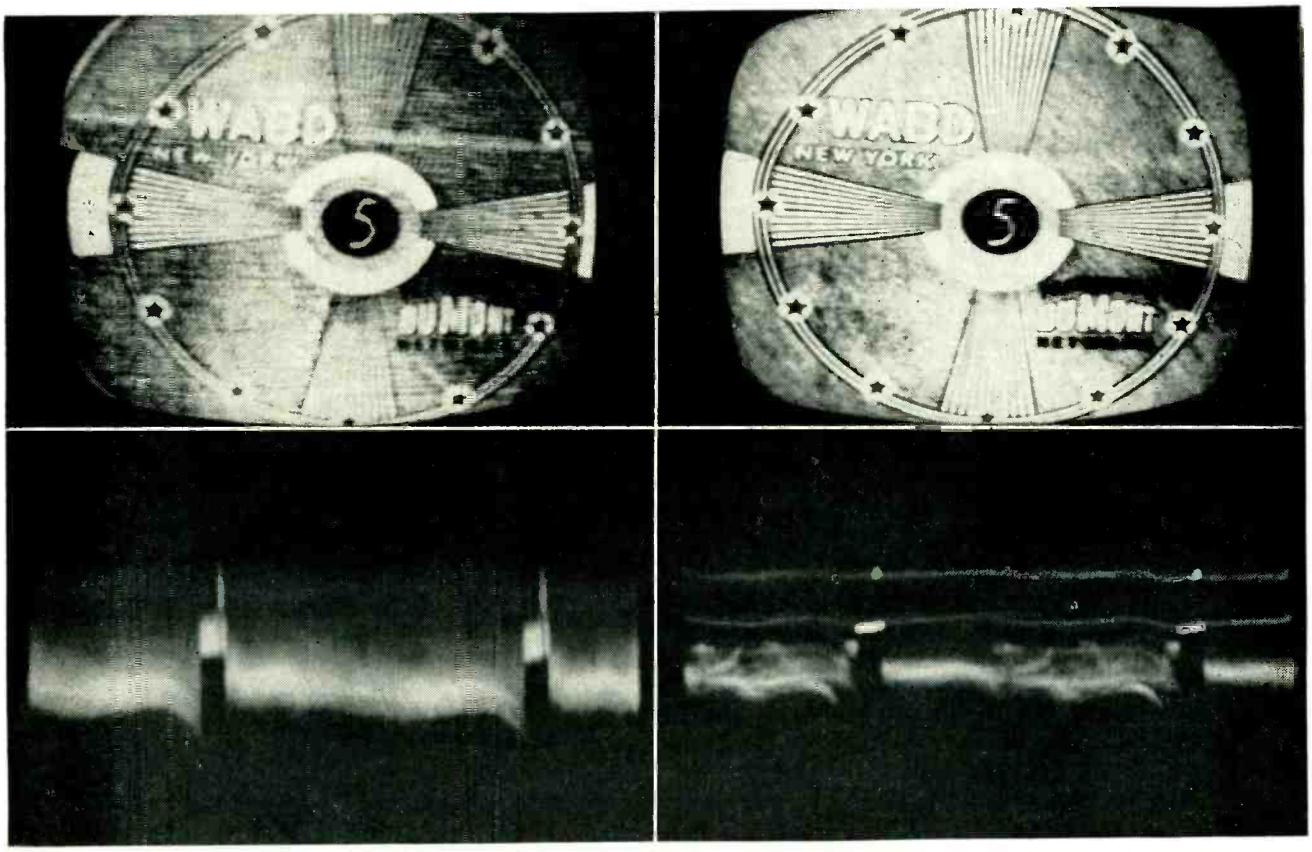
Conclusion

The game as laid out in this design is meant to produce, with a minimum of parts, a device that will entertain players and illustrate a few basic principles in the employment of air power. The values chosen have little relation to the specifics of any engagement with a possible enemy of the United States. No attempt is made to simulate combat loss effects except to say that each side suffers losses in proportion to the amount of its force in being, the loss rate being the same on each side. Transportation, power and many other types of targets are not represented in the industrial complex. The important principles of war—offensive, concentration, mass and security—are illustrated and emphasized by the dynamics of an engagement speeded up many-fold.

Panel of game. More labels can be added, identifying types of targets represented by flashing neon lamps and switch positions



Game with cover lifted. Meters, one facing each player, show amount of voltage remaining to fight with



Received test pattern and video wareform, left, illustrates cross-modulation interference between channels caused by overdriving television receiver. Test pattern and waveform, right, show how the signal overload circuit corrects this condition

Signal Overload Relay for Television Receivers

Automatic circuit prevents overdriving tv receivers in strong-signal areas. Relay in r-f and i-f plate circuits releases when increasing agc drops tube currents. Relay contacts open cathode circuit of cascode r-f amplifier, removing it from circuit to reduce gain

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DESIGNERS of home television receivers have tended to design increasingly high sensitivity into their sets. Many receiver manufacturers use a cascode r-f amplifier in their vhf tuners followed by a mixer and three or four intermediate-frequency stages.

The increased gain available from these receivers augments the signals from transmitters that are radiating increasingly higher power and gives rise, in some areas, to the serious problem of overloading the receiver circuits. For example, in the New York area signal levels in the order of 1.0 volt have been measured.

Two possible problems associated with this increased radiated power and high receiver sensitivities are the prevention of receiver overload in areas where all signals are high and the prevention of receiver over-

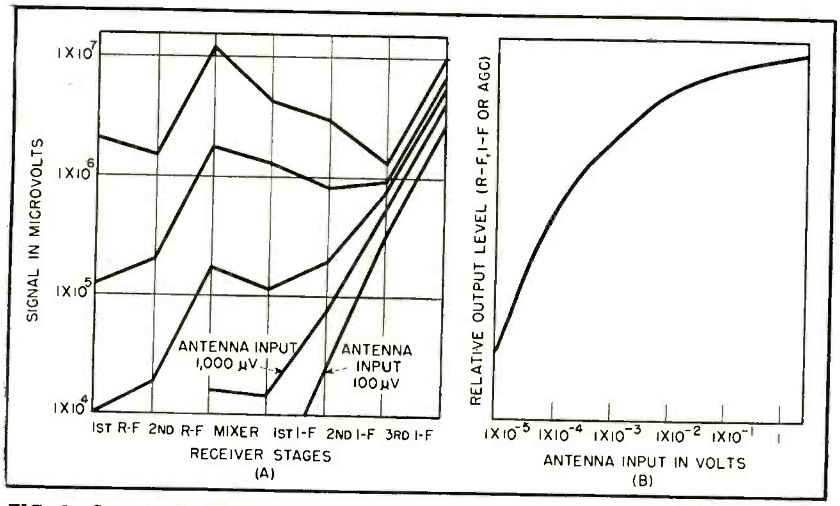

FIG. 1—Signal distribution for constant input (A), and typical stage performance (B)

load in areas where some signals are strong and some are weak.

This latter problem requires an automatic device that will reduce the receiver's sensitivity or gain for the strong channel and restore it on the weak channel. This unit, while not necessary, is also valuable for the first condition.

Overload Characteristics

Overloading in a television receiver manifests itself in numerous ways. A few examples are:

(a) Cross-modulation interference between channels not necessarily adjacent. The received test pattern and corresponding video waveform shown at the left in the photograph illustrate this effect. The test pattern and waveform at the right show how the tv overload circuit to be described corrects this condition.

(b) Noisy pictures in high-signal areas. This is a result of operating the i-f tubes beyond cutoff.

(c) Loss of picture synchronization as a result of the compression of the sync information into the video.

(d) Complete reversal of picture.

Figure 1 is a graphical presentation of the signal voltages at various stages for fixed antenna input levels. As can be seen from the signal distribution throughout the receiver, there may be more than one point of overload as the input signal increases. Also, for each individual stage, the signal output increases up to a given level and then remains relatively constant for any additional input signal. The point of flattening can be called the overload level for each stage. This figure also shows that agc cannot be used without considerable additional amplification to control overload.

System Considerations

A desirable automatic overload system should supply the necessary attenuation for strong signals in such a manner as to prevent grid rectification in the first r-f stage and should be removed when the signal decreases to a predetermined level. It is essential, however, that insertion of attenuation be at a signal strength other than that at which it is removed so that a given signal will not cause the system to chatter. Above all, from the standpoint of economy and reliability, the system should require a minimum of components and wiring.

Possible methods of reducing the sensitivity of a receiver include inserting a resistor attenuator in the antenna lead-in, inserting a resistor attenuator in the r-f tuner and inserting attenuation in the r-f amplifier by opening the cathode circuit.

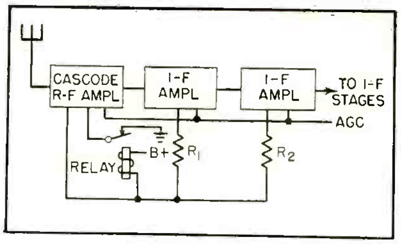

FIG. 2—Block diagram of receiver with overload circuit

The first method reduces the overall sensitivity of the receiver and precludes the satisfactory reception of weak signals.

The second method is good but expensive and requires individual field modifications.

Opening the r-f amplifier cathode circuit results in a marked decrease in gain and eliminates any possibility of grid rectification. This is the method that will be described in this article.

Some possible methods of controlling the point at which the gain reduction occurs in the receiver include use of a relay to open the r-f cathode by either the agc bus or a vacuum tube at the r-f grid and use of a modified t-r tube with a keep-alive voltage that can vary the reset.

Automatic Attenuation

The use of the first control method is preferable from the standpoints of simplicity, reliability and economy. Figure 2 is a block diagram of the method.

The relay coil is in series with the combination of the cascode stage and one or more i-f stages to utilize the d-c amplification of the agc voltage. By placing the relay in the B+ side of the decoupling filters, its resistance and inductance have no detrimental effect on r-f and i-f operation. The spst contact of this relay is connected between ground and cathode of the cascode stage. Experiment has shown that, during warmup of the receiver the current drain of the i-f stages will close the relay and it will be held closed by the added cascode current.

As the signal strength increases, the agc voltage becomes more negative and the relay coil current decreases. As the overload point is approached, the decreasing relay current allows the contacts to open the r-f amplifier cathode, thus attenuating the signal and stopping the cascode amplifier current flow through the relay coil.

At this time the agc voltage decreases, thereby increasing the current through the i-f stages and relay coil. This increase, however, is not sufficient to close the relay again. If the signal decreases or the

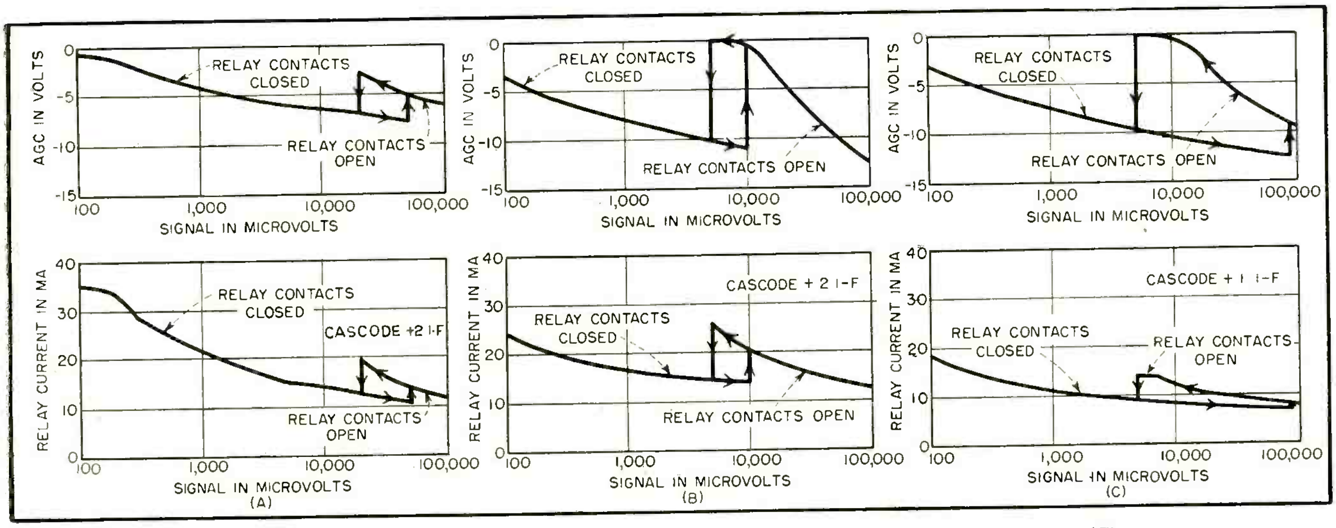

FIG. 3—Receiver overload control characteristics for medium range (A), wide range (B) and narrow range (C)

receiver is switched to a weaker signal, the further decrease in agc supplies sufficient current to actuate the relay, closing the cascode cathode circuit and allowing the receiver to operate with normal sensitivity. A quantitative analysis of this action is shown in Fig. 3A.

As the signal strength increases from 100 μv to the preset overload point of 50,000 μv, the relay coil current decreases from 33 ma to 11 ma and its contacts open, attenuating the signal a predetermined 29 db. This attenuation causes an agc voltage change from —7 v to —5 v that increases the relay coil current from 11 ma to 13.6 ma. This current, however, is insufficient to close the contacts

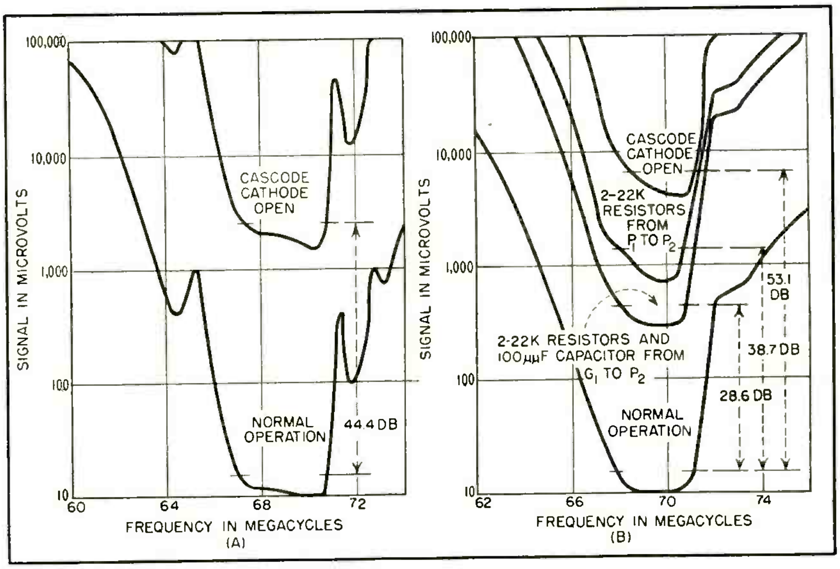

FIG. 5—Receiver response with and without overload elimination (A), and response with varying amounts of attenuation (B)

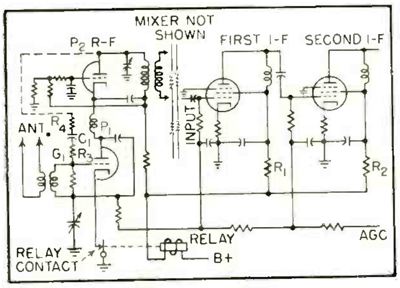

FIG. 4—Receiver overload control circuit

again and the relay remains open for this and any increased signal strength. When the signal decreases to less than 20,000 μv, the relay closes and gives normal receiver gain.

The flexibility of the system is seen in Fig. 3B and 3C. In the former, attenuation was inserted and in the latter, it was removed. Both adjustments can be made to predetermined signal levels by adjusting the relay.

Circuit Considerations

As is shown in Fig. 4, the circuit requires the addition of one relay and two resistors, R_1 and R_2. The control point can be adjusted by choosing a relay that opens at a given current. The point at which the relay closes may be determined by the pole-to-armature spacing.

The receiver's overall bandwidth is affected very little by opening the cathode, as shown in Fig. 5A. The attenuation can be varied up to approximately 50 db by bridging the cascode amplifier with a suitable resistance or R-C network. Typical networks with their resultant attenuations are shown in Fig. 5B. This network can remain in the circuit at all times.

The lead length from the cascode cathode to the relay contacts should be as short as possible and is easily accomplished by mounting the relay on the tuner.

The assistance of R. Zitta of the physics laboratories, in making the many measurements required is acknowledged, as is the assistance of the Du Mont Television Network for the use of the channel 5 test pattern.

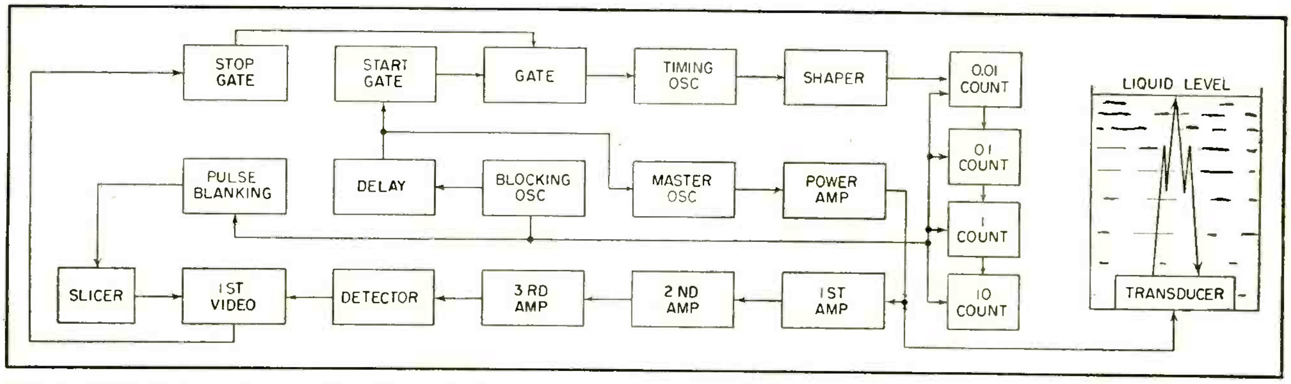

FIG. 1—Block diagram of manually calibrated ultrasonic gage, suitable for liquids having known, stable acoustical characteristics

Ultrasonic Liquid Level

Height of surface or interface is indicated remotely to hundredths of a foot on decade counters, by using a 400-kc sonar type transducer at bottom of tank. One system compensates automatically for changes in velocity of sound. Chief use is for fully automatic process control and inventory in petroleum refineries and chemical plants

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ACCURATE liquid level measurements are a most important adjunct to fully automatic process control and inventory. Although hundreds of different types of level gages have been available, many large industries have found it expedient to depend on simple dip sticks and calibrated chains to obtain reliable readings. One reason for this is the inability of moving-float systems to withstand continuous operation in the corrosive liquids found in industry. Another shortcoming has been the difficulty of accurately remoting level information obtained from sight gages.

The basic requirements for a useful gage, in approximate order of importance, are accuracy, reliability and low cost. Accuracy requirements of $\pm\frac{1}{8}$ inch error in 50 feet are not uncommon in the petroleum industry where $\frac{1}{8}$ inch change in the level of a large gasoline storage tank represents a difference in inventory of several thousand dollars.

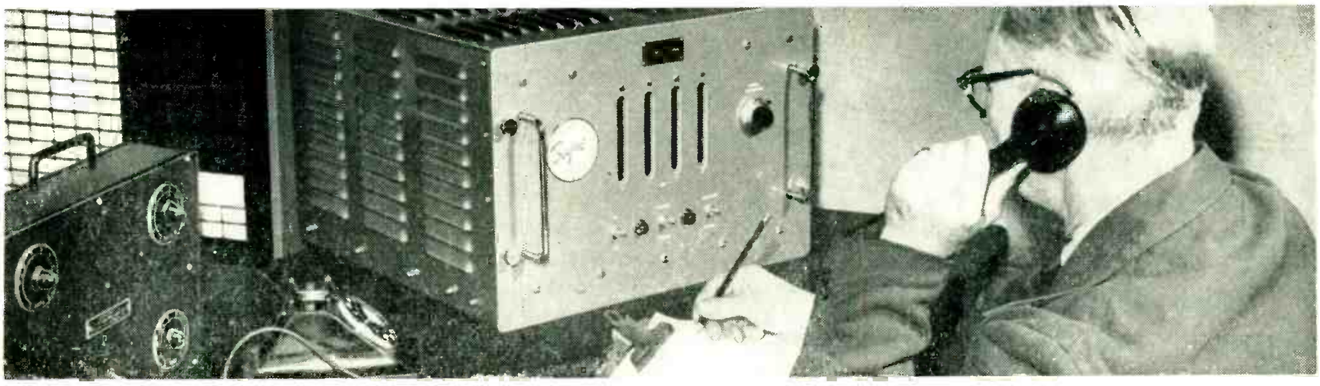
This paper describes two sonar-type liquid level indicating systems which were designed to eliminate moving parts that sooner or later fail in rigorous industrial service. One of the equipments is automatically calibrated to compensate for changes in the velocity of sound with temperature and in different liquids. The other equipment incorporates manual calibration facilities and lends itself to special measurement problems involving liquids of known and stable acoustical characteristics.

Some pertinent features of both new instruments are the complete absence of floats, linkages, synchros, potentiometers and similar moving parts, as well as static capacitance probes that have usually been associated with the level-sensing elements of most existing gages. No direct-current flow is present in or around the tanks being gaged or in the coaxial cables that form the only connection between the indicators and the tanks themselves. Alternating-current energy is far below that required to strike gasoline fumes under any open or short-circuit conditions, and therefore these systems are safe for use in explosive tank areas. Any number of tanks may be gaged economically by a common indicator which displays level readings directly in tens, units, tenths, and hundredths of a foot.

System Theory

In the usual case, sound pulses are directed up through the liquid to the surface by a common transmitting-receiving transducer, where they are reflected back as echoes. Round-trip time intervals are measured, and the data are converted to decimal readings corresponding to the levels in feet. Energy is also reflected back from interfaces existing between immiscible liquids, including many having practically the same specific gravity; hence, the sonic level indicators may be used to determine the locations of these lines of demarcation.

Since digital information techniques are used, commercially available digital recorders and tape printers may be fed from the indicators over long distances. Inventory can be made automatic



Automatic setup for gaging two groups of petroleum tanks from office of plant superintendent. Control box at left switches tank units

Indicator Systems

from the data-taking stage to the printing of the actual level at some remote location such as the office of the plant superintendent.

From an electronic standpoint the fundamental operation of the two new systems closely resembles conventional sound-ranging techniques except that the operating frequency has been raised to 400 kc and the data presentation has been considerably improved and simplified. Echoes are returned from either air-liquid or liquid-liquid interfaces, the magnitudes being related to the specific acoustic impedances of the materials involved. The greater the difference in impedances, the stronger the returned echo. Interfaces between liquids and air reflect back practically all of the incident wave.

Manual Calibration

The block diagram in Fig. 1 illustrates the operation of the manually calibrated sonic liquid level indicator. A free-running blocking oscillator, operating at a repetition frequency of about 0.5 cps, synchronizes the equipment and establishes the frequency of the level readings. Output pulses from the blocking oscillator are applied to time interval measuring circuits to reset the previous level reading back to zero prior to the start of another cycle of operation a short time later. This delay, used to insure the completion of the resetting process, is achieved with a monostable multivibrator triggered by the astable blocking oscillator.

The trailing edge of the delay multivibrator output is used, after differentiation, to trigger the transmitter and start the time interval measuring circuits. These circuits are turned off again at the receipt of an echo pulse.

The actual transmitter consists of a pulsed master oscillator-power amplifier producing a 100-microsecond damped 400-kc sinusoid having a peak-to-peak amplitude of about 40 volts on the balanced twin-conductor coaxial cable to the transducer. Returning echoes pass over the same cable to a receiver consisting of a three-tube stagger-tuned band-pass amplifier followed by a detector and a video amplifier.

Indicator

Liquid level readings are displayed in decimal form to the hundredths place on four chain-connected decade counters. The highest frequency counter, which reads hundredths of a foot, is fed a series of sharp input pulses derived from a pulsed sine-wave timing oscillator that is started and stopped by a bistable timing gate multivibrator operative only in the interval between transmission and reception of an echo. Translation of the time-interval measurement into level in feet is attained by manually adjusting the timing-oscillator frequency to a point where the period of each cycle corresponds to the time required for a sound pulse to travel 0.01-foot round trip through the particular liquid. Thus, each squared-up pulse fed to the first counter increases the level reading by a hundredth of a foot. The following three decades successively accumulate the carryover in the usual manner.

In water, sound travels 0.01-foot round trip in about 4 microseconds, the exact value depending upon the temperature and the degree of purity. This velocity corresponds to a correct timing-oscillator frequency of 250 kc. Other liquids require different frequency settings; the range required for commonly found liquids varies approximately 3 to 1, with water at about the center.

The counting interval is but a small part of the repetition period. The level readings, which are maintained for practically the entire time remaining before the start of another cycle of operation, thus appear continuous to the eye because of the persistence of vision. The counting itself is so rapid that it is all but invisible.

A pulse-blanking circuit is used to remove the amplified transmitting pulse appearing at the video amplifier. A slicer control is provided in the video stages to allow for selection of the desired echo above the general base-line noise.

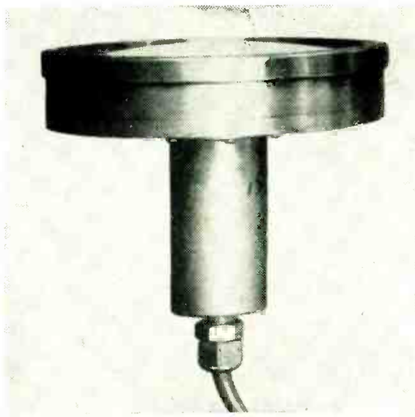
Calibration may be accomplished by setting the level to a known height and manually adjusting the front panel selector control until the indicated reading is in agreement. Readings taken thereafter will be accurate to ±0.01 foot providing the liquid temperature and composition remain constant. If, for example, the temperature changes, a series of calibration data may be taken for future use.

Automatic Calibration

Manual compensation is best suited to specialized applications that are not too frequently encountered in general industrial use. Automatic calibration is therefore a necessity in many cases. This is achieved with a closed servo loop system embodying a main pulsed transducer and an associated elapsed-time measuring circuit adapted to gage distance to a liquid surface (or liquid-liquid interface). In the same liquid is a similar calibrate system adapted to develop a series of spaced echo pulses from reflectors located at set intervals from a second transducer. The calibrate system automatically modifies the operation of the main circuit section so as to obtain true level readings despite changes in the velocity of sound for any reason, including variations in molecular structure and temperature differences.

The circuits employed are shown in block diagram form in Fig. 2. The two transducers used per tank are each mounted at the bottom of separate stillwells which are, in effect, acoustic waveguides. The calibrate stillwell is fitted with internal protuberances which reflect back echoes used for the calibration. The other stillwell serves no other function than to confine the sound pulses of the main transducer to a small part of the tank, and thus simplifies the placing of the tank elements with respect to nearby reflecting structural members. In filled tanks transducers may be at the top as in Fig. 3.

The transducers are pulsed in synchronism, and the echoes derived from the reflectors are compared in phase with similarly spaced pulses generated within the indicator itself by a series of frequency dividers energized by the timing oscillator. The timing oscillator is started and stopped by a multivibrator gate operative only during the interval of time between transmission of a pulse by the main transducer and receipt of the corresponding echo.



The adp transducer in corrosion resistant housing, with pressure-sensitive teflon window at top

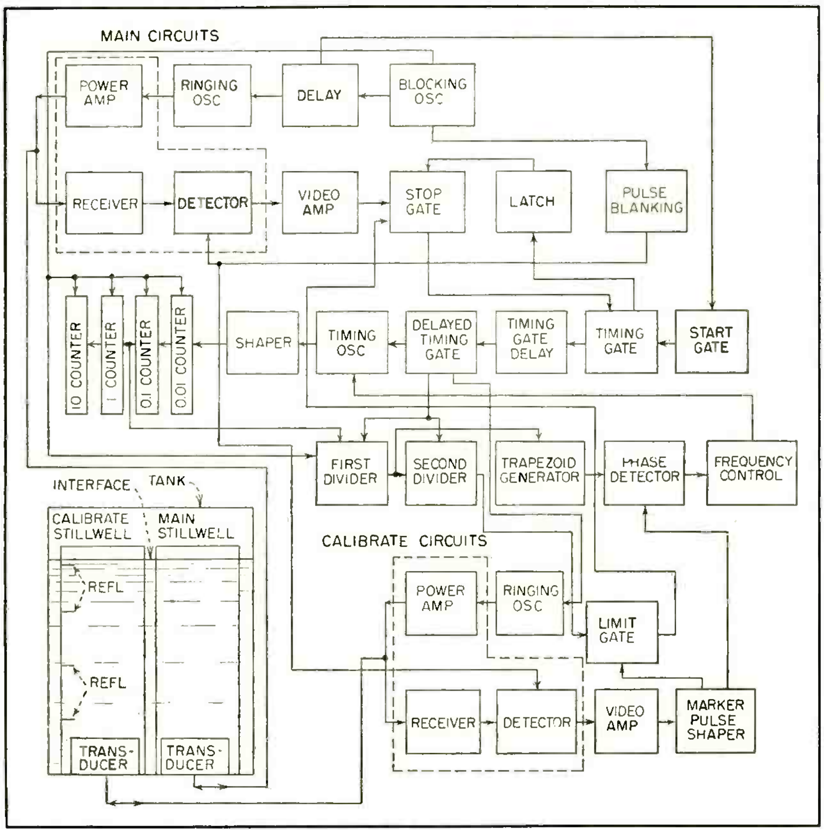


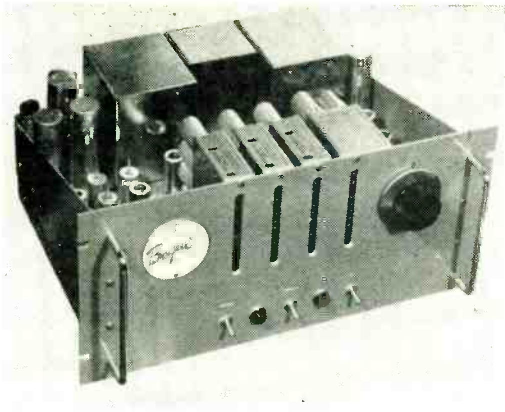
FIG. 2—Block diagram of automatically calibrated ultrasonic gage, using a separate transducer in a calibrate stillwell inside tank to measure distances between fixed metal reflectors. Associated calibrating circuits then correct for any variation in the velocity of sound in the tank

Any difference in spacing between the two sets of pulses causes the timing oscillator to be shifted in frequency to reduce the spacing error to zero. Thus, this servo action automatically adjusts the timing oscillator to a frequency corresponding to the velocity of sound in any particular liquid.

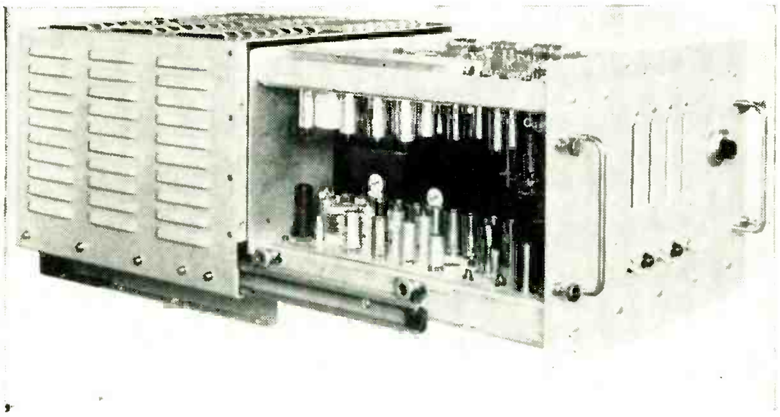
Depending upon the size of the tank, reflectors are spaced either 4.00 or 8.00 feet apart starting from the first, or closest, reflector which is usually 2.00 feet away from the active face of the calibrate transducer. These spacings are ordinarily close enough to insure the adequate averaging of small differences in velocity which may be caused, for example, by heavier liquids settling to the bottom and by temperature gradients existing within the containers.

Synchronizing Circuits

Operation is synchronized to a free-running blocking oscillator which operates at about 15 cps. Each blocking oscillator output pulse resets the decade counters to zero, starts a resetting delay circuit multivibrator and energizes a pulse-blanking multivibrator which is used for gating out the undesired transmitted pulses which feed through the two receivers. At the termination of the resetting delay



Manually calibrated system. Only other part is transducer in tank. Neon lamps of decade counter indicate height from 00.00 to 99.99 feet



Automatically calibrated system used with two transducers in tank. Calibrate circuits are in upper pan, and main circuitry is below. Chassis can be pulled out on roller slides as shown, for easy servicing of either pan

interval, the main transmitter, consisting of an exponentially damped ringing oscillator and a power amplifier, pulses the main system transducer for 100 microseconds. At the same instant the timing gate multivibrator is started and is turned off again the instant the returning echo arrives. The timing-gate output is delayed several hundred microseconds through a delay multivibrator and is reproduced in width at the delayed timing gate.

Actual on-off control of the timing oscillator is achieved by the delayed timing gate whose duration is exactly equal to the round-trip transit time. The shaped output of the timing oscillator is applied to the highest frequency decade counter. This in turn drives the three lower-frequency decades to produce a reading in tens, units, tenths and hundredths of a foot.

The leading edge of the delayed timing gate is also used to trigger the pulsed calibrate transmitter, which is identical to that used in the main system. One or more echo pulses will subsequently be received from the calibrate reflectors, the number depending upon the level of the liquid. The echo pulse from the surface or liquid-liquid interface will also be received.

At low liquid levels only the first reflector will be illuminated by the transmitting pulse, as the remaining reflectors are effectively blocked by the interface. Conversely, a long series of reflector echoes will be returned when the tank is almost full.

In order to remove the unwanted interface echo that follows the reflector echoes, the calibrate receiver output is passed through a coincidence stage which is gated on by the undelayed timing gate, which ends before the calibrate interface echo returns. The delay multivibrator delays the timing gate sufficiently for removal of this interface echo.

Error Voltage Circuits

The reflector echoes are then applied to a one-shot multivibrator that produces an identical series of sharp pulses free from amplitude and width variations. Both the unwanted transmitted and interface echo pulses have been removed prior to this stage, so that only pulses representing the reflectors are passed to the following phase detector.

This comparison stage is also supplied with a series of trapezoidal pulses which are synchronized to a submultiple of the timing oscillator frequency by the dividing action of the two highest frequency decades and one additional scale-of-two divider. The division is such that when the sonic indicator is in normal operation the reflector pulses fall in the middle of the sloping leading edges of symmetrical trapezoids spaced apart by the same distance as the reflectors themselves.

An output error voltage is obtained from the phase detector which is proportional to the spacing time difference between the two sets of pulses. This difference is a function of both the velocity of sound, which changes the time spacing between returning reflector echoes, and the timing oscillator frequency, which directly sets the trapezoid period.

For a particular liquid, the velocity may be considered as a constant and the timing oscillator frequency as the variable. In this case the error voltage derived from the phase detector is applied to a frequency-controlling element in the timing oscillator. This changes the frequency by the correct amount and in the appropriate direction as necessary to equalize the spacing between the two sets of pulses. When the pulses are exactly in time coincidence, the timing oscillator frequency will correspond to the velocity for the liquid being gaged, and the readings will be precisely correct.

Timing Oscillator Circuits

Frequency control of the timing oscillator is achieved with a saturable reactor whose control winding is energized by a d-c amplifier fed from the output of the phase detector. The signal winding of the reactor is a part of the resonant circuit of the timing oscillator.

Coincidence between the reflected pulses and the trapezoids does not necessarily represent a zero error voltage. The reactor is held at a center frequency, usually representing the median velocity of sound through water, by a fixed bias on the grid of the d-c amplifier. Error signals may vary the control current of the reactor about this bias value over the full operating range of the amplifier.

Because of the wide frequencyshifting capability of the timing oscillator servo loop, means must be provided to prevent reflector echoes and trapezoids from becoming incorrectly matched when the timing oscillator frequency falls considerably away from its normal operating point, as would be the case when the equipment is turned on or when the common indicator is switched to another tank. The block diagram in Fig. 2 illustrates the location of a limit gate circuit that overcomes the possibilities of misalignment by first allowing only the nearest reflector at 2.00 feet to pass from the calibrate video amplifier to the phase detector circuits. The 2.00 foot reflector pulse is then compared with its corresponding trapezoid, and the resulting error voltage pulls the timing oscillator close to its correct frequency, a step that allows the following reflector pulses to pass through for comparison.

A simple coincidence amplifier is used as the limit gate, with reflector echoes applied to grid 1 and a suitable gating square wave applied to the suppressor grid. When the two inputs are misaligned by a sufficient amount the stop gate stage is prematurely energized by a pulse developed at the plate of the coincidence tube, and all further circuit functions involving the generation of trapezoids are terminated. The stop gate normally turns off the timing gate when the main interface echo is received. At coincidence, however, the limit gate output disappears, and normal circuit functions resume.

Repetition Frequency

The time constants in the R-C integrating network of the phase detector have been made considerably longer than the repetition period in order to obtain adequately smoothed d-c error voltage. Practical limitations on the maximum time constant obtainable with reasonably chosen components have necessitated the raising of the repetition frequency of the entire equipment to about 15 cps, as compared to the 0.5-cps figure found adequate for the manually calibrated system. At this high repetition rate the counting interval, encompassing the time required for a pulse to travel the maximum measurable height through the liquid, becomes comparable in duration to the following wait interval. Unless provisions are taken to eliminate the flicker, the counter readings would be unreadable, being rapidly in motion for practically half the time. A simple gating circuit has been added to disable the neon glow indicator lamps of all four decade counters during the counting. This circuit[1] does not affect the dividing action of the decades and eliminates the flicker by illuminating the lamps only during the wait interval prior to another complete cycle of operation.

Manual-Automatic Switch

The circuit of the timing oscillator and the following pulse-shaper amplifier is given in Fig. 4. In the manual position of the switch, the signal winding of the saturable reactor is disconnected from the cathode capacitors of the shock-excited timing oscillator, and an ordinary inductor shunted by a variable capacitor is substituted. The manual-calibrate switch also disconnects the B+ power from the calibrate receiver in the manual position.

In calibrate operation, the saturable reactor is reconnected in the circuit with its signal winding in the plate circuit of d-c amplifier tube V_{1A}. The 6,800-ohm resistor and V_{1B} across V_{1A} act as limiters controlling the maximum frequency excursions permitted the timing oscillator. The resistor sets the minimum current and hence the lowest frequency, while diode V_{1B} determines the highest frequency. Discriminator output voltage is fed directly to the grid of V_{1A} for frequency control.

The output of the pulse shaper, consisting of sharp negative-going pulses, is fed to the hundredths-place decimal counter which is a standard Berkeley unit.

Transducers

Both Rochelle salt and ammonium dihydrogen phosphate (adp) transducers are used in conjunction with the sonic level indicators. The former material, being both temperature-sensitive and temperature-limited to operation in liquids below 40C, is best suited to gaging water at room temperature. For more rigorous applications an adp transducer 7 inches in diameter is used.

To protect the internal crystal array, the face is fitted with an acoustically transparent teflon window that is impervious to practically all corrosive liquids. Upper temperature limit of the adp unit is 130C, while half-power beamwidth is in the order of 5 degrees. The rear of the transducer incorporates a line matching transformer and optional provisions for resonating the capacitance of the crystal array when additional system sensitivity is required.

The basic manually calibrated equipment may be installed with only a single bottom-mounted transducer pointing upwards in a vertical fan-shaped cone approximately 10 deg wide, which must be free from reflecting supporting structures and similar objects. This is the simplest installation, although most applications require

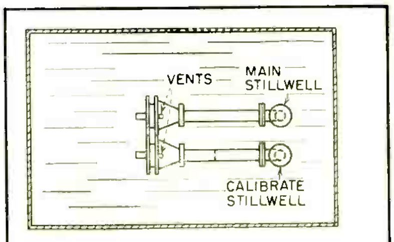


FIG. 3—Method of mounting transducers at top of continuously filled tank for monitoring gasoline-water interface

some additional means for confining the sound energy to an even more restricted part of the container. Stillwell pipe is frequently used to direct the sound energy up a narrow path to the interface and to prevent nearby objects, such as agitators, heating coils and braces from contributing echoes.

Stillwells

In the automatic system the use of stillwells has been made standard, since this type of assembly is ideally suited to supporting the acoustical reflectors used in the calibrate section. Holes are provided for introducing the liquid into the pipe so that inside and outside levels are equal. Small holes used for this purpose will reduce turbulence frequently found in large mixing tanks and will thereby stabilize the reading of the sonic indicator.

The stillwell pipe, which is acoustically treated internally, may also be mounted on the outside wall of a tank providing sufficient tap-off pipes are provided for equalizing levels. This type of installation facilitates transducer cleaning which may be required periodically when the system is used to gage thick gummy liquids.

A typical tank installation of the automatic system is diagrammed in Fig. 3. This application involved the gaging of an interface level existing in a tank completely filled with varying proportions of two immiscible liquids, water and gasoline. Two internal stillwells were used, one for the main system and the other for calibration. The transducers were mounted at the top of the tank, pointed horizontally at right-angle reflectors several feet away. This arrangement reduced the minimum range of the equipment, which is ordinarily 2.10 feet, to approximately one-half the diameter of the stillwell pipe flanges or about 0.50 foot. The reducing sections couple the larger transducer radiating area to the smaller-diameter stillwell pipe. This installation was designed to be immersed in the tank, and holes were provided to allow the liquids to seep into the stillwells. An electrical modification to the indicator was necessary to subtract the added horizontal distance.

Application Data

Sonic liquid level indicators are also being used to gage more conventional petroleum storage tanks and similar large containers filled with corrosive and radioactive liquids. Both internal and external stillwell installations have been made, the choice depending upon particular local conditions.

One of the economic advantages of the sonic level indicators is the use of a common indicator in conjunction with a large number of transducer-equipped tanks. To facilitate tank-to-tank switching, a motor-driven remotely controlled rotary type switch was developed. This switch is specially designed to handle two-conductor balanced coaxial cable. Up to 24 positions may be selected from a remote control point by means of a seeking-type selector assembly energized from a conventional rotary control switch on the control desk.

The indicators may be arranged to deliver digital level data to commercially available tape printers for automatic inventory purposes. These recorders may be up to several thousand feet away from indicators without necessitating special data transmission accessories. The level information may be remoted even greater distances, if necessary, over conventional wire-radio transmission networks. The new equipments can thus satisfy the need for versatile gages capable of accelerating the trend to completely automatic process control and inventory, particularly in large refineries and chemical plants.

Particular credit for their contributions to these developments is due John A. Herbst, vice-president of Bogue Electric, as well as Lawrence Saper, E. Kohler, William D. Becher, S. Zitovsky, W. Wojtulewicz, and many other members of the Bogue research department.

The author acknowledges the assistance of Clevite-Brush Development Co. and Thompson Products Co. Members of the instrument departments of the Esso Bayway, New Jersey refinery and the Sarnia, Ontario refinery of Imperial Oil, Ltd., graciously assisted in conducting field evaluation tests of sonic equipment. Part of the work undertaken to produce the sonic liquid level indicators was conducted under Bureau of Ships Contract No. NObs-54478.

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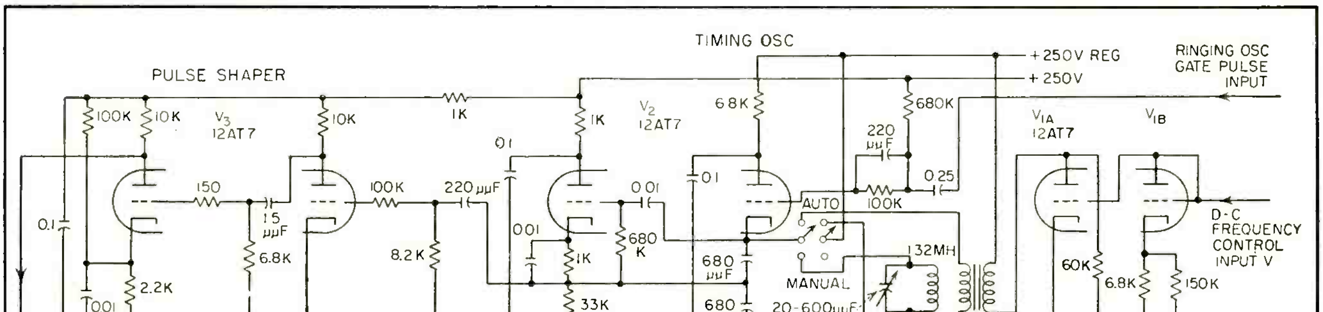


FIG. 4—Switching arrangement used in timing oscillator to provide optional manual calibration in automatic system

Scale model of *USS Mount McKinley* being tested at scale radio frequencies to determine directivity effects caused by ship's structure

Ship Models Predict

Scale replica vessels constructed from brass sheet and rotated on a 22-foot metal turntable are illuminated at scale frequencies by distant antennas. Shipborne scaled antennas connected to receiver and polar recorder predict full-scale propagation patterns

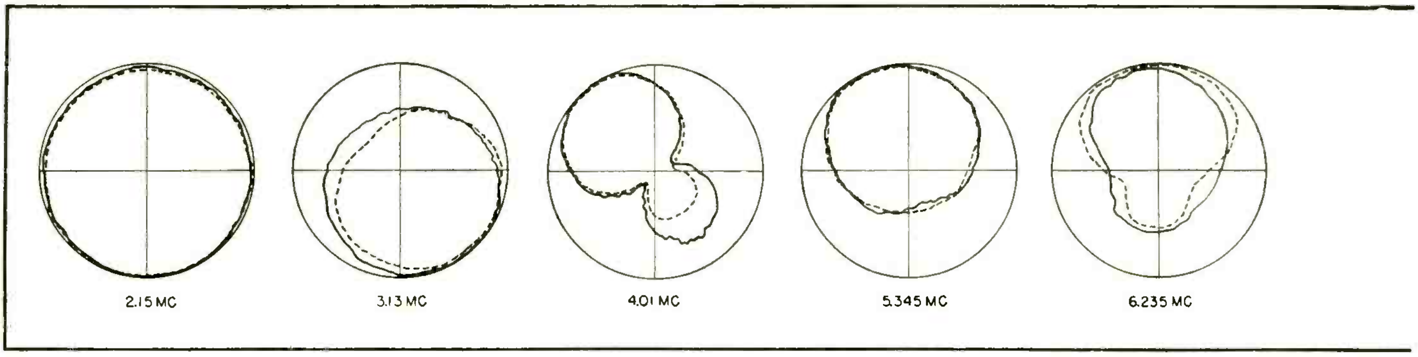
ONE of the world's most unusual fleets sails on a specially constructed ocean of lead at the Navy Electronics Laboratory's Ship Model Range in San Diego, California.

Every vessel in the force is a scale replica of a real U. S. Navy warship already at sea or on drawing boards for tomorrow. The vessels and the model range are used in continuing studies of ships' antenna systems. Thousands of dollars and man-hours are saved annually by the techniques developed during and since World War II.

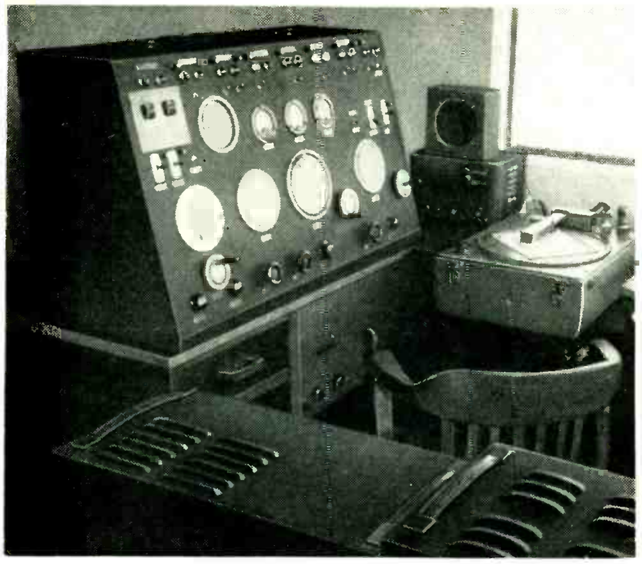
First approach to the antenna system study was to test and measure antennas on operating ships, a procedure painfully expensive in terms of ship availability as well as money. Furthermore, new ships need accurate forecasting for communcations design. The Bureau of Ships began in 1944 a complete shore-based ship model systems study. From 1945 to 1948 techniques and instrumentation were investigated on a series of preliminary facilities. Permanent plans were ready by 1948. The present range and model laboratory has been in operation since 1950.

Valid results may be obtained from models, experience shows, if ship size and wavelength are scaled to the same value. It has been found that for frequencies greater than 2 mc the ship's structure usually has considerable effect on radiation patterns. Below 2 mc the structure is usually too small in terms of wavelength to affect patterns.

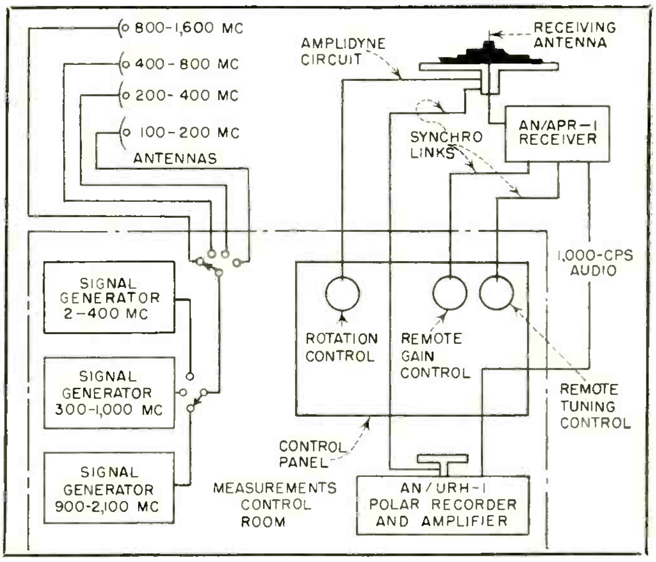
The primary factor influencing



Comparison of antenna patterns of actual ship and scale model



Control room shows positioning dials and recorder



Model antenna is illuminated by proper frequency

Antenna Patterns

By VAL SMITH
Head, Radio Antenna Systems

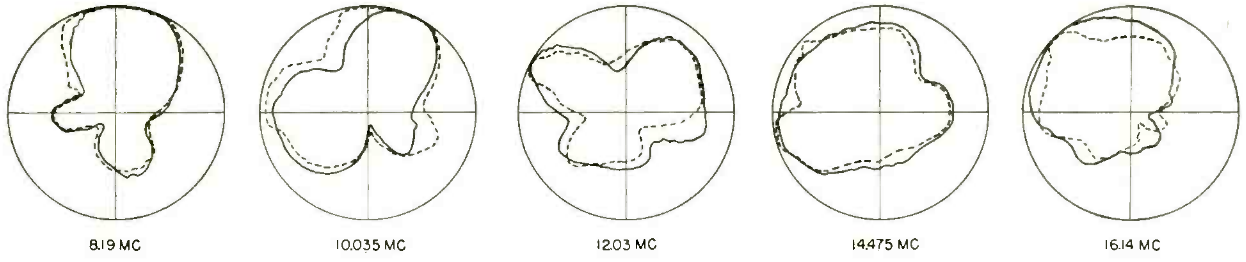
and C. M. HATCHER
Publications Editor
Navy Electronics Laboratory
San Diego, California

directivity for vhf-uhf antennas, which are usually installed high on the mast, has been found to be nearby objects. A natural division of instrumentation has resulted, therefore, with one set of techniques for the 2-to-30 mc range and another for vhf-uhf. Complete ship models are made for the 2-to-30 mc studies. They are built usually to 1/48 scale (sometimes to 1/24) for ease in construction and to utilize available electronic equipment. Each model ship is made of sheet brass.

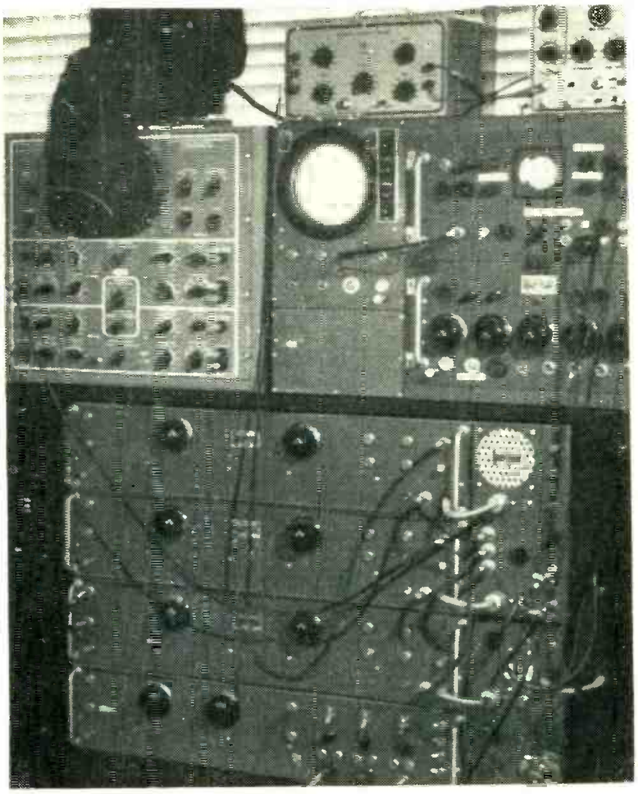
The ocean is simulated by a large, unobstructed, highly conducting ground plane. Center section of the plane is a flat metal turntable 22 feet in diameter. Surrounding it is a circular asphalt-concrete field, 160 feet in diameter, covered with a 0.008-inch coating of sprayed lead.

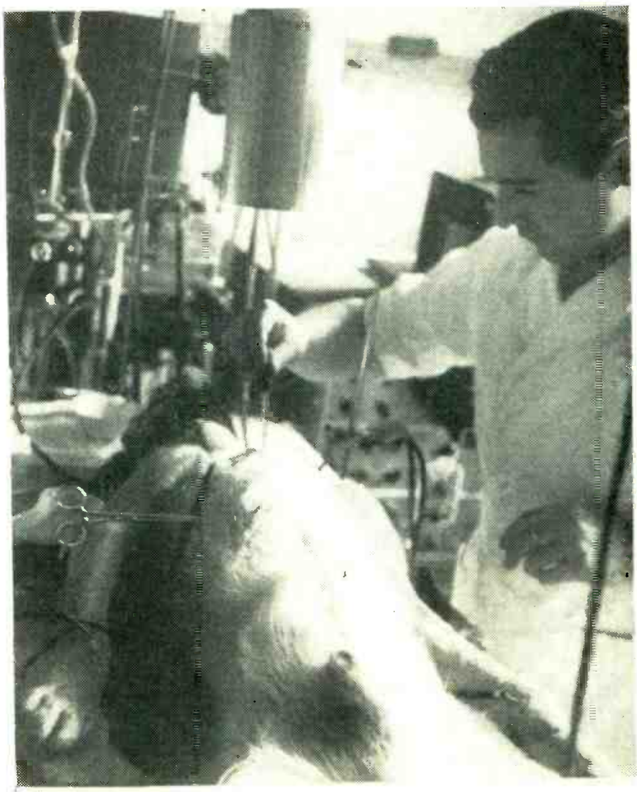
To record an antenna directivity pattern a continuous signal is sent to the model from a parabola at the edge of the field. The model antenna under test is connected to a receiver from which an audio output is obtained. The magnitude of the audio signal is used to control the deflection of a pen on a polar recorder, the turntable of which is rotated in synchronism with the revolving model. Signal-strength amplitude is plotted as a function of bearing. This plot is a characteristic of the ship antenna and is applicable whether the antenna is used for transmitting or receiving.

Ground plane and turntable were designed to eliminate variances in directivity patterns caused by discontinuities within the field. Periphery of the field is sharply scalloped to reduce standing waves, which might be produced by reflections from the outer edge. The turntable was designed with an overhanging lip that turns within a mercury-filled trough in the ground plane. Discontinuities between the ship model and the turntable are eliminated by soldering the model to the turntable.



Dotted lines show 35-foot whip while solid lines are 1/24 scale





Electronic equipment (left) amplifies and records low-level nerve-current impulses picked up from animal on operating table (right)

Sensitive Amplifier

Nerve impulses of 5 microvolts are amplified and recorded in studies aimed at providing a better understanding of nervous-system behavior. Equipment incorporates several unusual features. A dozen techniques for ultrasensitive amplifier design are described

By JOHN R. BECKWITH

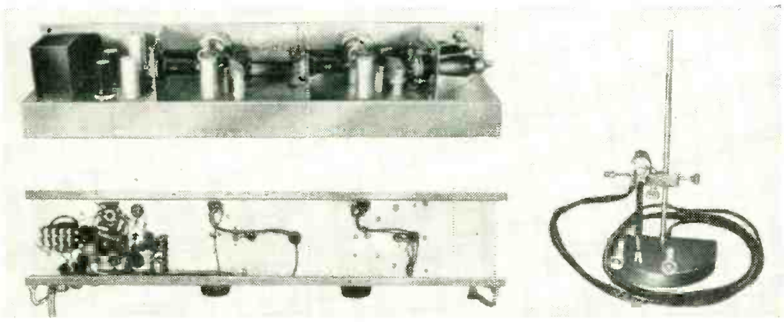
Raytheon Manufacturing Co. Chicago, Ill.

HIGHLY SENSITIVE audio amplifiers with broad band-pass characteristics play an important role in studying the functional behavior of the nervous system. The equipment to be described is used to amplify and record nerve-current impulses. Its specifications are listed in Table I. The design is especially useful in handling low-level audio signals that cover a wide range of both frequency and output level. The installation shown in the photograph has been in operation for several years at the electrophysiology laboratory of the National Polytechnic Institute in Mexico City.

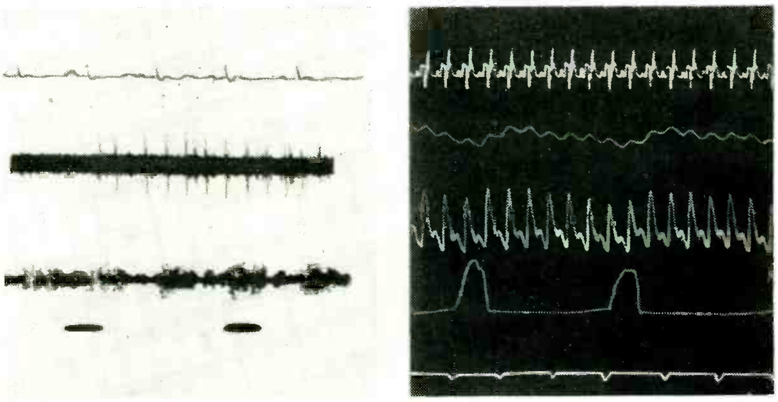
Figure 1 is a functional block diagram of the equipment. It consists of dual amplifier channels feeding a dual-beam oscilloscope equipped for motion photography. Monitoring is provided by both a speaker channel and a 5-in. cathode-ray oscilloscope. The equipment also includes a third amplifier channel for electrocardiograph or electroencephalograph signals and appropriate sweep circuits for the recording oscilloscope.

The first stage is the most important portion of the amplifier. Referring to Fig. 2, this stage comprises V_1 and V_2 for one of the dual channels and V_{11} and V_{12} for the other. The channels are identical in every respect and each has four stages of amplification.

Each stage is built in a chamber by itself, as can be seen in the photograph. All components are chosen for their low noise characteristics. The coupling capacitors are high-voltage mica and the resistors for the first stage are all noninductive wire wound. Resistors R_1 and R_2 control the first stage and largely determine the performance and noise characteristics of the



Bottom and rear views of amplifier (left) illustrate special shielded construction. Tantalum electrodes (right) connect directly to nerves of organism under study



Oscilloscope traces (left) show electrocardiograph trace, nerve-current impulses and one-second time markers. Smoked-paper traces (right) record electrocardiograph signals, blood pressure, respiration and one-second markers

Table I—Requirements of an Amplifier for Studying Bioelectric Potentials

Sensitivity: 5 microvolts for full output (corresponding to a 3-in. displacement on a 5-in. cathode-ray tube having an accelerating potential of 5,000 v).

Input Capability: 5 microvolts to 100 millivolts.

Bandwidth: 10 cps to 25 kc.

Hum: Equivalent to a signal of 2 microvolts maximum.

Interaction: Not detectable from other amplifiers or devices connected simultaneously to the same nerve.

Recording Response: Zero inertia at 25 kc.

Monitoring Outputs: Aural and visual.

Number of Channels: Two for amplifiers and one for electrocardiograph or electroencephalograph.

Distortion: Less than one percent at 100 millivolts input and 50-percent output.

Power Source: All a-c operated, 50 or 60 cps.

Display: All signals must be available for either separate or simultaneous display

for Medical Research

amplifier. Their value is found experimentally and varies with different amplifiers and even with different tubes. The optimum value is in the order of 10,000 ohms when the amplifiers are to be connected to the nerve through special platinum or tantalum electrodes.

The insulation used in supports and sockets is of high quality glazed ceramic to reduce noise and afford good insulation. Resistors R_3 and R_4 furnish bias for V_1 and V_2 and also form part of the feedback circuit. Resistor R_5 is the common screen resistor. The screens are unbypassed to degenerate spurious signals appearing on only one of the push-pull grids.

The desired signal appears 180 deg out of phase at the screens, and bypass is not needed. For this same reason, the common connections at the cathodes of the following stages are left unbypassed.

Resistors R_6 and R_7 constitute the plate load for the first stage and are brought to a wire-wound potentiometer used for balancing the plate voltages of the two tubes. This helps obtain indentical performance and good cancellation of in-phase voltages through screen action.

Two 0.05-μf capacitors provide coupling to the second stage. Resistor R_9 is the hum and/or interference balance control. It is a 2-watt carbon composition poteniometer. A 470-ohm resistor provides bias for the second stage. Resistors R_{11} and R_{12} need not be wire wound since considerably more noise can be tolerated in this stage; they are 2-watt carbon composition units. A 50,000-ohm resistor balances plate voltages of V_3 and V_4.

Negative Feedback

A network of R_{11}, R_{14}, R_{13}, R_{15}, and a 0.01-μf capacitor provide variable feedback for one leg of the push-pull amplifier and for the other, R_{12}, $R_{16,\ 17\ or\ 18}$ and their capacitor. This control is available on the front panel and assists in elimination of residual hum voltages with some loss of amplification.

Up to and including the third stage, V_5 and V_6, the heater voltages are reduced one half by connecting the two tubes of each stage in series. A considerably lower temperature and activity level of the cathode is obtained, thereby materially reducing noise and hum in the tubes. The a-c field set up by the heater wires is so reduced that it can practically be disregarded provided that certain other precautions are observed.

Even though the 1620 tubes in the first stage are noted for low noise and hum and freedom from microphonism, they still must be selected for low noise and equal transconductance. All tubes must be selected in pairs.

The plate load for the third stage

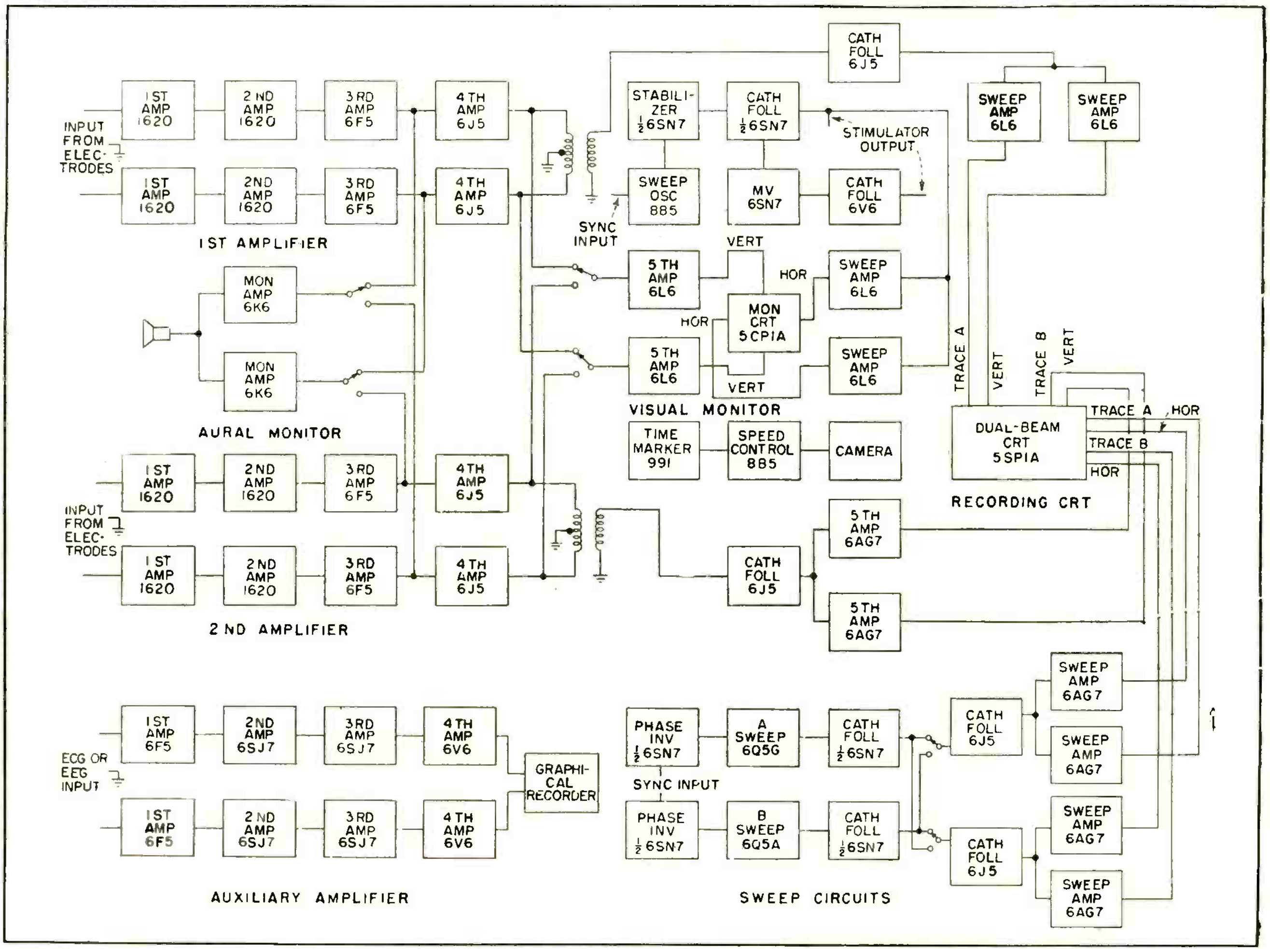


FIG. 1—Functional block diagram of complete equipment shows major units: amplifier channels, auxiliary amplifier and monitors

comprises R_{19}, R_{20} and R_{21}, the balancing potentiometer. Here connections are made to the aural monitor selector switch on the front panel. This switch selects the signals from either one of the amplifiers or any other source. Potentiometer R_{22} is the gain control for the aural monitor, which consists of two 6K6's in push-pull and a sensitive loudspeaker.

Tubes V_7 and V_8 in the fourth stage of amplification feed an output transformer which combines the push-pull signals to give an unbalanced output for connection to the dual-channel oscilloscope used for recording. Tuning of the transformer windings provides extended frequency range. Tuning is accomplished by inductance in the transformer and stray, tube and shielded cable capacitances.

The outputs of the amplifiers are fed to the dual-channel recording oscilloscope. Recording is accomplished by attaching a moving camera to the oscilloscope and by letting the oscilloscope run without sweep. A sharp point is obtained on the screen for each channel on the same ordinate. A time signal is applied by means of a neon light that

TWELVE TECHNIQUES FOR DESIGNING ULTRASENSITIVE AUDIO AMPLIFIERS

Stringent performance requirements placed upon electronic amplifiers for neurophysiological research necessitate use of special fabrication and design techniques to reduce noise, hum and microphonism:

- *Mica capacitors* with high voltage ratings are used in the critical first stage of amplification.
- *Noninductive* wire-wound resistors also are used in the first stage. High-quality carbon composition units are used in subsequent stages.
- *Glazed ceramic* tube sockets and supports are employed for best insulation and lowest noise factor.
- *Unbypassed* screen and cathode resistors in push-pull amplifier stages degenerate spurious pickup while amplifying desired signals.
- *Negative feedback* through R-C network from plates of second stage to grids of first eliminates residual hum voltages.
- *Filaments* of push-pull amplifier stages are connected in series to reduce hum and noise in tubes.
- *Amplifier tubes,* type 1620, are hand-picked in pairs for low noise, hum and microphonism.
- *Tube envelopes* are washed in alcohol for degreasing and subsequently handled with cloth gloves.
- *External light* is excluded from tube compartments to avoid noise pickup or spurious modulation.
- *Solder joints* are made without flux to prevent leakage or noisy carbonized spots at connections.
- *Heater leads* are encased in steel tubing to afford both electrostatic and magnetic shielding.
- *Chasses* are fabricated from heavy-duty aluminum and each amplifier is housed in its own steel cabinet

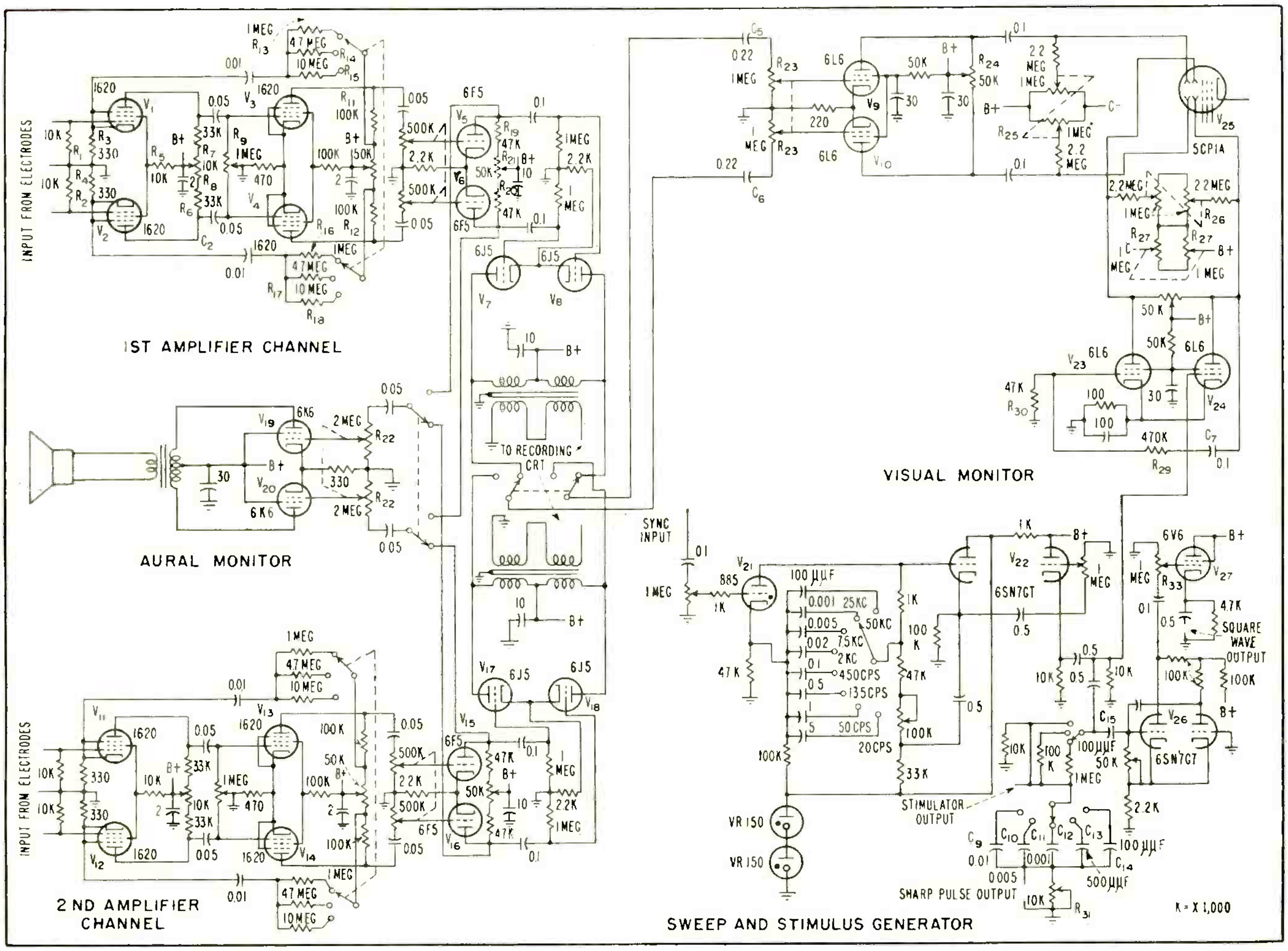


FIG. 2—Schematic diagram of dual amplifiers, aural monitor and visual monitor with stimulus and sweep generator

when excited projects a spot on the film. When the gain controls are opened and the camera started, records are obtained such as those shown. Visual monitoring is accomplished by a separate oscilloscope. Signals are obtained from the amplifiers at the plates of V_7 and V_8 for one channel and from V_{17} and V_{18} for the other. These signals are brought through selector switch, coupling capacitors C_5 and C_6 and gain control R_{23} to the control grids of two 6L6's in push-pull. Resistor R_{24} is the common plate load, semivariable for adjusting plate currents. Display tube is a 5CP1A; R_{25} and R_{26} are the vertical and horizontal positioning controls. Potentiometer R_{27} provides astigmatism control.

The horizontal circuit for the oscilloscope is also in part the nerve stimulator used in the experiments. It consists of a thyratron V_{21} used as a sweep oscillator with means for synchronization. An eight-position switch controls the frequency from 2 cps to 2 kc. The sweep circuit must be linearized particularly in the low-frequency ranges and V_{22} performs this function. The tube is a double triode and functions as a cathode follower for the sweep voltages. The sweep oscillator plate voltage is stabilized by two VR-150's. Tubes V_{23} and V_{24} are the sweep amplifiers. The exciting voltage is applied to the control grid to V_{24} and the voltage developed at the plate of this tube is reduced by voltage divider C_7, R_{29} and R_{30} and applied to the control grid of V_{23} to obtain phase inversion.

Nerve Stimulation

From the sweep cathode follower the signal is coupled to an attenuator from which voltage is obtained for stimulating nerves. This voltage is differentiated by capacitors C_9 and C_{14} inclusive and variable resistor R_{31} so that sharp pulses may also be obtained. Capacitor C_{15} comprises a differentiating circuit together with the grid resistor. The pulse provided by this combination is applied to multivibrator V_{26}. This produces a square wave of varying duration at the exciting frequency. When the exciting pulse is of a repetition rate that exceeds the duration of the rectangular wave produced by the multivibrator, the oscillator will lock in at ½ or ⅓ the frequency or any integral multiple and become a counter that will stay in synchronism with the applied signal. Cathode follower V_{27} isolates the multivibrator from the output. Potentiometer R_{33} controls the size of the output wave.

Sometimes it is advantageous to brighten only a certain part of the response to a certain stimulus. This can be accomplished by lowering the total brightness of the picture until it is barely visible and then applying the square-wave output to the grid of the picture tube. This wave will be in synchronism with the

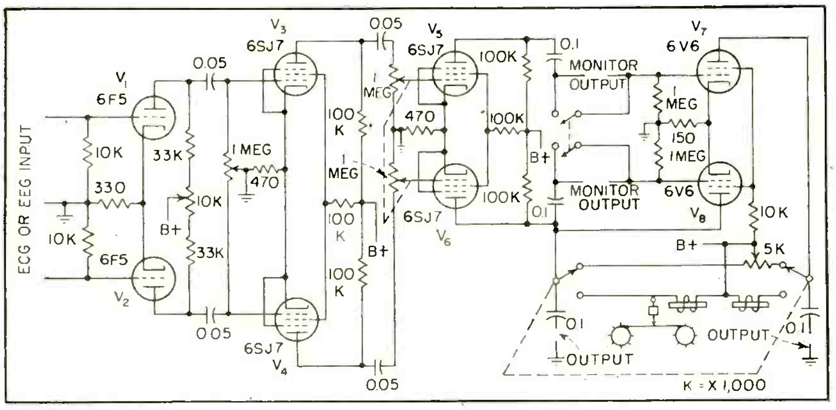


FIG. 3—Auxiliary amplifier is used to handle electrocardiograph or electroencephalograph signals

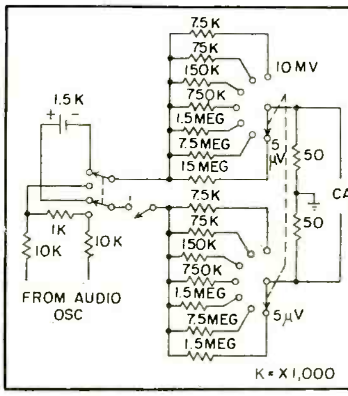


FIG. 4—Calibration circuit

stimulus and the sweep. Several parts in the trace can be illuminated when the multivibrator is run at a higher frequency than the stimulus.

The leads for the electrodes are flexible shielded cable terminating in coaxial connectors to be connected to the amplifier input. The electrodes consist of a short piece of lead shielding covering two insulated wires that terminate in tantalum or platinum hooks over which the nerve is placed. The separation between hooks is varied to meet different conditions. The lead conduit imparts ductibility to the end of the electrodes so they retain their shape once bent as required. This is an important feature, since nerves cannot be cut or strained during an experiment. Connection should leave them completely undisturbed to prevent mechanical stimulus. The nerves and electrodes must operate under a continuous bath of serum to prevent the nerves driving out and causing a major disturbance to the organism under study.

An auxiliary amplifier of the same general characteristics as the main amplifiers but not of such high sensitivity and good frequency response, utilizing carefully picked commercial tubes, serves for recording an electrocardiogram on smoked paper. On the same paper is recorded respiration, arterial pressure, time signals and electromagnetic signals that point out when a certain stimulus or condition was changed or applied and restored. Thus a complete record of the experiment is obtained. The schematic diagram of the auxiliary amplifier is shown in Fig. 3. The output of the third stage of amplification is broken by connectors so that the signal may be applied to either the visual or aural monitors or the output of the nerve-signal amplifier fed to the recording amplifier composed of V_7 and V_8. Thus this signal may also appear on the smoked paper.

A calibrator shown in Fig. 4, is built as a separate unit so that any of the amplifiers may be calibrated and checked periodically at the following voltages: 10μv, 50μv, 100 μv, 500 μv, 1 mv and 10 mv. Operation of the calibrator is by a snap-action switch in series with the battery or a-c voltage from an audio oscillator. The output of the calibrator is available at low impedance and applied directly to the grids of the amplifier being calibrated.

The author thanks R. Alvarez-Buylla, chief investigator of the Dept. of Electrophysiology of the Instituto Politecnico Nacional in Mexico City, for his cooperation in numerous experiments and valuable suggestions.

STUDYING NERVE-CURRENT CONDUCTION

The human nervous system is a vast and intricate communications network. The brain is the control center and the nerves the cables that carry the signals. Incoming signals describe the functional conditions of the various body organs (kinesthesis) as well as external conditions determined by the sense organs. The brain then dispatches through the nerves electrical commands that cause the body organs to react to these conditions.

Nerve-current conduction is an ionization phenomena. It transmits signals at about the speed of 10 meters a second. One theory about how this ionization takes place states that nerve fiber is composed of calcium ions on one side of an insulating membrane and potassium ions on the other. A heavier insulating membrane surrounds the nerve. An unbalanced potential between the metals makes the intervening membrane partially conductive and this unbalanced condition is transmitted along the nerve as a voltage pulse.

The study of nerve-current conduction involves recording both the signal going to the brain and the response returning from it. Since nerve potentials are in the order of microvolts, electronic amplification must be employed. The amplifier must have exeremely high fidelity since nerve pulses occur at repetition rates of a few cycles while the pulses themselves contain frequency components of several kilocycles.

In addition this amplifier for neurophysiological research must be largely free from noise, hum and instability. Each amplifcation channel must be shielded from extraneous pickup either from adjacent amplifier channels or from the nerve stimulator used in the study

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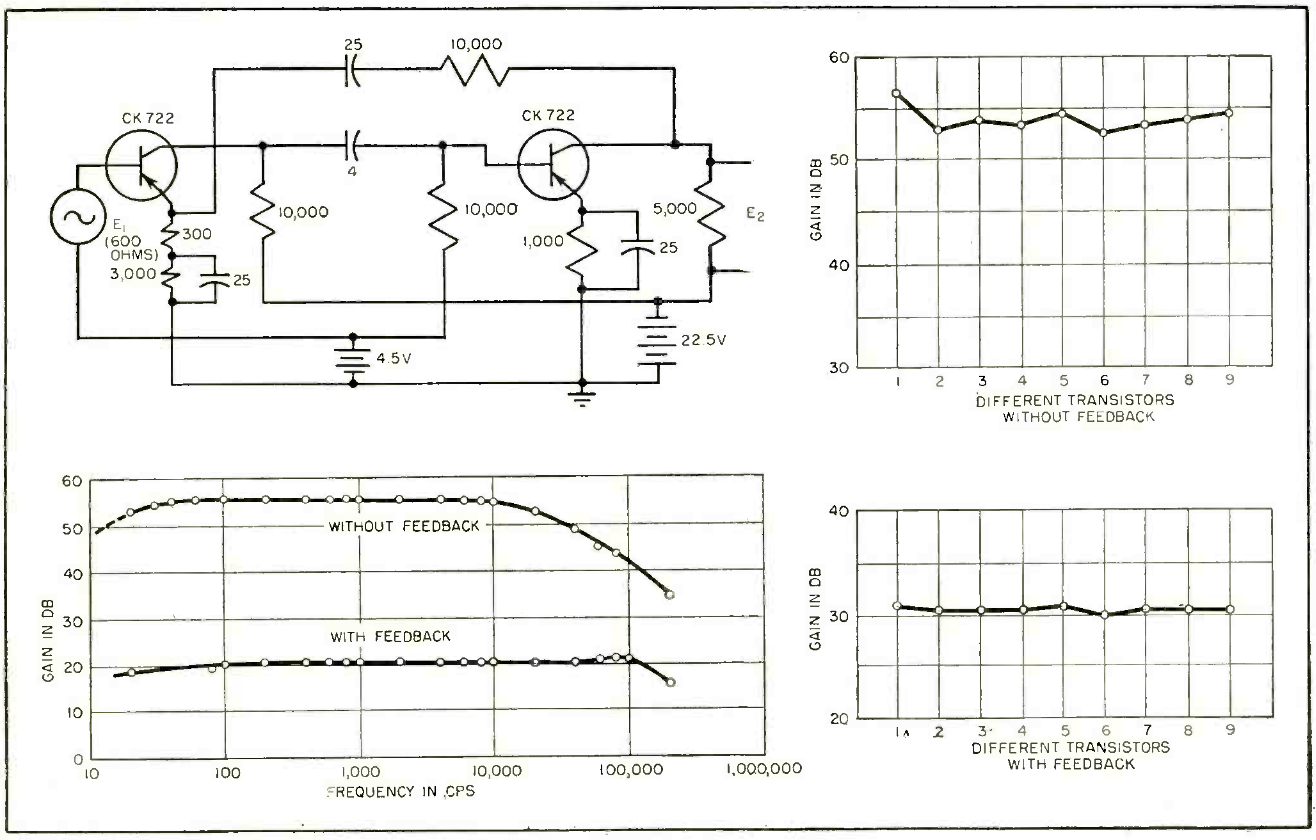

FIG. 1—Circuit and operating characteristics of grounded-emitter to grounded-emitter circuit

Practical Two-Stage Transistor Amplifiers

Effects of feedback and choice of cascading arrangement are discussed. Curves show capabilities of various configurations in experimental circuits using commercially available junction transistors. Transistor interchangeability is also considered

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TWO-STAGE resistance-coupled transistor amplifiers are finding increased application in the fields of communications and industrial electronics. Although requirements for various applications differ, it is generally desirable to choose a design that will provide maximum gain with impedance characteristics that permit use of simple coupling circuits.

Theoretical analyses show that of the nine configurations possible, using two transistor stages, four may be eliminated because of low gain when R-C coupling is used between stages. Two of the remaining configurations have limited usefulness because of low output impedance.

The remaining three configurations (grounded-emitter to grounded-emitter, grounded-base to grounded-emitter, and grounded-collector to grounded-emitter) have been tested experimentally with a variety of commercially-available transistors, with and without negative feedback. The results of these tests are presented in the accompanying curves to provide designers with comparative data for choosing an optimum circuit for a given amplifying job.

GE to GE

The grounded-emitter to grounded-emitter configuration has the greatest gain potential, as shown in Table I. This circuit is seen to have medium input and output im-

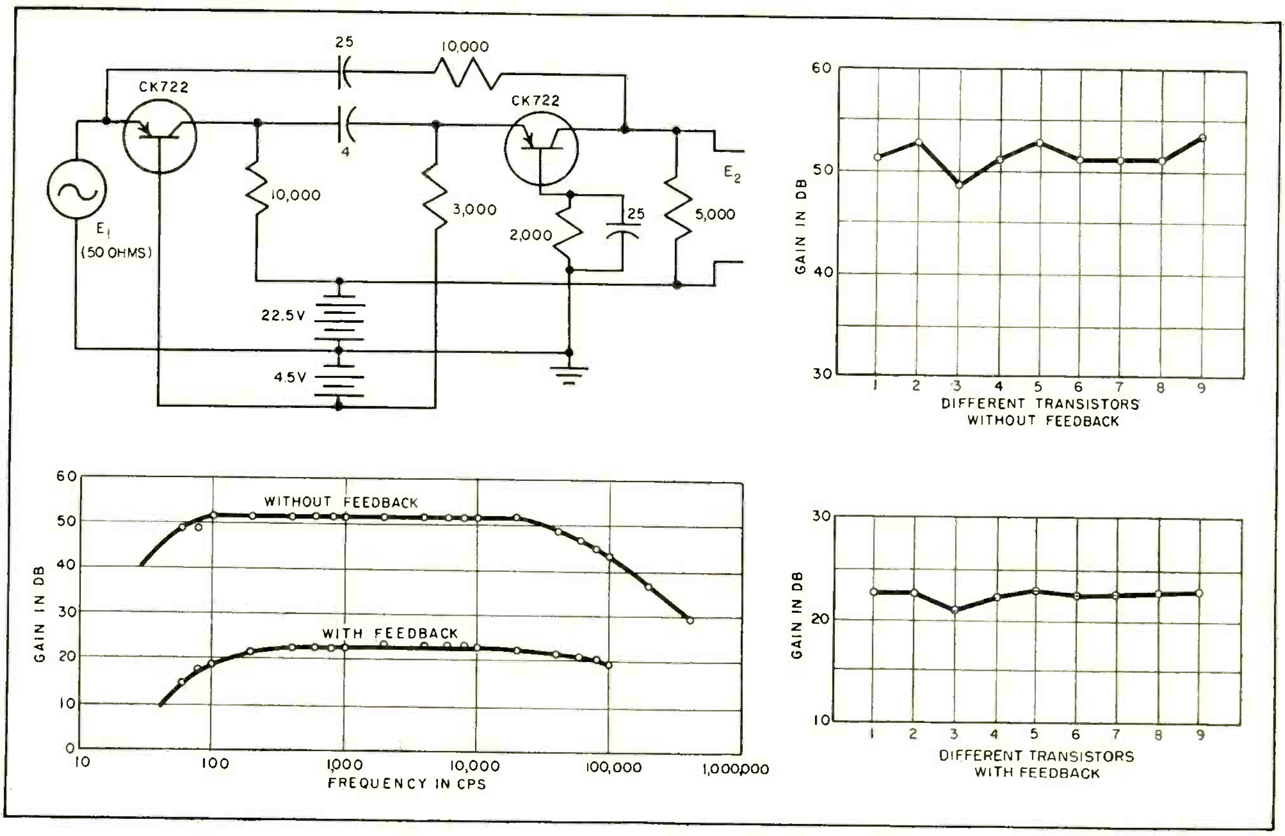

FIG. 2—Circuit and operating characteristics of grounded-base to grounded-emitter circuit

Table I—Theoretical Data for Two-Stage Transistor Amplifiers

Circuit	Gain	Relative Input Impedance	Relative Output Impedance	Gain in db
GE to GE	$\frac{R_L}{R_i}\left(\frac{\alpha}{1-\alpha}\right)^4$	med	med	67 db
GE to GC	$\frac{R_L}{R_i}\frac{\alpha^2}{(1-\alpha)^4}$	med	low	51 db
GE to GB	$\frac{R_L}{R_i}\frac{\alpha^4}{(1-\alpha)^2}$	med	high	35 db
GC to GC	$\frac{R_L}{R_i}\left(\frac{1}{1-\alpha}\right)^4$	high	low	25 db
GC to GE	$\frac{R_L}{R_i}\frac{\alpha^2}{(1-\alpha)^4}$	high	med	50 db
GC to GB	$\frac{R_L}{R_i}\left(\frac{\alpha}{1-\alpha}\right)^2$	high	high	30 db
GB to GB	$\frac{R_L}{R_i}\alpha^2$	low	high	25 db
GB to GE	$\frac{R_L}{R_i}\frac{\alpha^4}{(1-\alpha)^2}$	low	med	52 db
CB to GC	$\frac{R_L}{R_i}\left(\frac{\alpha}{1-\alpha}\right)^2$	low	low	52 db

pedances, relative to the other configurations, and should provide a gain of 67 db for high-α transistors.

The grounded-emitter stage gives a phase shift of 180 deg from input to output, resulting in the input and output being in phase in a two-stage cascade amplifier. This results in relatively complicated degenerative feedback connections.

The experimental circuit used to check the GE-to-GE combination is shown in Fig. 1, along with curves showing frequency response with and without feedback and curves showing effect of using different transistors. In this circuit, input impedance was matched and the output impedance mismatched to obtain high gain-bandwidth product.

Shunt to series degenerative feedback was used. This required an unbypassed resistor in the emitter lead of the first stage. This resistor resulted in local feedback in the first stage, reducing the overall effect of the feedback.

The power gain in db was obtained by using the expression

$$\text{gain in db} = 10 \log \frac{E_2^2/R_L}{E_i/R_i}$$

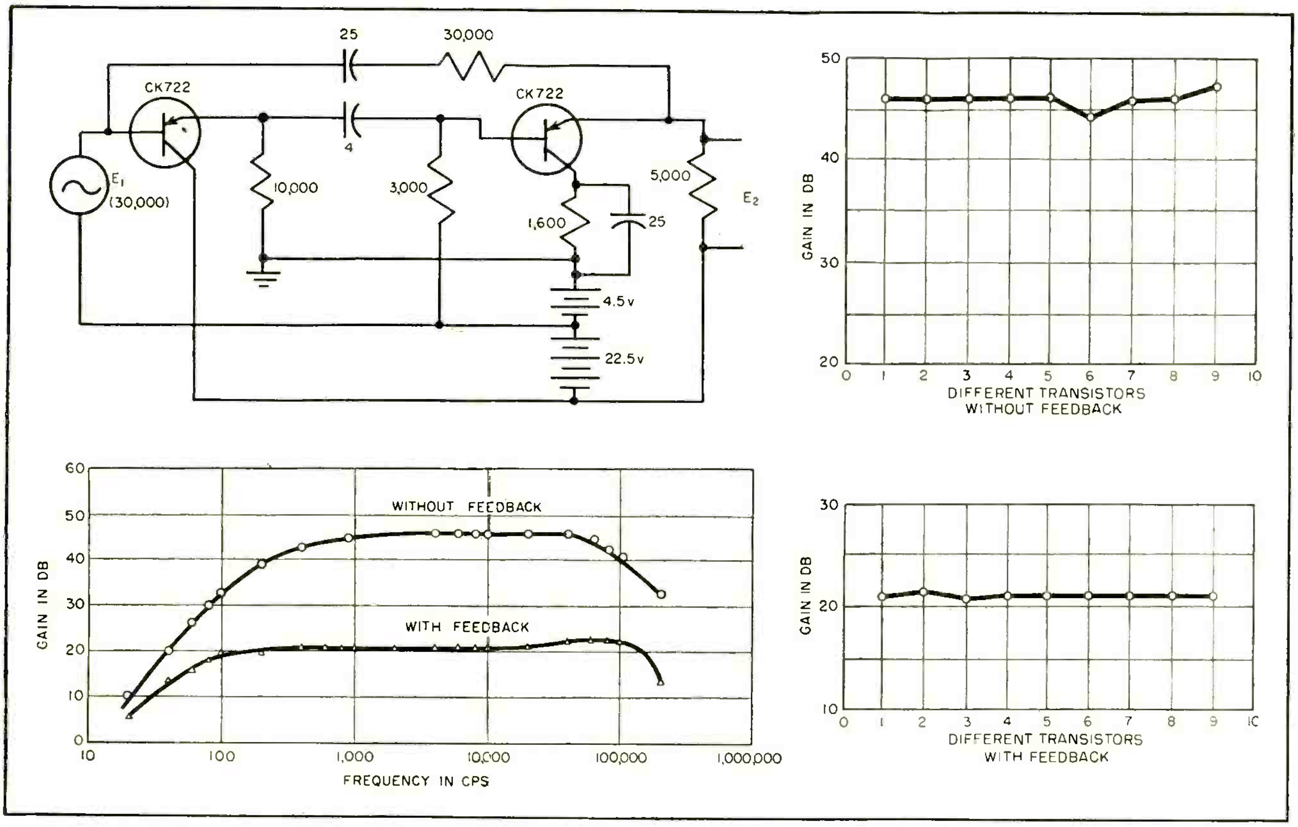

FIG. 3—Circuit and operating characteristics of grounded-collector to grounded-emitter circuit

where E_2 is the output voltage, E_1 the input voltage, R_L the load impedance and R_i the input impedance.

Feedback resulted in a flat frequency response curve over three decades from 100 to 100,000 cycles and reduced the variation with change in transistors from 3 db to 1 db.

GB to GE

The circuit used for the grounded-base to grounded-emitter connection is shown in Fig. 2. In this circuit the input and output voltages are out of phase by 180 deg and therefore the feedback can be shunt-to-shunt feedback. This eliminates the local feedback in the first stage that was present in the GE-to-GE circuit. This should have resulted in greater stability for the gain with feedback when transistors were changed. This was not the case and can be attributed to the impedance levels present at the input and output. A change in the output impedance resulting from a change in transistors in the second stage results in a greater change in the feedback loop here over that of the GE-to-GE circuit.

The gain from this circuit is not as high as in the case of the GE-to-GE circuit and the frequency response is not as good.

GC to GE

The final circuit tested was the grounded-collector to grounded-emitter combination. The circuit and curves for this configuration are shown in Fig. 3. In this circuit, as in the GB-to-GE circuit the input and output voltages are 180 deg out of phase and shunt-to-shunt degenerative feedback may be used. This circuit, like the others, was designed to give a large gain-bandwidth product. As a result the maximum gain was slightly lower than that predicted in Table I. The frequency response is similar to that of the GE-to-GE circuit and better than that of the GB-to-GE circuit.

Variation of gain with changes in transistors was very good for this circuit. Without feedback it was 2 db and with feedback it was 0.2 db. The better performance of this circuit is produced by high input impedance and 180-deg phase shift which permits feedback effective over the entire circuit.

The equations given in Table I are approximate gain equations for the nine possible two-stage cascade amplifiers. These equations neglect interstage losses. In these equations R_L is the load resistance of the last stage and R_i is the input resistance to the first stage.

The impedance levels indicated in Table I are relative. The input impedance to a grounded-base stage is low in comparison to a grounded-emitter stage, and the input impedance of a grounded-collector stage is high in comparison to a grounded-emitter stage.

Some of the equations shown in Table I are similar, such as those for the GE to GB and GB to GE but the differences in R_i and R_L result in the gains being different.

The GE-to-GE circuit gives the greatest overall gain without feedback but has less uniformity with change in transistors. The GC-to-GE circuit is most uniform in the latter respect, but it offers less overall gain without feedback.

The author wishes to thank R. G. Santilli and G. E. Romaine for their help in obtaining data presented in this article.

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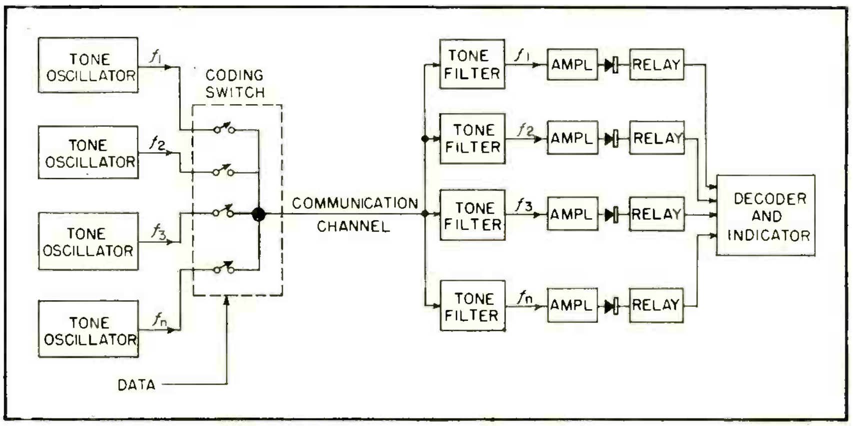

FIG. 1—Functional diagram of basic frequency-code telemetering system

Frequency-Code

Analog data is conveyed numerically by simultaneous transmission of audio tone pulses whose on and off states correspond to binary digits. Synchronization of transmitter and receiver is unnecessary; channel interruptions produce no cumulative errors

FREQUENCY-CODE telemetering, using the equipment to be described, conveys analog information, such as shaft-rotation data, in digital form over either telephone lines or radio links with minimum vulnerability to noise and other common sources of error. The data are readily reconverted into easily interpretable form at the output.

Operation

The basic principles of the system are illustrated in Fig. 1. Shaft settings are converted into digital signals by a special multisection coding switch that selects oscillator tones corresponding to digits of the binary number giving degrees of shaft rotation. Complete binary numbers, each represented by a tone group, are transmitted successively in direct response to changes in input data.

At the receiver, the composite tone is analyzed by a group of band-pass filters each followed by an amplifier, detector and sensitive relay. The relays are connected in decoding circuits that convert the binary numbers into decimal data for display either on an indicator dial or lamp register.

Seven-Digit System

A simplified schematic of a complete seven-digit frequency-code telemetering system is shown in Fig. 2. Seven tones, representing the seven digits of a binary number, are generated by a group of Wien-bridge oscillators each employing a 12AU7 dual triode. The oscillators are tuned to different frequencies within the range 500 to 1,700 cps. The output voltage from each oscillator is fed to a wiper on a seven-track printed-circuit coding switch, which is attached to a rotatable shaft. The shaft can be turned and set to any desired angular position by a control knob. The knob is fitted with a pointer that sweeps a 360-degree graduated scale. The rotatable coding switch and the oscillator assembly are shown in Fig. 3. The electrical contact pattern on the coding switch conforms to the minimum-error code (or Gray code) given in Table I.

In the seven-digit system, a maximum of 2^7 or 128 binary numbers can be coded and transmitted, making it possible to divide the circular scale into 128 equal parts. Only 120 binary numbers are used, each representing a three-degree sector of the dial.

Coding Process

Each track of the coding switch consists of alternate conducting and nonconducting segments, corresponding to the 1 and 0 values of each digit in the binary number to be coded. Two additional tracks, each consisting of an unbroken conductive ring, are connected electrically to all the conducting segments on the seven tracks. The wipers that contact the eighth and ninth tracks serve as the common output terminal of the coding switch. Thus, for any of the 120 three-degree set-

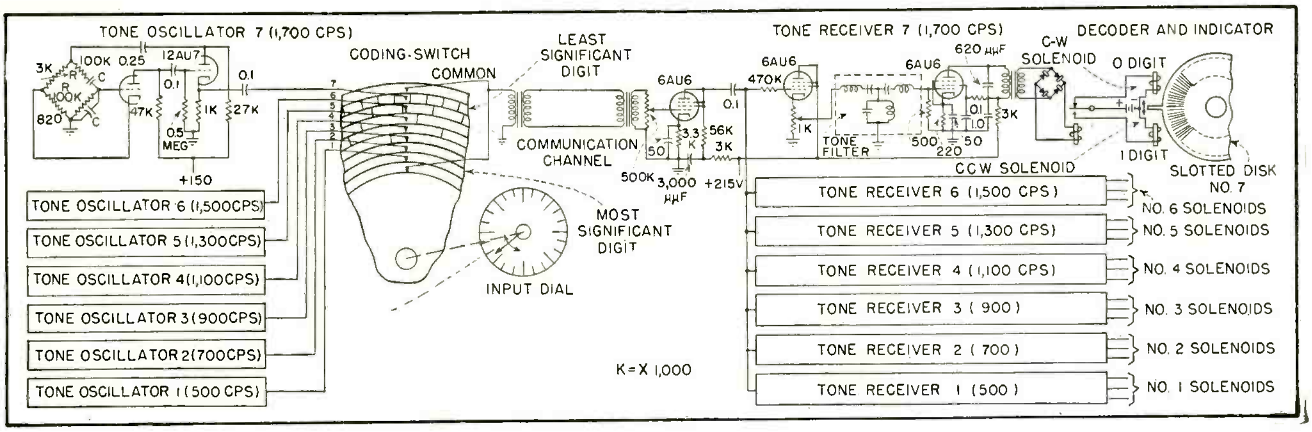

FIG. 2—Circuit of frequency-code telemetering system sending 2-unit binary code

Telemetering System

tings of the coding switch shaft, a distinct combination of tones appears as a complex a-c voltage at the output terminals of the switch. This composite signal is applied through a transformer to a telephone line at a level of 0.27 volt rms per tone.

The oscillators are of plug-in construction and are assembled on a common chassis with an unregulated power supply. Space is provided for up to ten oscillators. Temperature compensation of the oscillator frequency-determining circuits holds frequency drift to less than ±4 cps within the temperature range —20 to +80 C. Supply-voltage variations of —10 to +15 percent produce less than ±1-cps frequency shift.

Tone Receivers

The tone receiver assembly is shown in Fig. 4. Ten complete tone-receiving channels are provided, although only seven are used. The composite tone signal is passed through a single triode-connected 6AU6 preamplifier and then applied through isolation resistors to the input circuits of the individual tone channels.

Each channel consists of a 6AU6 triode-connected cathode follower, 600-ohm constant-K tone filter designed to pass only one of the tone signals, 6AU6 pentode amplifier, bridge rectifier and sensitive relay. Each filter has a 3-db bandwidth of 60 cps and adjacent-channel attenuation of 30 to 35 db.

Use of temperature-compensating capacitors in the filter tuned circuits prevents the 3-db points from drifting more than ±8 cps within the temperature range —20 to +80 C. The sensitive relays have 1,000-ohm coils and are adjusted to

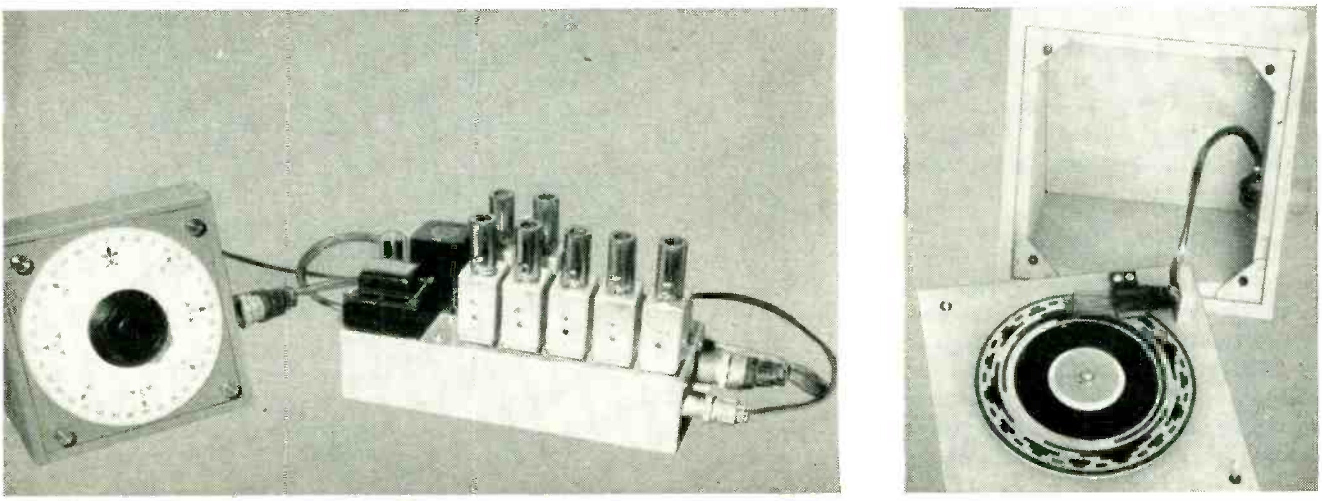

FIG. 3—Shaft-position coding switch and tone oscillator assembly. Open view of switch (right) shows binary-coding commutator rings

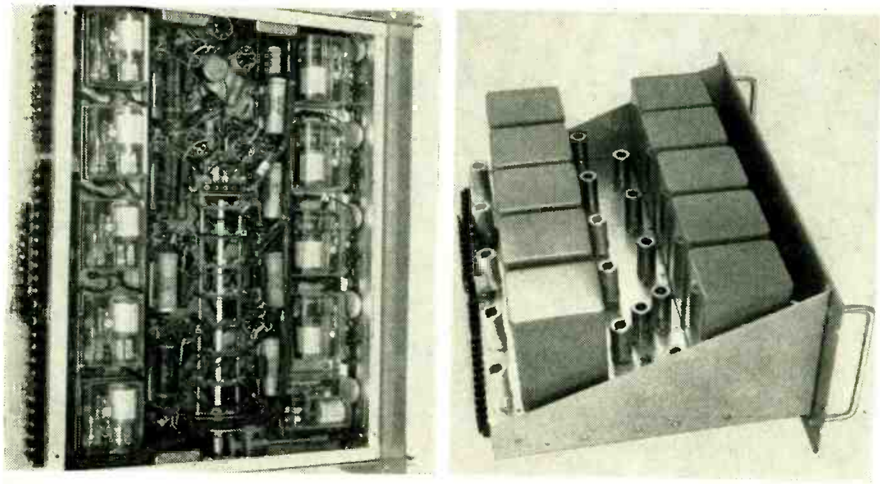

FIG. 4—Top and bottom views of tone-receiver chassis

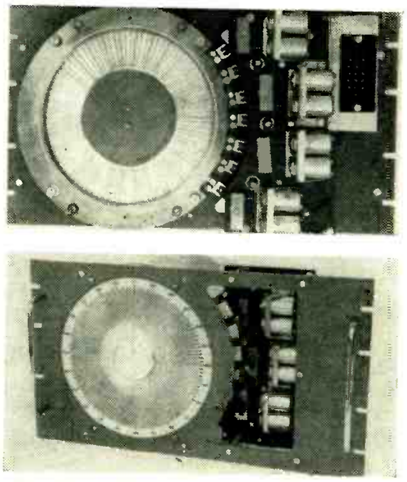

FIG. 5—Dial-type decoder and indicator

operate when the rectified tone current reaches 2.6 ma.

Decoder and Indicator

The spdt contacts on each sensitive relay are connected to a pair of solenoids located in the decoder and indicator assembly shown in Fig. 5. The assembly contains seven pairs of solenoids, each corresponding to one digit of the incoming binary number.

The plungers in each pair of solenoids are connected mechanically to a projecting tab on one of seven circular code plates mounted on a common fixed center. Each code plate contains 120 radial slots spaced to conform with the 0 and 1 pattern of one digit of the minimum-error code. Each code plate is moved independently by its pair of solenoids between two stops that limit rotational motion to $1\frac{1}{2}$ degrees.

When a tone is present at the input of any channel, the corresponding relay is energized causing voltage to be applied to the 1 solenoid in the decoder assembly. In the absence of a tone, the relay is applied to the opposite, or 0, solenoid of the pair.

Dial Indication

A 1 signal causes the code plate to be held against its counterclockwise stop and a 0 signal causes it to be held against its clockwise stop. For any combination of code-plate settings, one continuous passage is opened through all the plates by mutual alignment of one group of radial slots. A 150-watt lamp mounted in back of the assembly projects light through the open slit onto a graduated scale affixed to the front panel of the indicator.

The illuminated slot sweeps the scale in unison with the rotation of the transmitter coding-switch and the angular setting of the shaft is registered continuously by the light-slot indicator to an accuracy within $\pm 1\frac{1}{2}$ degrees. The indicator responds accurately to shaft-rotation rates in excess of 10 rpm.

Lamp Matrix

An alternate decoder and indicator, capable of direct conversion and display, is the numbered-lamp register. This unit is much simpler in construction than the slotted-plate decoder and is preferred where a circular display is not required. The circuit of a seven-digit 120-number lamp matrix is shown in Fig. 6. Relays RE_1 through RE_7 actuated by the sensitive relays in the tone-receiver assembly are divided into two groups, each of which is arranged in a transfer-tree circuit.

Relay Operation

Eight horizontal conductors, *A* through *H*, of a rectangular matrix are connected to the eight contacts of the third relay in the first group RE_3 and sixteen vertical conductors, 1 through 16, are connected to the sixteen contacts of the fourth relay in the second group RE_7. The matrix has 8 × 16 or 128 crossovers, corresponding to the 128 numbers in the seven-digit minimum error code. At each crossover point a

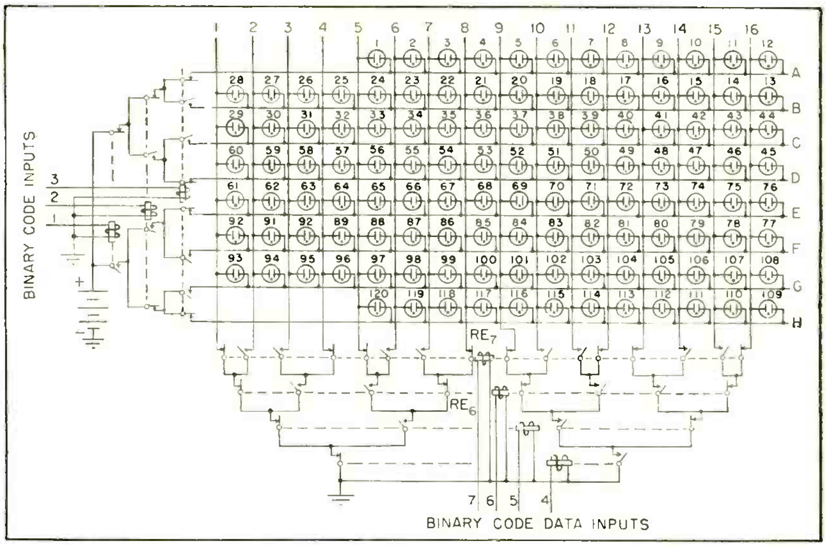

FIG. 6—Circuit of lamp matrix. Relay numbers correspond to binary inputs

neon indicator lamp is bridged between a horizontal conductor and a vertical conductor.

By numbering the lamps in a zigzag manner and with the relay contacts wired as shown, the 120 numbered lamps match the sequence of the minimum-error binary code. For example when the binary number 0000110 is received, one terminal of the source voltage is connected through RE_1, RE_2 and RE_3 to horizontal conductor A, and the opposite voltage terminal is connected through RE_4, RE_5, RE_6 and RE_7 to vertical conductor 5 causing lamp No. 1 to light.

Multichannel Operation

Data sampling and distribution techniques permit multichannel operation with the frequency-code telemetering system. A block diagram illustrating the method of providing multichannel operation is shown in Fig. 7. A multipole commutator or stepping switch having one pole for each binary digit is inserted between the tone oscillators and the several angular-position coding switches.

The commutator applies the output voltage from the group of tone oscillators sequentially to the four individual data channel coding switches. The system illustrated is a four-channel, seven-digit system.

The seven oscillator output voltages are applied first to Coding Switch No. 1, then to Coding Switch 2 and so on repeating the cycle continuously. To allow the discrete data samples to be identified and separated at the receiving station, a second group of tone oscillators is used to produce a designation code that is transmitted by another section of the commutator in synchronism with each quantity code. Since the designation code is also a binary code, the number of additional oscillators required for a multichannel system is 2^n where n is the number of different input sources to be telemetered. Two oscillators generate designation codes for the four data channels of Fig. 7.

Table I—Minimum-Error Binary Code*

Decimal Number	Binary numbers: Natural binary code	Binary numbers: Minimum error code
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

* Binary numbers are so arranged that adjacent numbers differ by only digit to avoid large errors due to coding ambiguities

The output signals from both groups of tone oscillators consist of a series of pulses, each pulse comprised of a combination of tones representing both the coding-switch position and the identification of the switch. This system may be classified as a pulse-frequency-code modulation or PFCM system. With the equipment described, the maximum sampling rate is about twelve binary numbers per second, making it possible to sample the output data of each of four coding switches at the rate of three readings per second from each switch.

Number Storage

When binary numbers representing different measurements are transmitted sequentially over a common system, it is usually necessary to prevent interruptions or discontinuities in the displayed output information. In this system, interruptions in the output information due to the data-sampling and distributing processes are prevented by a number-storage circuit inserted between the output-data distributor and each of the indicators.

Circuit Operation

Each indicator responds only to the binary data appearing in its respective number-storage circuit. In the absence of incoming data, each number-storage circuit holds the last binary number received, causing the indicator to remain locked at the desired position. Upon

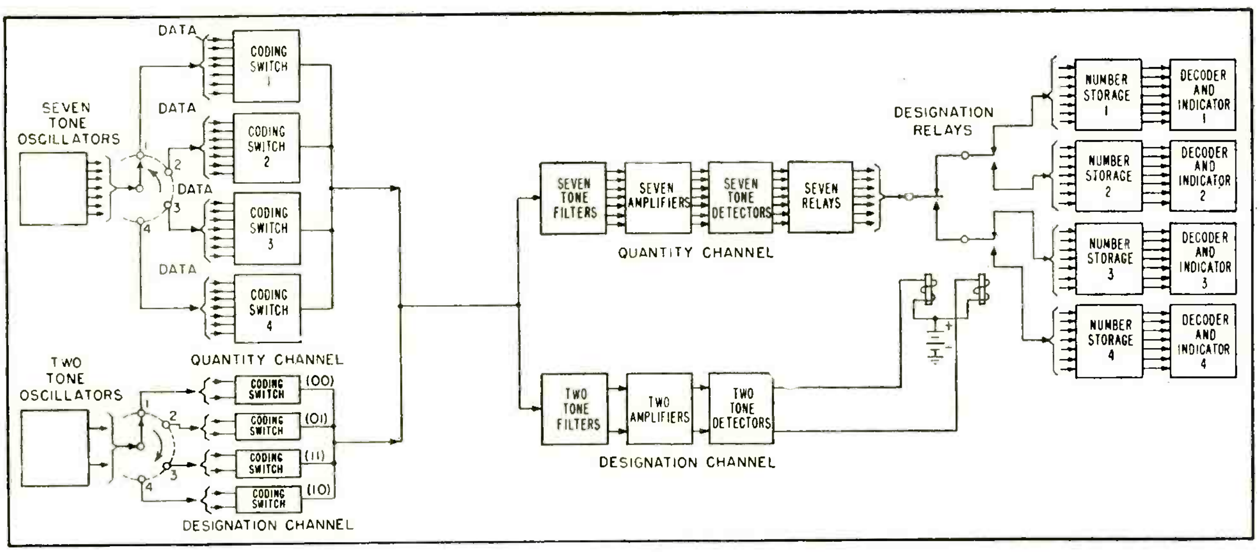

FIG. 7—Pulse-frequency-code modulation system showing four data channels

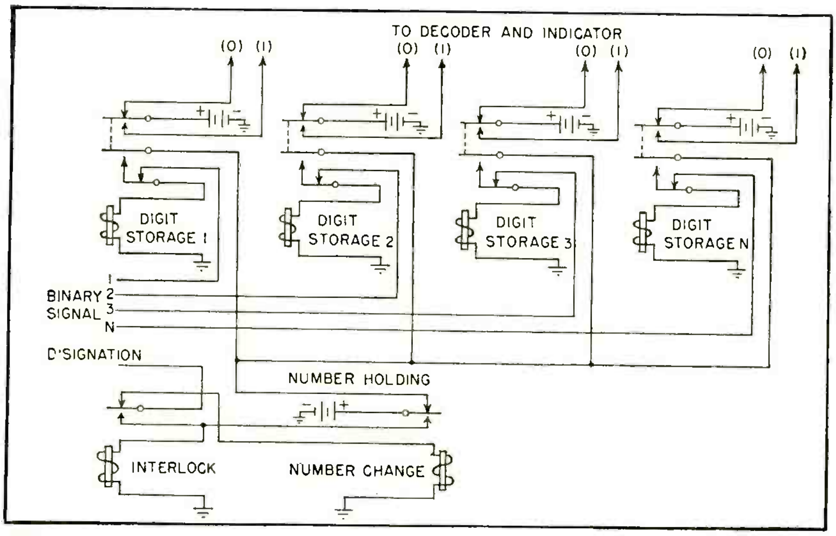

FIG. 8—Number-storage circuit for multichannel system

receipt of the predetermined function-designation code the last number held in the number-storage circuit is cancelled and the new incoming number assimilated and stored. The indicator then registers the new number.

Operating Threshold

Each number storage circuit consists of a set of slow-operate relays, one for each binary digit in the quantity code plus a number-change relay and an interlock relay. The number-change relay is actuated momentarily when the designation code corresponding to its particular information channel is received. A typical number storage circuit is shown in Fig. 8.

Data-sampling is performed either automatically as with a continuous-running commutator, or upon demand.

With the latter method, a manually operated switch is added to each shaft-position coder to permit changing any one of the coding-switch settings and its corresponding remote indication without disturbing any of the other readings.

Performance

The only source of fixed error in the frequency-code telemetering system occurs in the conversion of angular shaft settings into binary electrical signals. Neglecting an occasional random error when transmitting in the presence of noise, transmission, decoding and display produce no errors. Resolution of one part in 256 (about 0.4 percent or 1.4 degrees) is readily obtained in an eight-digit frequency-code system using a coding switch five inches in diameter.

In a switch assembly of this diameter, slight mechanical imperfections may introduce errors as large as ±0.2 degree. Hence the overall accuracy of an eight-digit system is such that the output indication will match the input shaft setting within ±1 degree. The ultimate or potential accuracy has not been determined. However, if no limitations are imposed on the permissible diameter of the coding switch, accuracies of ±0.4 degree (nine digits) and ±0.2 degree (ten digits) appear practicable.

The ability of the system to function accurately in the presence of noise depends to a large extent upon the operating threshold adjustment and the differential adjustment of the sensitive relays in the tone-receiver output circuits. There is sufficient gain to adjust the relays to an operating current threshold (2.6 ma) at least twice as great as the maximum noise current (1.3 ma) due to internal-system noise from all sources. Also there is sufficient gain to insure that the rectified tone signal applied to each relay is at least three times as great (7.8 ma) as the 2.6-ma threshold operating current, with nominal tone-receiver input voltage.

Average internal-system noise due to all causes is approximately 20 db below the operating threshold of the sensitive relays. The greatest amount of internal noise is contributed by crosstalk, with noise due to intermodulation, oscillator harmonics, filter ringing and residual circuit noise contributing less in the order named.

Above the error threshold, amplitude variations as great as 30 db in the level of any tone or tone combination produce no change in output data. A signal-to-noise ratio of plus 1.5 db at the input to the tone receiver is adequate for error-free system operation.

Approximately 24 cps of the 60-cps bandwidth of each tone filter is reserved for cumulative frequency drift of the oscillator and filter. The remaining 36 cps is sufficient to accommodate transmission rates up to twelve binary numbers per second with no reduction in accuracy. This rate is equivalent to a shaft speed of three rpm in an eight-digit system, or six rpm in a seven-digit system. In operational use, transmission rates in excess of 20 binary numbers per second (10 rpm in a seven-digit system) have been attained with no discernible error or loss of data.

Service Experience

Over a period of one year, using telephone lines and vhf radio channels, the frequency-code telemetering system has proved dependable and accurate, requiring no repairs or replacement of parts and only occasional minor adjustment.

The frequency-code telemetering system and data-handling components described in this paper were developed under contract with the U. S. Navy Bureau of Ships, Electronics Design and Development Division.

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Gated Marker Generator

Marker train of 1-microsecond pips spaced 10 microseconds apart is initiated and stopped by negative-gate impulse. Spacing of continuous train of pulses is determined by two-way time of delay line connected across quaternary winding of blocking transformer

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IN RADAR and oscillography a need is frequently encountered for means of generating a train of evenly spaced electronic markers whose start and stop can be accurately controlled by an external signal, usually a range gate or a sweep gate. These marks can then be used to facilitate time or distance measurements, check sweep linearity or calibrate sweep speeds.

Double Triode

In the circuit described this effect is accomplished in a simple dual-triode arrangement. Results are comparable in accuracy and quality to other methods using three dual triodes. The gating is effected using the principle of core saturation in the blocking-oscillator transformer. Interpulse spacing is determined by the two-way delay time of the lumped-constant delay line D.

The circuit operates as follows. In the absence of an initiating gate, V_1 is at zero bias and the current flowing through the tube passes also through L_2. This current establishes a saturation flux condition in the core of the blocking-oscillator transformer. The grid of the blocking oscillator tube V_2 being returned to a negative bias insures that it is cut off.

When a negative gate is received at the grid of V_1 current through it is rapidly cut off and collapse of the field in L_2 induces a positive voltage at the grid of V_2 by means of L_3. When current starts to flow in V_2, a regenerative process takes place that produces a sharp voltage pulse across R_K in the cathode of V_2. This is the output point of the circuit.

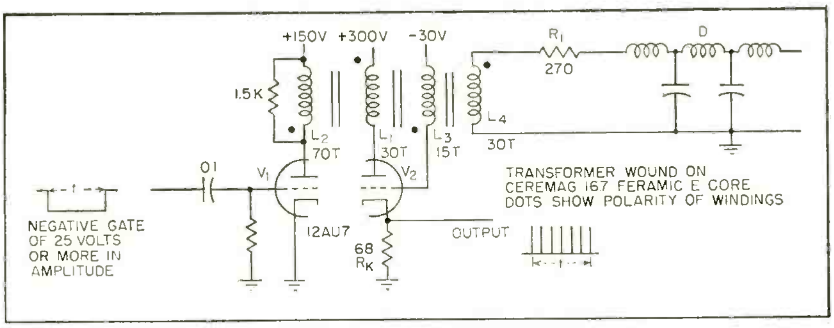
The pulse of current through V_2 produces a similar pulse of voltage across the L_4 winding of the blocking-oscillator transformer. The impedance of the L_4 winding during the block is matched to the characteristic impedance of the delay line by resistor R_1. This positive pulse travels down the delay line and is reflected back in the same polarity by the open-circuit termination of the delay line.

When the pulse arrives back at L_4, the grid of V_2 has returned to a cutoff condition. Polarity of the windings is such that the positive pulse at L_4 induces a positive pulse at the grid of V_2 and the oscillator blocks again. Thus when V_1 is cut off a continuous train of pulses is produced across R_K and their spacing is determined by the two-way delay time of the delay line.

Saturated Core

When the negative gate ends and V_1 conducts again, flux in the blocking-oscillator transformer core reaches a saturation condition. As the next reflected pulse arrives at L_4 it can produce no further change in the flux in the transformer and hence does not trigger V_2. The circuit stays off until the next gate is received.

The delay line is built up of 14 sections with a delay of 0.358 microsecond per section. The pass band of 900 kc is just adequate for the application. Marker pulses appearing across R_K are spaced 10 microseconds apart. The marks are 30 volts in amplitude and one microsecond wide at the base. Delay between the leading edge of the initiating gate and the first mark is less than 0.5 microsecond. The damping resistor across L_2 prevents ringing of the transformer-windings from interfering with operation of the circuit, which would otherwise occur.



Circuit of the blocking-oscillator marker generator includes double triode, four-winding blocking transformer and open delay line

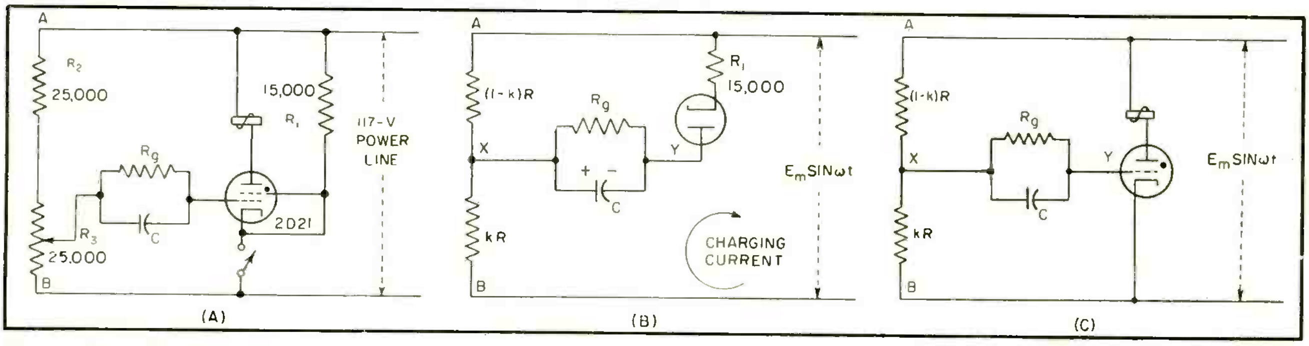
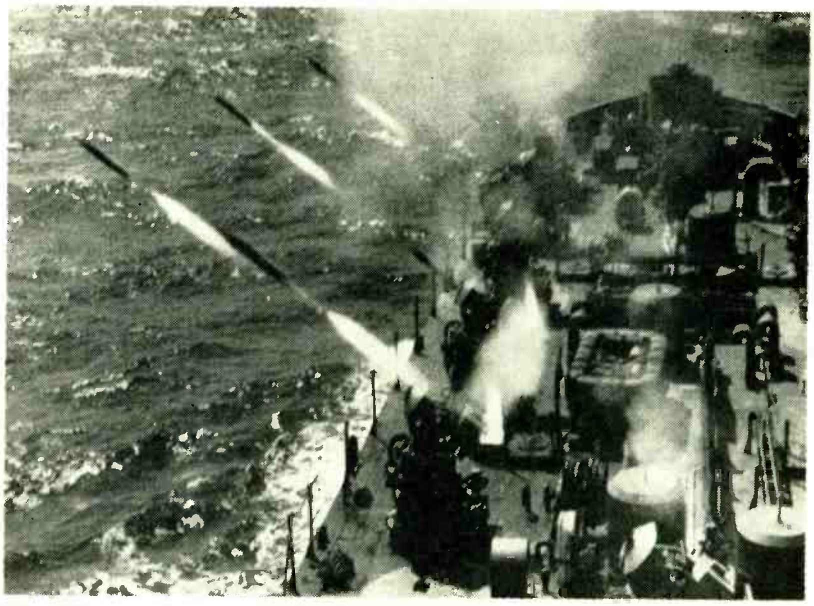


FIG. 1—Basic thyratron time-delay circuit (A), equivalent diode circuit when switch is open (B) and equivalent circuit when switch is closed (C). Timing interval is actuated by closing switch in thyratron cathode circuit.

Simple Time-Delay Relay



Time-delay circuit was originally developed as part of firing circuits of the rocket launchers shown here firing a salvo from a naval vessel

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TIMING circuits utilizing thyratrons are quite common and widely used. Many of them however, require elaborate circuitry and regulated d-c sources.

The circuit to be described operates from an a-c power line and requires no auxiliary d-c supply. Its accuracy compares favorably with more complicated types and it uses no precision components.

The circuit is designed to actuate a relay at a given time interval after the closing of a switch. The schematic is given in Fig. 1A.

While the switch is open, capacitor C is charged by the grid current of the thyratron. Upon closing the switch, the capacitor discharges exponentially. Unlike more conventional applications, however, an a-c waveform is superimposed upon this decaying voltage. The combination of these two voltages determines the instant of firing of the thyratron, allowing more accurate selection of the time of firing as determined by the setting of potentiometer R_3.

Grid Cycles

The switch position determines whether the grid circuit is being charged or discharged.

With the switch open, the cathode of the thyratron is connected through R_1 to one side of the a-c line. The plate of the tube is connected through the relay to the same side of the line. Consequently, there is no possibility of the tube firing.

The grid is connected through R_g and C to an alternating voltage somewhere between the potential difference between points A and B. When B is positive with respect to A, the grid is at some positive potential and the subsequent grid current charges capacitor C. This is analogous to diode action and the corresponding equivalent circuit is shown in Fig. 1B.

In this circuit, voltage divider R_2 R_3 of Fig. 1A has been drawn as two equivalent resistors. That portion between the center arm of R_3 and point B has been indicated as kR and the total resistance between the center arm and point A as $(1 - k)$ R. As k varies between zero and one, every possible setting of R_3 is covered.

Resistance R_1 limits the peak charging current. If R_g is much larger than $(1 - k)$ R, the potential at point X with respect to point A is E_m $(1 - k)$ $\sin\omega t$. Neglecting the effect of R_1, C will charge quickly to the peak value of this voltage on the positive half-cycles. If time constant R_gC is large compared with T, the period of the supply frequency, C will remain charged at a value of

$$E_{d-c} = (1 - k) E_m \qquad (1)$$

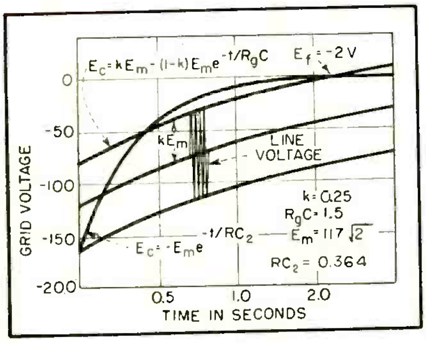

FIG. 2—Typical grid-discharge curve showing addition of waveforms

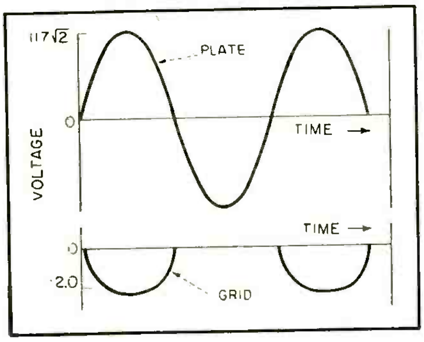

FIG. 3—Critical grid voltage curve for 2D21 with 117 volts rms applied

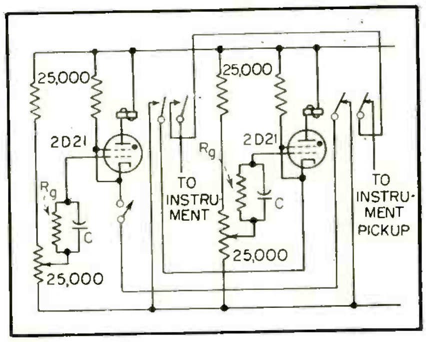

FIG. 4—Schematic diagram of sequence timer developed from basic circuit

Thyratron control circuit uses only a-c line power. Combination of grid waveforms permits more accurate time selection than can be obtained with conventional capacitor-discharge circuits. May be used for critical timing applications.

with polarity indicated in Fig. 1B.

When the switch in Fig. 1A is closed, the cathode of the thyratron is connected to point B and the plate and relay coil to point A. The circuit then assumes the form shown in Fig. 1C. The a-c potential at point X is now $kE_m \sin \omega t$ with respect to point B. Capacitor C discharges exponentially through R_g. The sum of this exponentially decaying capacitor voltage and the a-c component forms the instantaneous grid voltage

$$E_c = kE_m \sin \omega t - (1-k) E_m e^{t/R_gC} \quad (2)$$

The thyratron fires when the positive peak value of this voltage reaches the critical firing potential, E_f, of the tube. Only the positive envelope of this voltage is of importance and

$$E_c = kE_m - (1-k) E_m e^{-t/R_gC} \quad (3)$$

If E_c is set equal to E_f, the critical grid voltage, an expression indicating the time of firing after the closing of the switch is obtained. Thus

$$E_f = kE_m - (1-k) E_m e^{-t/R_gC} \quad (4)$$

$$e^{-t/R_gC} = -\frac{E_f - kE_m}{(1-k)E_m}$$

$$\text{or} \quad t = R_g C \ln \frac{(1-k) E_m}{kE_m - E_f} \quad (5)$$

The maximum value which k may assume is one making $t = 0$. Setting $t = 0$ in Eq. 4 and solving for k, or k_{max}, as it may be called

$$E_f = k_{max}E_m - (1 - k_{max}) E_m$$

$$\text{or} \quad k_{max} = \frac{E_f}{2E_m} + \frac{1}{2} \quad (6)$$

As E_f is normally close to zero, it may be assumed that $E_f = 0$ and k_{max} may never exceed one-half. With $k = \frac{1}{2}$, the capacitor would charge initially to $-E_m/2$ and the a-c component which is superimposed would have a peak value of $E_m/2$. The grid voltage would then equal zero upon closing the switch and the thyratron would fire on the first positive cycle of the applied voltage.

General Considerations

A typical grid discharge curve is shown in Fig. 2. Values are given for 117 volts rms applied to a 2D21 thyratron connected as in Fig. 1A. Time constant R_gC has been chosen as 1.5 seconds and k as 0.25. A few cycles of line voltage are shown to indicate the envelope curves discussed previously. The critical grid voltage, E_f, is approximately –2 volts.

A simple d-c exponential curve has also been plotted on the same graph. This curve was chosen with an initial d-c charge equal to the peak applied a-c value, and with an R-C time constant adjusted to give the same time delay as the composite curve.

The accuracy of the timing interval is determined in part by the slope of the grid-discharge curve at the critical grid potential.

Figure 2 indicates that the envelope curve has a steeper slope at the time of firing than the simple d-c exponential curve. This insures more precise selection of the timing interval.

As k decreases, the d-c potential becomes greater and the a-c potential smaller. Thus, when $k = 0$, the circuit degenerates into a simple d-c grid control system.

In practice, the capacitor charges to somewhat less than the d-c voltage indicated making the actual time delay slightly less than that indicated by the equations.

Although the critical firing voltage, E_f, has been taken as a constant, it varies as the instantaneous plate potential varies. A graph of its value for a 2D21 is shown in Fig. 3. At the peak of the a-c cycle (when both grid and plate voltages are at their maximum positive values) E_f is constant at about –2.2 volts with 117 volts rms applied.

Applications

Figure 4 is the schematic diagram of a sequence timer based on this circuit. It is designed to complete the input circuits of a group of instruments at a chosen time and to open these same inputs at a selected later time. The initiating switch is actuated automatically by associated devices.

The circuit described in this article was developed by Willard L. Hayes of the U. S. Naval Gun Factory.

Designing Surface-Wave

Experimental data show optimum criteria for plastic-coated wire dimensions and launching horns. Surface-wave lines using polyethylene-coated wire have loss of 6 db per mile for a two-mile line at 250 mc. Recordings of propagation over 130-foot line at 2,000 mc indicate total loss of about 2 db

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THE SURFACE-WAVE transmission line (SWTL) is a relatively new type of transmission line that employs a single conductor as the wave-conducting means. Early theoretical investigations, originated by Sommerfeld in 1899, suggested the possibility of transmitting electromagnetic waves along a single conductor without radiation loss. However, the existence of such waves had not been verified experimentally.

On the contrary, experience showed that waves on a single conductor suffered large attenuation by radiation and this radiation from long-wire antennas has been extensively used. From that observation and also from later theoretical investigations it was generally concluded that nonradiating surface waves along a single conductor are nonexistent. The true situation, however, has been cleared up only in the past few years, as described below.

A nonradiating wave mode on a single conductor does exist but, under normal conditions, it is excited so weakly that it cannot be observed for it is overshadowed by the radiating or long-wire wave. The nonradiating wave mode is brought about by the resistivity of the wire. A plain, perfectly conducting wire would not guide a nonradiating wave at all. The finite conductivity causes a reduction in the phase velocity of field, compared to the free-space velocity and it is this reduction in phase velocity that establishes conditions rendering nonradiating wave propagation feasible.

An ordinary wire, however, is a poor guide for a nonradiating wave in that the wave is easily upset by small bends and even by the normal sag of the wire. If phase velocity is reduced more, for instance by covering the surface of the wire with a dielectric layer, the nonradiating wave becomes stable and can be excited more easily and with much higher efficiency. A wire covered with a dielectric layer of proper thickness is the wave conductor actually used in the swtl.

Wave Development

The functioning of the swtl is best understood if it is compared with a coaxial line to which it is closely related.

Consider first a coaxial line filled with air as shown in Fig. 1A. Neglecting the effect of the finite conductivity, the guided wave is a transverse electric and magnetic wave that propagates with the velocity of light. If the space between inner and outer conductors is entirely filled with a dielectric material having a relative dielectric constant ϵ_i/ϵ (when ϵ = dielectric constant of air) the character of the wave is unchanged, but the velocity is reduced by the factor $\sqrt{\epsilon/\epsilon_i}$.

Assume that only part of the space is filled with the dielectric, so that the conductor is covered with a dielectric sheath (Fig. 1B). The velocity then has a value between that in free space and that in completely filled line. The structure of the electric field is basically changed in that the electric field has a longitudinal component. Field lines are curved as shown in Fig. 1B and some of them no longer reach the outer conductor. The conduction current in the outer conductor that, for Fig. 1A, has the same magnitude as the current in the inner conductor, is now reduced by the displacement current, caused by the longitudinal component of the electric field.

If the radius of the outer conductor is increased while the inner conductor and the dielectric sheath are unchanged, more return current is formed by displacement current. If the outer conductor is large enough, conduction current is practically zero. Thus, the outer conductor becomes unnecessary. The inner conductor with the dielectric coat is adapted to transmit the wave alone and there is no radiation if the considered wave mode is excited.

The preceding explanation immediately suggests a method for exciting this wave mode. Starting from a coaxial-line section, the inner conductor of which has a dielectric coat, the diameter of the outer conductor is gradually increased until it is so large it has no considerable effect on the field and thus becomes superfluous. In this manner the coaxial wave is gradually transformed into the surface wave. The termination or launcher of the swtl comprises a coaxial-line section the inner conductor of which is connected to a dielectric-coated wire. The outer conductor of this cable is continued by a metal cone. A sketch of a complete swtl is shown in Fig. 2.

It is known that the attenuation of coaxial lines having the same inner conductor decreases with increasing diameter of the outer conductor because the transmitted power associated with a certain current increases with the cross-section of the field. Power dissipated in the inner conductor, being proportional to the square of the current, remains constant. Disregarding dissipation in the outer conductor and dielectric losses, the loss in coaxial lines having the same inner conductor decreases in inverse proportion to the impedance of the line. This results because impedance is the ratio between transmitted power and the square of the current.

Impedance of the swtl (if defined as power divided by current squared) usually lies between 200 and 400 ohms. Therefore, the loss in such a line is a fraction of that of an ordinary coaxial line having an inner conductor the size of the surface-wave conductor.

Compared with a two-wire line of the same impedance and the same size wires, the loss is about half, because dissipation occurs in only one wire rather than in two.

Radiation Loss

Such comparison of the loss in the swtl to that of a coaxial or a two-wire line is not quite fair as there is radiation loss inherently connected with the formation of the surface wave. This loss, which is substantially independent of the length of the line, depends on the design of the launchers and their physical size. There is not yet a theory developed that will reveal their most favorable shape; it is a matter of experience to design them with high efficiency. An efficiency of 90 percent is easily obtained and requires no special precautions. If the taper of the cone were infinitely small the diameter of the opening alone would determine the efficiency.

Total loss of the swtl therefore consists of two parts, the termination or launching loss and the loss of the dielectric-coated wire. The latter is composed of the conductivity loss in the conductor and the dielectric loss in the dielectric layer. The dielectric loss is usually small compared to the conductivity loss.

Because of the launching loss, which is usually in the order of 1 db for both terminations together and substantially independent of the length of the line, the swtl cannot compete with ordinary transmission lines if they are so short that their loss is only 1 db or less. For longer lines the launching loss becomes of little importance and the superiority of the swtl becomes apparent.

Application of the swtl is also limited with regard to the frequency range. The practical lower-frequency limit, which appears to be around 50 mc, is determined by the extension of the field. The clearance around the conductor required for undisturbed transmission and the size of the launchers both become inconveniently large. The practical upper-frequency limit has not yet been established.

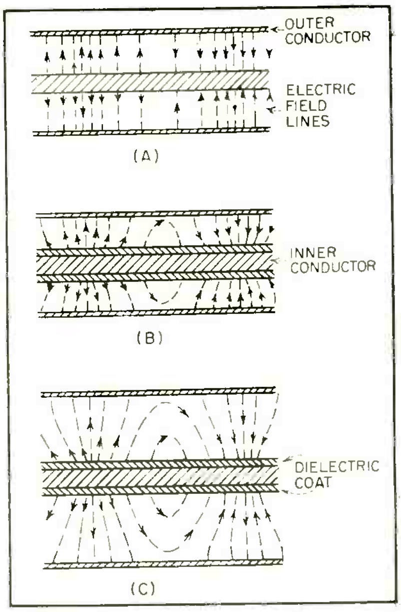

FIG. 1—Development of swtl from air coaxial (A), solid-dielectric and air (B) and increased outer sheath diameter (C)

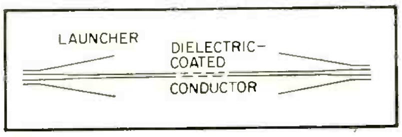

FIG. 2—Complete surface-wave transmission line

Climatic Effects

Being an open waveguide, the swtl is subjected to weather conditions, but to a much lesser degree than an open two-wire line. To study weather effects continuous recordings were made at two frequency ranges, one around 250 mc and the other around 2,000 mc. Measurements in the 250-mc range were made with a line two miles long, having a loss about 6 db per mile.

There was no noticeable increase during rain. Dry snow also seems to have little effect. Once, when the line was covered with a layer of about 1 inch of wet snow an increase of approximately 3 db per mile was measured. During the recording period of two years, little experience has been gained as to the effect of ice formation. Layers of ice formed were too thin to cause a detectable increase of loss. The recording equipment used was subjected to ambient temperature variations and not stable enough to detect with certainty signal variations of less than 1 db.

Precipitation Effects

The recordings at 2,000 mc were made with an antenna feed line 130 feet long having a total loss of about 2 db. At this frequency the effect of rain was noticeable and occasionally an increase of the loss by one db was measured. Horizontally stretched lines are more affected because drops hanging on the line act at this frequency like little dipoles and cause radiation loss. The formation of ice is more serious; layers that had no influence on the two-mile line at 250 mc effected about 5-db increase in loss on the 130-foot line at 2 kmc.

The swtl, in contrast to twin-leads, is practically unaffected by formation of a film of water on a layer of soot because the electric field is almost perpendicular to the surface. With twin lead such a layer forms a conductive bridge between the two conductors causing high attenuation.

A disadvantage of the swtl is its sensitivity to bends. If lines are properly designed, the loss caused by unavoidable bends at supporting points is negligibly small. Bends greater than 30 degrees should be avoided because they may cause a radiation loss of 0.5 db or more, depending on the reduction in phase velocity. Loss in a bend increases for small deflections approximately with the square of the deflection angle of the line. Conductors used for microwave lines should be prestressed to remove kinks in the wire.

Supports of lines require as little material as possible. The experimental 2-mile line mentioned is suspended by nylon ropes fastened to telephone poles. Although this method of supporting the line is quite satisfactory and causes practically no distortion of the wave, more rigid methods are under study. If only a few supports are necessary, thin sticks of wood or other insulating materials may be used.

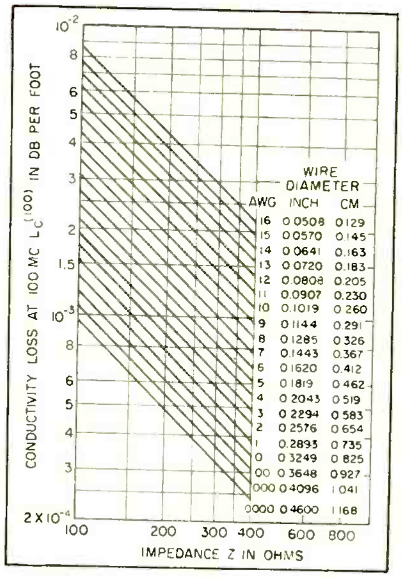

FIG. 4—Conductivity loss and impedance for various sizes of wire

Designing the Line

Graphs used for swtl design, given in Fig. 3, 4, 6 and 9, pertain to polyethylene-coated copper wires. They can also be used if the dielectric coat consists of other materials. The corrections required in that case are indicated below.

Figure 3 shows the relation between the ratio d_o/d_i (d_o = diameter of the wire including the dielectric layer, d_i = diameter of the plain wire) and the impedance Z of the line, which is defined as the ratio between transmitted power and the current squared. One set of curves refers to various ratios λ/d_i (λ = free-space wavelength), the other set to various values of the reductions in phase velocity δ_v expressed in percentage of the velocity of light c.

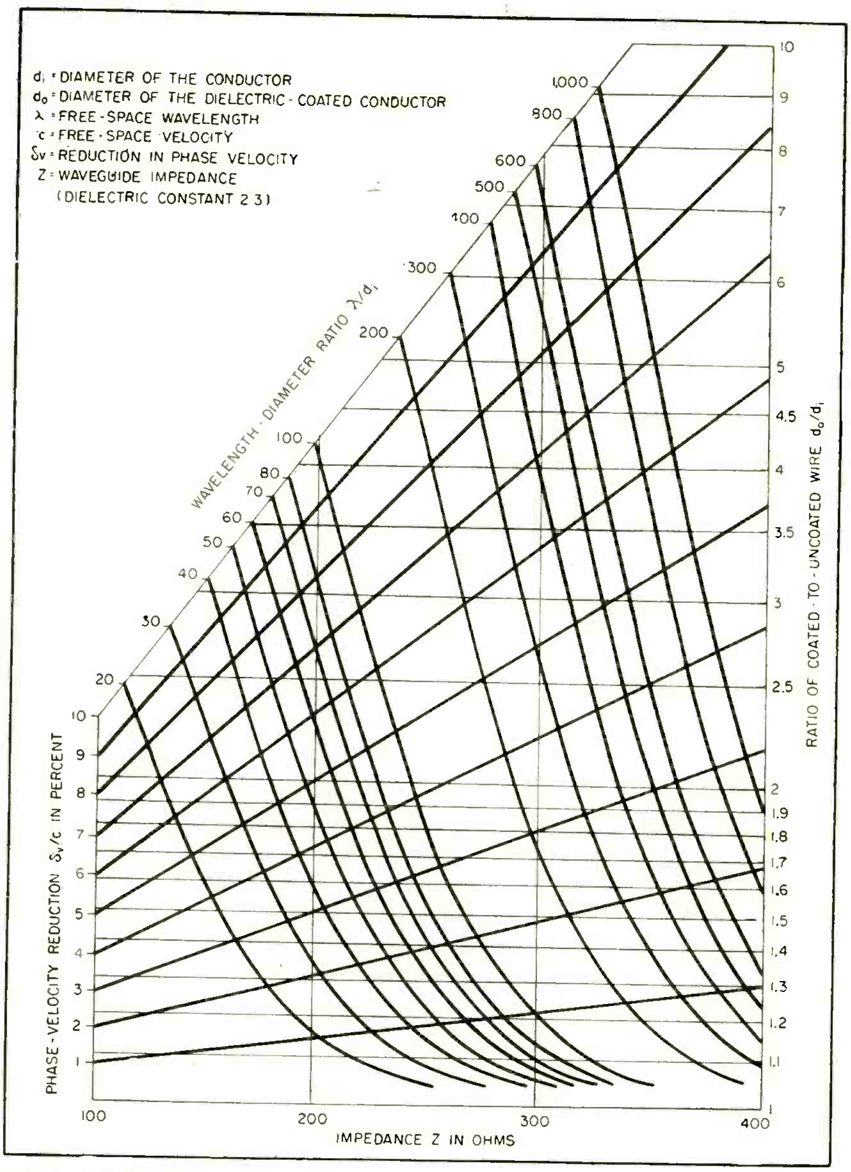

FIG. 3—Relationships among wire diameter, dielectric layer, phase-velocity reduction and impedance

Desirable Charcteristics

It is desirable to design the lines for high-impedance because loss decreases with increasing Z (see Fig. 4). On the other hand, the phase velocity should be reduced as much as is practical since the line is then less susceptible to bends. Furthermore, the extension of the field is smaller. Large Z and large δ_v/c are contradicting conditions. A compromise is necessary to obtain optimum performance.

In the microwave range, where λ/d_i is small, a high impedance can be obtained only if the reduction in phase velocity is small. In this frequency range the line is used primarily for antenna feeds where it can be strung directly between the transmitter or receiver and the antenna. Bends are therefore avoided and a small δ_v/c is not objectionable.

It is still advisable to have a reduction in phase velocity of at least 1 percent otherwise layers of dust or water film would cause a large fractional increase of the effective thickness of the dielectric layer and have a considerable effect on line impedance and field extension.

In the uhf range, where λ/d_i is in the order of 100, the impedance can be made large even for a reduction in phase velocity of more than 5 percent; in that case the line is quite insensitive to bends and can be easily supported.

Wire Size

Loss in the swtl is primarily determined by the size of the conductor. Therefore it is advisable to determine first the approximate wire diameter required for a specified loss of the line. This size is read off Fig. 4, which shows the conductivity loss per foot ($L_c^{(100)}$) of various sizes of copper wire at the frequency $f_o = 100$ mc, as a function of line impedance. The conductivity loss L_c per foot at any other frequency f is given by the expression $L_c = L_c^{(100)}\sqrt{f/f_o}$ (1)

An assumption must be made about the impedance of the line. Average value of Z is 250 ohms and this value may be used for a first approach. If the resulting reduction in phase velocity is too high or the extension of the field too great the assumed value can be modified.

An antenna feed line in the frequency range from 450 to 900 mc might have a maximum permissible loss of 0.01 db per foot. Allowing 20 percent for the dielectric loss, conductivity loss should not exceed 0.008 db per foot at the highest frequency of $f = 900$ mc. From Eq. 1, the maximum value of $L_c^{(100)}$ comes to 2.7×10^{-3} db per foot.

Assuming $Z = 250$ ohms, the table on Fig. 4 shows that No. 14 AWG wire is adequate. According to the graph this wire has an $L_c^{(100)}$ value of 2.75×10^{-3} db per foot for $Z = 250$ ohms.

The ratio λ/d_i for the highest frequency ($\lambda = 33.3$ cm. $d_i = 0.16$ cm) is then 204. Using Fig. 3, for $Z = 250$ ohms the ratio $d_o/d_i = 4$ and the reduction in phase velocity $\delta_v/c = 8.1$ percent. This reduction in phase velocity is high.

A ratio d_o/d_i of 3 and the same ratio λ/d_i would result in a δ_v/c of about 6 percent, which is adequate if the line is essentially straight. Choosing for d_o/d_i the value of 3, Z and δ_v/c for several frequencies within the considered band are determined. The result is plotted in Fig. 5.

The impedance varies between about 310 and 270 ohms and δ_v/c from 5.2 to 6.1 percent. Conductivity loss L_c within the frequency range of the wire is now determined with Fig. 4 using several of the values of the Z-curve obtained before.

Loss L_c is plotted in Fig. 5. Dielectric loss in the insulating layer is obtained from the curves in Fig. 6 showing this loss as a function of the δ_v/c for various values of Z.

It is interesting to note that the

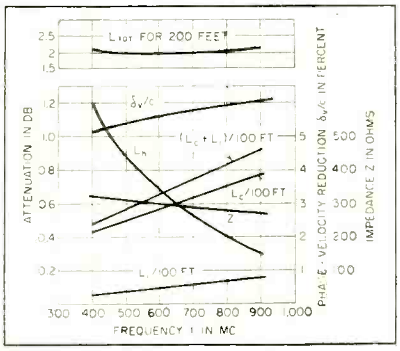

FIG. 5—Line characteristics for chosen parameters described in text

dielectric loss depends little on Z and almost entirely on the reduction in phase velocity. The curves in Fig. 6 pertain to a dielectric coat of brown polyethylene ($\epsilon_1/\epsilon = 2.3$, power factor 5×10^{-4}) at a frequency of 100 mc. As indicated in the formula shown on the figure the loss L_i increases in proportion to the frequency. The dielectric loss of the line under consideration is plotted in Fig. 5 (curve L_i).

Total theoretical loss of the dielectric-coated wire is $L = L_c + L_i$. At 900 mc this loss is about 0.93×10^{-3} db per foot. Experimental investigations have shown that the measured loss is usually several percent larger than the theoretical loss, probably owing to reduced surface conductivity of the copper. Therefore wire size 14 will just meet the requirements in this example.

While loss in the wave conductor can be predetermined accurately, this is not so for loss in the launchers. Considering the receiving horn, presumably that part of the wave energy is lost for reception that propagates beyond the radius of the horn opening. The energy entering the mouth of the horn is not entirely converted into the coaxial-wave mode picked up at the end of the horn. Thus, loss consists of two parts; one part results from the limited size of the horn opening. The other part is a conversion loss that depends upon the shape of the horn. It is evident from the reciprocity theorem that the efficiency of a horn is the same for launching and receiving.

Horn Loss

The loss of a horn can be expressed in terms of an impedance by dividing this loss by the square of the current of the surface wave. That part of the loss impedance due to the size of the horn opening (Z_ρ) can be calculated. The graphs shown in Fig. 7 have been prepared for determining Z_ρ if the size of the horn and the reduction in phase velocity are given.

There is no theory as yet regarding conversion loss. However, if it is understood how this loss comes about, it can be kept small. To explain the causes of conversion loss, consider the launching process on a simple construction of a launcher shown in Fig. 8A. First, there is a discontinuity at X where the surface-wave conductor is attached to the center conductor of the coaxial-line section. If X is close to the mouth of the horn, the discontinuity causes a stronger excitation of the radiating or long-wire wave.

If X is close to Y where the horn

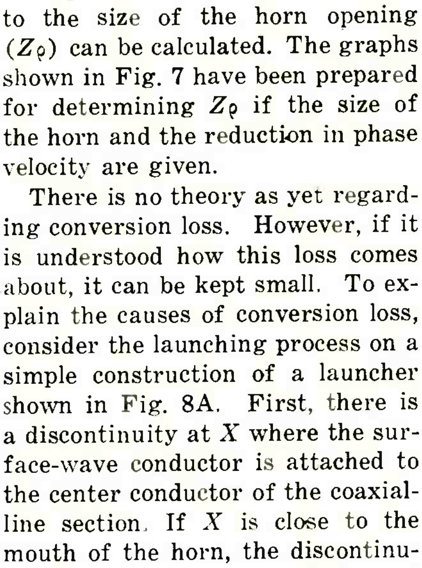

FIG. 6—Dielectric loss as a function of phase-velocity reduction

diameter is not much greater than the outer diameter of the coaxial section, the discontinuity may cause severe standing waves. Therefore, there is an optimum location for X, somewhere near the middle of the horn.

The coaxial wave, when expanded in the horn, tends to form spherical waves, as indicated in Fig. 8A, while the wave-front required at the mouth is plane, since the surface wave has plane phase surfaces. Also, the amplitude distribution of the expanded field at the mouth of the horn may not match that of the surface wave. This is particularly true if the horn diameter is too large and there is a possibility for the development of higher wave modes within the horn.

The best results were obtained with the launcher design shown in Fig. 8B. The coaxial section has large diameter and the inner conductor is tapered down until it approximately matches the diameter of the surface-wave conductor. The horn consists of two sections with different tapers. The one that encloses the tapered inner conductor has a smaller taper than that enclosing the surface wave conductor. With such launchers a conversion loss of less than 0.1 db has been obtained.

The total launching loss of a surface-wave transmission line with properly designed launchers is not more than 1 db. Figure 5 contains a curve (L_h) showing the launching loss of both terminations together, as it is determined with the graphs of Fig. 7. The curve is based on a horn diameter of 12 inches. The surface-wave conductor is that of the preceding example.

Launching Loss

The conversion loss is not taken into account. Assuming a line length of 200 feet the total loss of the line over the frequency band from 450 to 900 mc is that shown in the upper curve of Fig. 5 (L_{TOT}). Since the launching loss decreases with increasing frequency while the conductor loss increases, the curve is almost flat over the entire frequency range.

Many different lines have been tested and their loss compared with the theoretically expected loss. It was found that the discrepancy was usually less than 20 percent, showing fairly good agreement.

If the dielectric coat on the wave conductor is not made of polyethylene but of another material, Fig. 9 may be used to determine the thickness of the coat that is equivalent to one of polyethylene. In this figure d_o/d_i is the ratio of the diameter of the polyethylene-coated wire and that of the bare wire, d_o'/d_i is the equivalent ratio in case of dielectric coat having a relative dielectric constant ϵ_i'/ϵ as indicated at the various curves. The dielectric loss obtained from Fig. 6 is changed by a factor $2.6 \times 10^3 \tan \delta' / [(\epsilon_i'/\epsilon) - 1]$ where $\tan \delta'$ is the power factor of the dielectric material used.

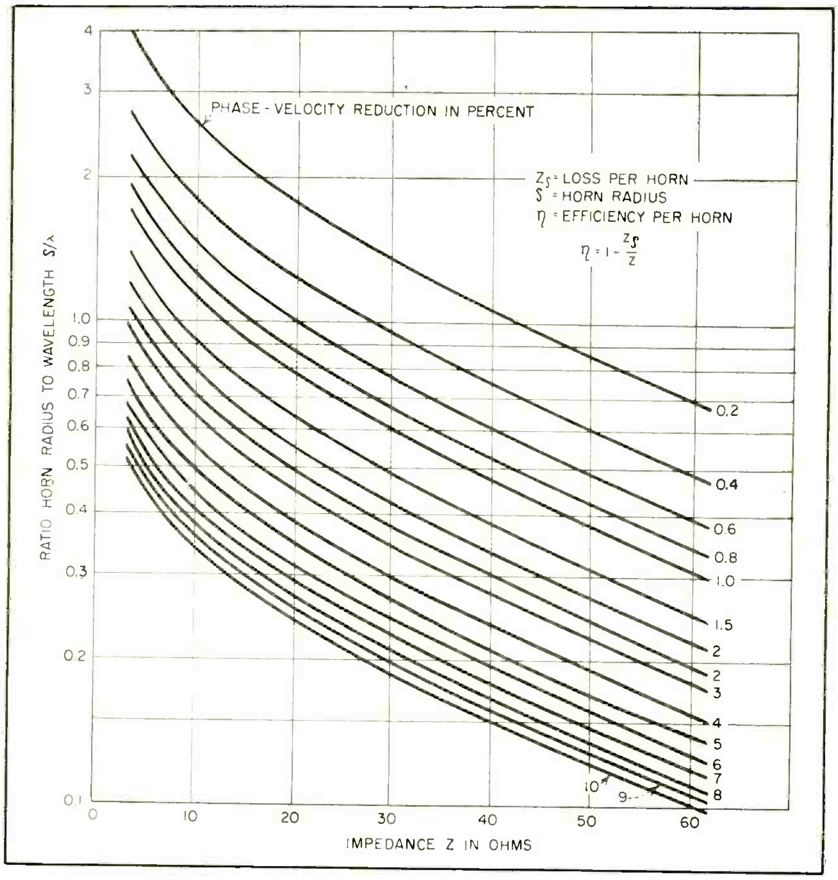

FIG. 7—Horn loss impedance related to dimensions. The curves show loss per horn when its size and reduction in phase velocity are known.

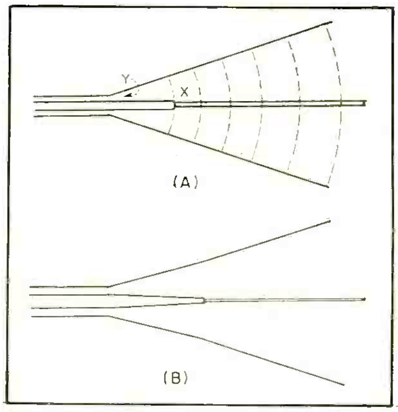

FIG. 8—Optimum launcher design employs tapered inner conductor

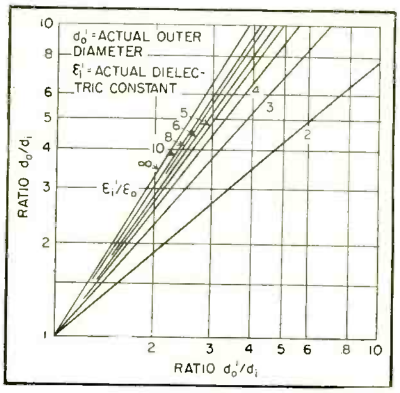

FIG. 9—Conversion chart for dielectric other than polyethylene

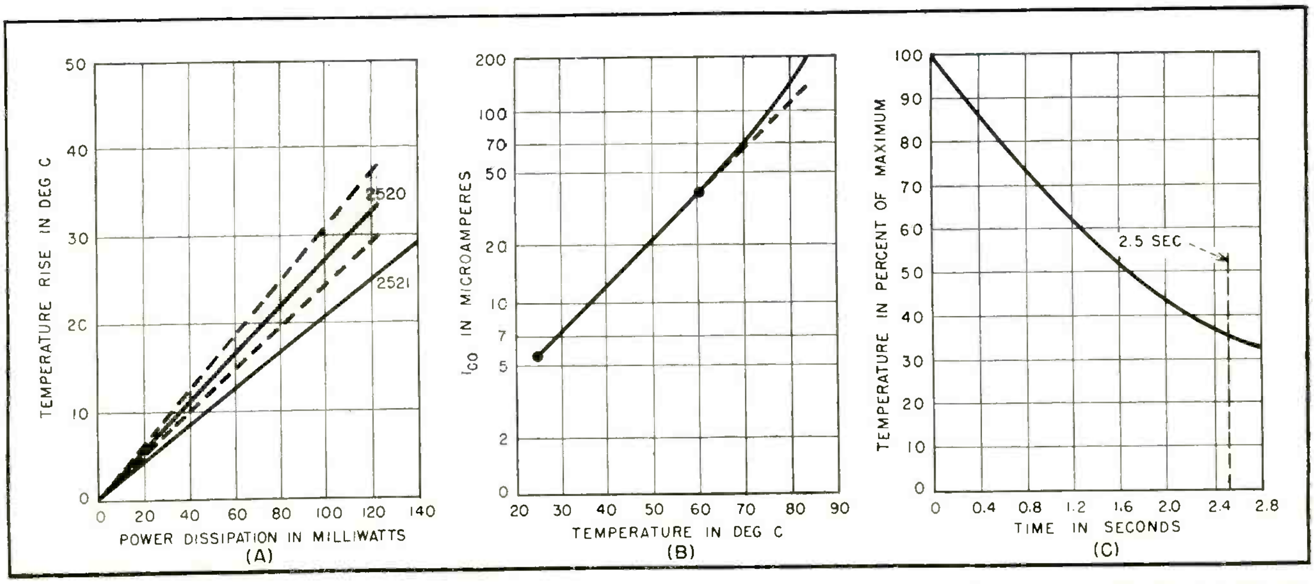

FIG. 1—Temperature rise with power dissipation (A) relates to corresponding change in reverse collector current (B). Themal time constant (C) illustrates need for rapid measurement

Measuring Transistor Temperature Rise

Rise in internal temperature at transistor junction may severely alter operating parameters. Test set described measures temperature rise with power dissipation indirectly by noting change in magnitude of reverse collector current with zero emitter current

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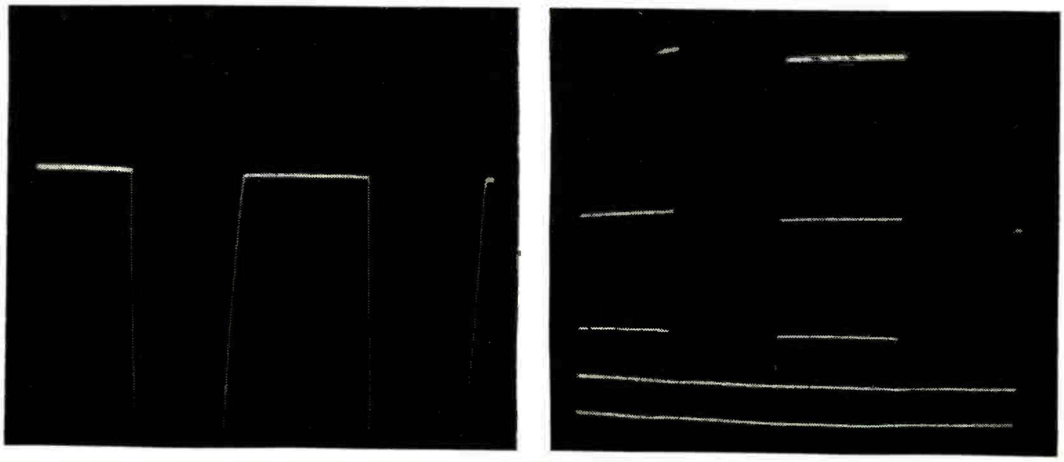
APPLICATION of transistors is restricted by their maximum allowable internal temperature as is application of most electrical products. In the transistor, however, the immediate problem is excessive changes in operating parameters rather than destruction of insulation or permanent deterioration of performance characteristics. In fact, permanent deterioration due to temperature is not important below 110 C in diffused-junction transistors or 130 C in grown-junction types.

Parameter Changes

Variation in transistor parameters due to temperature rise may either alter a-c performance or change the d-c bias so severely in some circuits that the transistor may run away and destroy itself. This article presents a simple method of determining the approximate temperature rise in a transistor and shows how such knowledge may lead to more complete circuit analysis and more efficient utilization of transistors.

Curves of transistor parameter variations as a function of temperature have been prepared[1,2] from which transistor circuit analyses at different temperatures may be realized. These parameter versus temperature plots have been determined at the low dissipation of approximately 4.5 mw. To analyze transistor performance at higher dissipations, it is necessary to know the temperature rise at the junction, for it is the junction temperature that effects the magnitude of I_{co}, reverse collector current with zero emitter current; R_c, collector resistance; and A_1 current gain.

Consider a case where the maximum ambient temperature is 40 C and optimum power output is required. It is known also that beyond 70 C the I_{co} becomes excessive. Therefore the maximum power that



Base current waveform (left) describes half sine wave. Flat portion at top represents reverse collector current. Composite waveform (right) illustrates change of reverse collector current with power dissipation. From top to bottom the curves represent current at: 120 mw, 80 mw, 40 mw, 25 deg C level and zero level

can safely be dissipated will raise the transistor's internal temperature approximately 30 C. Figure 1A gives temperature rise as a function of dissipation for Germanium Products transistor samples in freely circulating air. This curve cannot be universally applied since different type transistors do not have the same thermal conductivities and different methods of mounting will provide variations in heat conduction. To utilize transistors efficiently a knowledge of the temperature rise per milliwatt dissipation for individual applications is desirable. This should be especially true in power transistor applications.

Measuring Temperature

Inserting a thermocouple into a transistor junction and thereby opening the unit changes its thermal conductivity. Also the thermocouple itself acts as a conductor in removing the heat. Thus, an indirect method of finding the temperature rise is the more reasonable solution.

The transistor parameter most sensitive to temperature variation is I_{co}. This I_{co}, which is usually of the order of a few microamperes, contains a constant and an ohmic component. The constant term is due to thermally generated minority carriers that diffuse into the junction and is an exponential function of temperature. The ohmic component may be the result of surface leakage across the space-charge region or possibly of local defects in the germanium.[1] Consequently I_{co} is directly affected by changes in the junction and in the immediate vicinity of the junction. By measuring I_{co} the magnitude of junction temperature is actually obtained.

Measurement Technique

The experimental procedure of obtaining temperature rise versus dissipation requires measurements of I_{co} first as a function of known temperature, then as a function of dissipation and finally correlation of dissipation with temperature rise.

The first step simply means applying a voltage E between the collector and base with the emitter disconnected and measuring the collector current while the transistor is exposed to different temperatures in an oven. Up to about 60 C, I_{co} follows very closely an exponential function and two points on semilog paper, as shown in Fig. 1B, will approximately define the I_{co} versus temperature function. Above 60 C, I_{co} usually rises more sharply but it is commonly not necessary for I_{co} measurements to be taken above that temperature. The I_{co} slope on the semilog plot may not only differ for different make transistors but even for transistors of the same make. To avoid

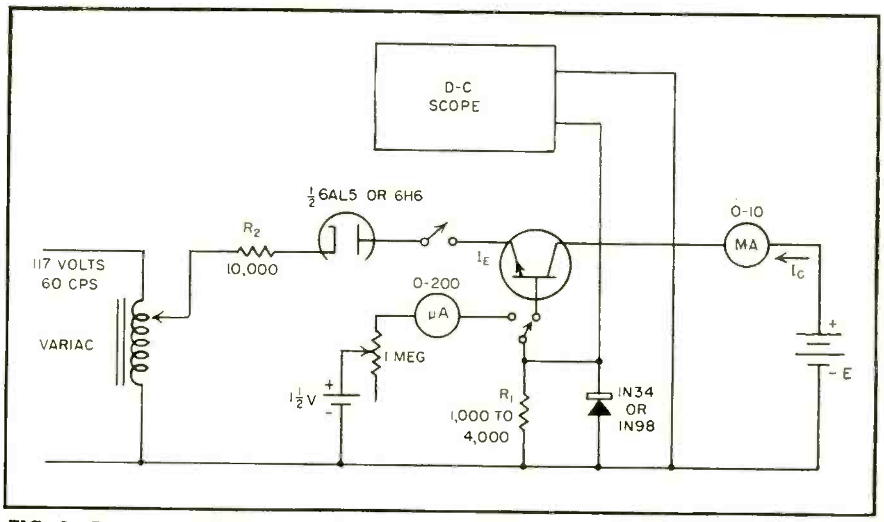


FIG. 2—Basic test set for measuring transistor temperature rise with power dissipation utilizes a d-c oscilloscope

excessive errors, it is advisable to obtain that slope for each transistor under measurement. Only those transistors should be selected to complete the temperature rise measurements for which I_{co} readings can be closely repeated at any one temperature. Aging or temperature cycling may sometimes be necessary to obtain stable I_{co} readings.

Reverse Collector Current

The next step is to measure I_{co} as a function of power dissipated in the transistor. Since the thermal time constants of most commercial transistors are of the order of only two to three seconds and internal temperature drops off exponentially as shown in Fig. 1C, to avoid excessive errors I_{co} must be measured within roughly $\frac{1}{5}$ second after switching off the power source. Since opening the emitter circuit and then measuring I_{co} on a microammeter results in excessive time lag and requires special transient-recording equipment, the circuit of Fig. 2 is shown as an example of a simple experimental technique having negligible time-lag errors.

A half-wave rectified current I_e flows in the emitter of the transistor. The magnitude of the current can be controlled with the continuously variable input transformer. This causes a rectified current of roughly AI_e to flow in the collector circuit. The power dissipated in the collector junction is essentially EI_c where E is the voltage source, which must be of the same magnitude used to obtain the I_{co} versus temperature plot, and I_c is the d-c collector current read on the milliammeter. The diode in the base circuit minimizes the voltage drop across the base resistor insuring that the expression EI_c for power dissipated will be correct. Part of EI_c is dissipated in the base of the transistor but that portion is usually negligible.

During one half the time interval of the cycle the diode in the emitter circuit opens the emitter circuit so that I_{co} flows through the collector and the base. Consequently the base current $(I_e - I_c)$ is a half-wave rectified current and on the d-c scope the flat portions of the cycle represent a voltage $I_{co}R_1$. The rise of level of the flat portions give the increase of I_{co} due to heating of the junction. The rise of I_{co} can be converted into temperature readings from the curve of Fig. 1B and a plot of power dissipation versus temperature change made.

VTVM-Chopper Circuit

An alternative method of obtaining I_{co} as a function of power dissipation is shown in Fig. 3. Here a chopper and either a d-c or a-c vacuum-tube voltmeter substitutes for the scope. This circuit measures I_{co} somewhat more indirectly. The voltage across R_1 is a half-wave rectified voltage and it is desired to obtain the rise of the flat portion of the wave which changes as a function of I_{co}. The chopping circuit excited by the same source as the emitter circuit has polarities as indicated and transfers about 85 percent of the flat part of the voltage, greatly attenuating the curved portion. Thus the chopping-circuit output should ideally be a square wave linearly changing with I_{co}.

This method is a little less accurate in its performance than the scope method because of the bridge drift in null voltage and the bridge's imperfect shorting action when clipping. A d-c vtvm that can read millivolt levels would be more desirable than an a-c vtvm in that the clipping bridge a-c null voltage, which is of the order of 10 to 15 millivolts, would not enter into any readings. The dissipation is essentially EI_c.

Experimental data compiled by the first method described with 10 Germanium Products type 2520's and 2521's is shown in Fig. 1A. The ends of the transistor leads were attached to a heavy terminal block and the units exposed to freely circulating air.

Various methods have been explored for reducing the temperature rise. A type 2520 with 1½ in. lead length was connected to a heavy terminal block. At 92 milliwatts dissipation in freely circulating air, a 26 C temperature rise above a 27 C ambient was observed. Upon applying a blower for several minutes the temperature rise reduced to 20 C.

Taping the transistor to a heavy piece of steel reduced the rise to 21 C. When the blower was in addition applied to the metal heat sink, the total temperature rise was only 19 C. Thus heat sinks or blowers permit an additional 25 to 30-percent power dissipation in the transistor with the same temperature rise as is shown when the transistor is just exposed to freely circulating air.

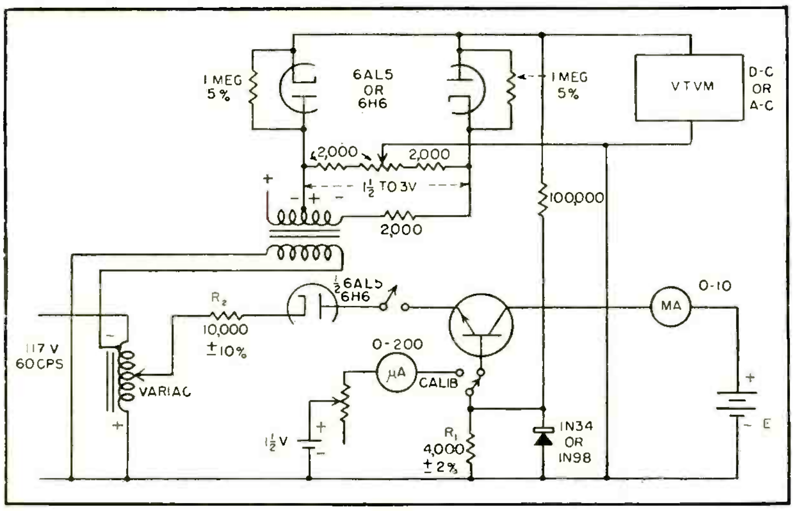


FIG. 3—Variation of test set has chopper and vacuum-tube voltmeter for direct-reading. Either an a-c or d-c vacuum-tube voltmeter may be used

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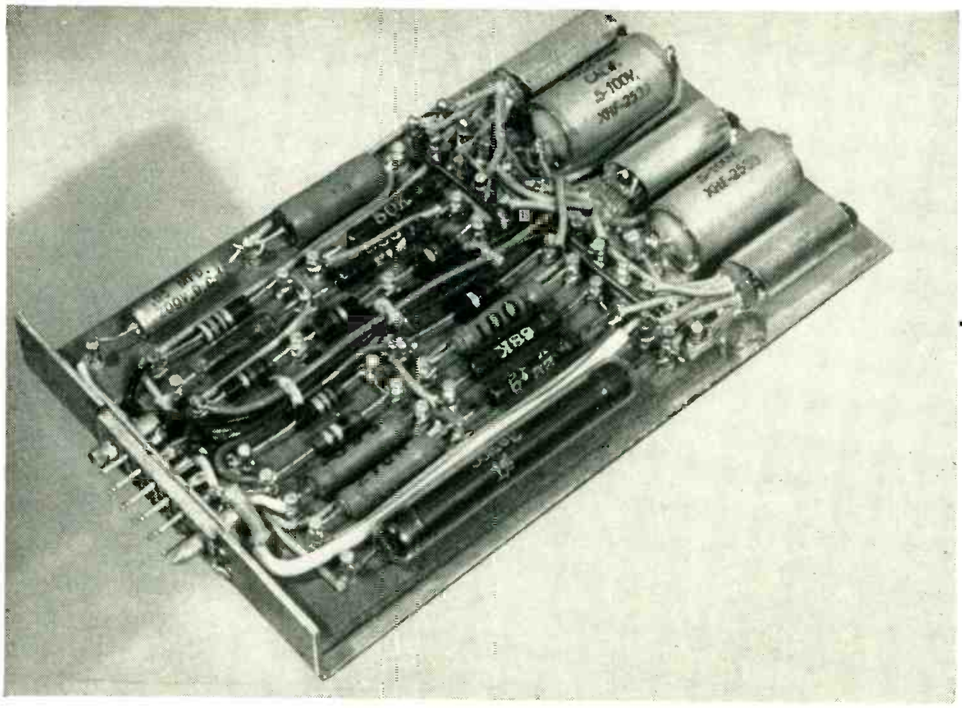
(2) John S. Saby, Fused Impurity *PNP* Junction Transistors, *Proc IRE*, **40**, No. 11, p 1,359, Nov. 1952.



Pulse amplifier uses three subminiature tubes. Shielded input lead and input grid lead are joined on insulated stand-off terminal at lower right of board to eliminate terminal board leakage

Time-Shared Amplifier

To maintain zero output for zero input in d-c amplifiers used in analog computers special techniques or auxiliary devices are usually employed to reduce drift.

The operational amplifier[1], circuit shown in Fig. 1, is a high-gain wide-band d-c amplifier having a zero d-c output level for zero input. The short-circuit transfer impedances z_i and z_f of the input and feedback networks are frequently complex in nature.

Impedances are selected to give a desired transfer function according to the equation

$$\frac{E_{output}}{E_{input}} \cong \frac{Z_f}{Z} \qquad (1)$$

One of the most common methods of zero stabilization connects an inherently drift-free chopper-amplifier to the d-c amplifier input[2]. The rectified and filtered chopper-amplifier output zeros the amplifier. Zero offset or drift is reduced by a factor approximately equal to the d-c to d-c gain of the stabilizing amplifier.

Motor-driven rotary sampling switches have been developed for commutating a single stabilizing amplifier among several operational amplifiers.[3] The input section of the switch samples each summing junction in sequence. The output section of the switch is synchronized with the input, connecting the output of the stabilizing pulse amplifier to the individual amplifiers through low-pass filters.

R-C Amplifiers

If a simple resistance-coupled amplifier is employed as a pulse amplifier, interaction between the operational amplifiers may be caused by the time constants of the coupling capacitors in the pulse amplifier.

If one of the computer operational amplifiers is overloaded its summing junction frequently assumes a relatively large voltage. When the sampling switch contacts this junction, the pulse amplifier is overloaded and may be usable to recover in time to handle succeeding pulse samples from other summing junctions. A cumulative process results in which all the operational amplifiers loose stabilization and saturate. It is then difficult to locate the amplifier at fault.

D-C Pulse Amplifier

A direct-coupled pulse amplifier suitable for application as a non-overloading stabilization amplifier is shown in Fig. 2 and in the photograph. It employs three subminiature tubes.

Since there is no blocking capacitor at the amplifier input, grid cur-

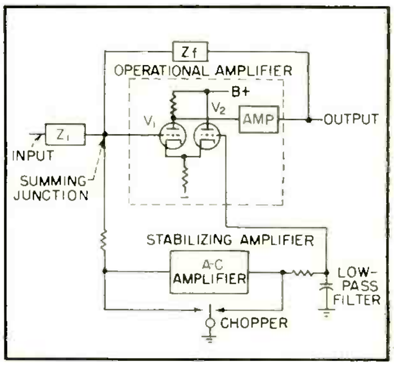


FIG. 1—Operational amplifier using chopper-driven a-c amplifier to provide stabilizing signal

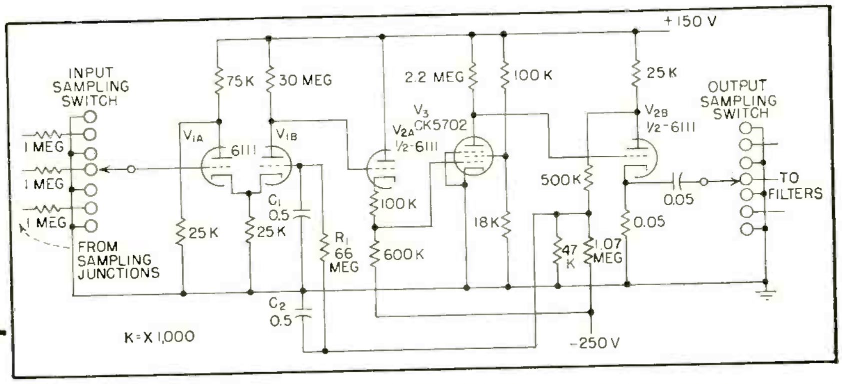


FIG. 2—Direct-coupled amplifier circuit has starved input stage to limit grid-current draw on operational amplifier summing junctions. Resistors are 1-percent deposited-carbon type. A 5-rpm, 60-contact Applied Science Corp. switch is used for input-output sampling

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Quick recovery d-c amplifier furnishes zero-point stabilization to 30 operational amplifiers used in analog computer. Interaction between amplifiers can be held to less than 2 millivolts by circuit and filter design techniques

Stabilizes Computers

rent is drawn by the input tube $V1_A$. This current flows through the resistor used to isolate the summing junctions from the switch contacts. The resulting voltage drop is equivalent to an error input signal of that amount. To reduce grid current to a negligible value, a starved input stage is employed.

Starved Input

The input stage has a heater voltage of 5 volts instead of the usual 6 volts, a plate voltage of 35 volts and a plate current of 5 microamperes per section. The input stage employs a cathode-coupled circuit so that net phase reversal through the pulse amplifier is 180 deg, as required. The gain of this stage is 8 or 9.

A cathode follower V_{2A} couples the starved amplifier into the pentode amplifier stage V_3 to avoid loading effects. The output stage V_{2B} is also a cathode follower.

The overall gain of the pulse amplifier is about 1,500. With this much gain in a direct-coupled amplifier, some way must be provided to prevent the last stage from being driven to cutoff by drift in the operating point of the first stage. Amplifier d-c gain is reduced to about 20 by d-c negative feedback to the grid of V_{1B}. Pulses that the amplifier is designed for are amplified at full gain because they are eliminated from the feedback path by the filter $C_1R_1C_2$.

The filter causes a small amount of pulse overshoot. Since the overshoot generated by a given pulse sample is still decaying when the next channel is sampled, overshoot can cause interaction between operational amplifiers unless it is held to a negligible value.

The amount of overshoot is directly proportional to d-c feedback through the filter and inversely proportional to the filter time-constant. If d-c gain is made less than 20 by feedback, overshoot will be excessive. If the filter is too large, the amplifier will be slow to recover from a temporary loss of supply voltages.

To assure adequate pulse rise-and-fall times, the amplifier should be laid out and wired to avoid excessive wiring capacitance. A d-c filament supply is essential for V_1. The supply voltages must be regulated to maintain about 45 volts at the output cathode. If different supply voltages are used, the d-c feedback circuit components must be altered.

Output Low-Pass Filters

A 5-rpm switch is used for sampling. Each of the two poles of this switch has 60 shorting-type contacts. Every other contact is intended to be grounded, providing 30 amplifier channels.

A filter suitable for shorting-type operation is shown in Fig. 3. The following design considerations exist: At the beginning and end of each sample, the filter input is shorted to ground momentarily. It is essential that signal pulses appear at the amplifier output only when the output coupling capacitor C_1 is connected to a filter, never when C_1 is grounded. For reliability, there should be a short period of time at the beginning and end of each pulse before C_1 is ungrounded or grounded. However, during these times, filter capacitor C_2 discharges back through the near-zero output impedance of the pulse amplifier. The effect is the same as that obtained by shorting the filter input to ground. In fact, the two phenomena may be lumped together so far as their effect upon the rectification efficiency is concerned.

A further design consideration involves internal leakage resistance between switch contacts. By the time the switch is ready for cleaning, resistance to ground at the filter input may be as low as 20 megohms. This resistance is denoted by R_1 in Fig. 3.

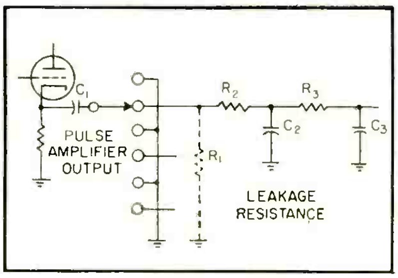

FIG. 3—Filter circuit used in output of stabilizing amplifier. Leakage resistance R_1 across contacts can be as low as 20 megohms when switch is in need of cleaning

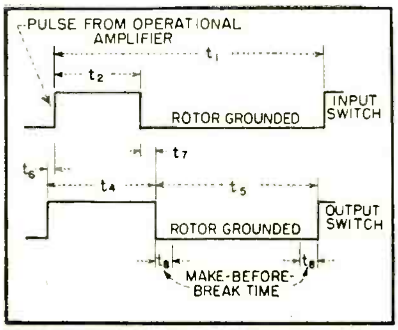

FIG. 4—Time relationships for stabilizing-amplifier input and output switch

Values for Timing

As shown in the switch-contact timing diagram, Fig. 4, the timing parameters are:

t_1 = time for one switch revolution or cycle
t_2 = single pulse length
t_3 = total filter discharge time = $(t_6 + t_7 + 2t_8)$, in general less than t_2
E = rectification efficiency = $\dfrac{\text{d-c voltage recovered}}{\text{pulse amplitude}}$

Rectification efficiency, considering the effect of the discharge time t_3 is

$$E_1 \cong \frac{t_2}{t_2 + t_3} \qquad (3)$$

Regarding the effect of leakage resistance R_1, capacitor C_2 of Fig. 3 discharges through R_2 and R_1 for a very long time t_1 and charges through R_2 for a relatively short time t_2. Rectification efficiency, considering this parameter alone, is

$$E_2 \cong \frac{1}{\frac{R_2}{R_1}\,\frac{t_1}{t_2} + 1} \qquad (4)$$

Net rectification efficiency is somewhat better than the product of E_1 and E_2. Efficiencies on the order of 50 percent are usual. Since the pulse-amplifier gain is 1,500, a d-c to d-c gain of 750 is obtained from the stabilizing circuit.

To obtain sufficient filtering, a second low-pass filter section R_3C_3 (Fig. 3) has been added. When a double-section filter is used R_2C_2 must be much smaller than R_3C_3 to prevent damped oscillations when subjected to transients. Time constants of 6 milliseconds and 30 seconds for R_2C_2 and R_3C_3, respectively, have been found satisfactory.

When an operational amplifier is overloaded, the low-pass filter charges to some large voltage. When the overload is removed, several seconds are required for this filter to discharge and for the amplifier to regain its stabilized zero. This phenomena is typical of any type of stabilizing circuit using continuous balancing.

A recovery time of 20 to 30 seconds is typical.

Recovery time can be improved if clamping diodes are added at the individual filters to prevent the filter from charging under overload conditions.

An improvement factor of 5 is easily realizable.

System Performance

With any of the stabilizing-amplifier inputs grounded through a 1-megohm resistor, the d-c voltage at the corresponding output filter due to rectified noise is less than 100 millivolts. This value is equivalent to about 100 to 200 microvolts of noise at the stabilizing-amplifier input.

The following data are given for a unity-gain inverting amplifier, that is, one having equal pure resistances for Z_i and Z_f of Fig. 1. A high-quality d-c operational amplifier with regulated power supplies was employed for the tests. With no signal input, noise output is about 1 millivolt peak-to-peak. The d-c drift is not more than a few tenths of a millivolt over periods of several days. Time required for the amplifier to regain a stabilized zero after a severe and prolonged overload is 20 to 30 seconds. A recovery time of 4 or 5 seconds can be obtained if filter clamping is used.

Channel Interaction

To measure freedom from interaction under normal conditions, signals of a varying character were fed into a gain-of-ten summing amplifier (Z_i = 100,000 ohms; Z_f = 1 megohm) with amplitudes equal at least to its maximum signal-handling capability. Another gain-of-ten summing amplifier was stabilized on an adjacent channel. Signal voltage at the output of this amplifier due to interaction did not exceed 2 millivolts. When amplifier gain was reduced to unity, interaction was negligible.

Some interaction does exist under overload conditions. When the summing junction of the first amplifier reaches 30 volts, the output of the adjacent amplifier may become offset as much as 30 millivolts. This is due to an energy transfer at the input sampling switch. It is apparently a result of dielectric absorption, not resistive leakage. This phenomenon occurs even with high-quality insulating materials because of the enormous difference between signal levels at the adjacent contacts. Some improvement could perhaps be obtained by locating a grounded guard ring around each contact.

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(1) J. R. Ragazzini, R. H. Randall and F. A. Russell, Analysis of Problems in Dynamics by Electronic Circuits, *Proc IRE*, 35, p 444, May 1947.

(2) E. A. Goldberg, Stabilization of Wide-Band Direct Current Amplifiers for Zero and Gain, *RCA Rev*, 11, p 296, June 1950.

(3) W. E. Ingerson, Drift Compensation in D-C Amplifiers for Analog Computers, paper presented at IRE National Convention, New York, 1951.

Transistor Equations Using h-Parameters

Equations based on four h-parameters of base-input common-emitter circuit permit rapid calculation of operating characteristics for other circuit configurations, using easily obtained measurements

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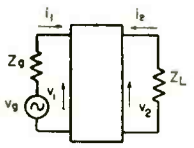
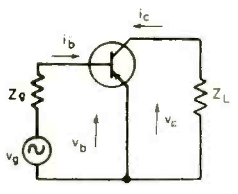
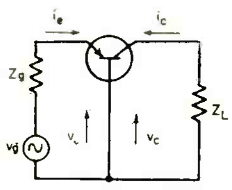
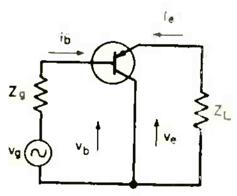
SIMPLIFICATION of transistor circuit calculations and measurements result from specifying the four-terminal network with input current i_1 and output voltage v_2 as independent variables and output current i_2 and input voltage v_1 as dependent variables. The h-parameters are thus introduced, and circuit equations become

$$v_1 = h_{11}i_1 + h_{12}v_2 = \frac{1}{y_{11}}\, i_1 + \mu_{12}v_2$$

$$i_2 = h_{21}i_1 + h_{22}v_2 = \alpha_{21}i_1 + \frac{1}{z_{22}}\, v_2$$

where h_{11}, h_{12}, h_{21} and h_{22} are the four h-parameters and $y_{11} = 1/h_{11}$ is defined as the short-circuit input admittance, $\mu_{12} = h_{12}$ the reverse open-circuit voltage gain, $\alpha_{21} = h_{21}$ the forward short-circuit current gain, and $Z_{22} = 1/h_{22}$ the open-circuit output impedance. These parameters are comparatively easy to measure and show directly the fundamental properties of the transistor, such as current gain. The fundamental parameters selected in this paper are the four h-parameters of the base-input common-emitter circuit. They are $y_{11e} = 1/h_{11e}$, $\mu_{bc} = h_{12e}$, $\alpha_{cb} = h_{21e}$, and $Z_{22e} = 1/h_{22e}$. All the circuit equations summarized in the following table for three basic circuit configurations are in terms of these four h-parameters so that application engineers can use them directly whenever the transistor h-parameters are specified.

CIRCUIT CONFIGURATION	COMMON EMITTER	COMMON BASE	COMMON COLLECTOR
			
h-Parameter $y_{11} = \frac{1}{h_{11}}$ $\mu_{12} = h_{12}$ $\alpha_{21} = h_{21}$ $z_{22} = \frac{1}{h_{22}}$ $S = 1 - \mu_{12}\alpha_{21}y_{11}z_{22}$	y_{11e} μ_{bc} α_{cb} z_{22e} $S_e = 1 - \mu_{bc}\alpha_{cb}y_{11e}z_{22e}$	$(1 + \alpha_{cb})y_{11e}$ $\mu_{ec} = \mu_{bc}\frac{S_e}{1 - S_e}$, if $\lvert\alpha_{cb}\rvert >> 1$ $\alpha_{ce} = \frac{-\alpha_{cb}}{1 + \alpha_{cb}} = -\alpha$; $\alpha \equiv -\alpha_{ce}$ $(1 + \alpha_{cb})z_{22e}$ $S_b = 1 + (1 + \alpha_{cb})S_e$	y_{11e} $\mu_{be} = 1 - \mu_{bc} \doteq 1 \quad \lvert\mu_{bc}\rvert << 1$ $\alpha_{eb} = -(1 + \alpha_{cb})$ z_{22e} $S_c = 1 + (1 - \mu_{bc})(1 + \alpha_{cb})y_{11e}z_{22e}$ $\doteq 1 + \alpha_{cb}y_{11e}z_{22e} \quad \lvert\alpha_{cb}\rvert >> 1, \ \lvert\mu_{be}\rvert << 1$

(continued on p 192)

Transistor Equations Using *h*-Parameters

(Continued from p 191)

CIRCUIT CONFIGURATION	COMMON EMITTER	COMMON BASE	COMMON COLLECTOR
Z-Parameters $z_{11} = \dfrac{S}{y_{11}}$ $z_{12} = \mu_{12} z_{22}$ $z_{21} = -\alpha_{21} z_{22}$	$\dfrac{S_e}{y_{11e}}$ $\mu_{bc} z_{22e}$ $-\alpha_{cb} z_{22e}$	$\dfrac{S_b}{(1 + \alpha_{cb}) y_{11e}} \doteq \dfrac{S_e}{y_{11e}}$ $\dfrac{S_e}{y_{11e}} - \mu_{bc} z_{22e}$ $\alpha_{cb} z_{22e}$	$\dfrac{S_c}{y_{11e}} \doteq \dfrac{1}{y_{11e}} + \alpha_{cb} z_{22e}$ $(1 - \mu_{bc}) z_{22e} \doteq z_{22e}$ $(1 + \alpha_{cb}) z_{22e} \doteq \alpha_{cb} z_{22e}$
Y-Parameters $y_{12} = -\mu_{12} y_{11}$ $y_{21} = \alpha_{21} y_{11}$ $y_{22} = \dfrac{S}{z_{22}}$	[illegible] $-\mu_{bc} y_{11e}$ $\alpha_{cb} y_{11e}$ $\dfrac{S_e}{z_{22e}}$	$\doteq \dfrac{S_e}{z_{22e}}$ $-\alpha_{cb} y_{11e}$ $= \dfrac{1 + (1 + \alpha_{cb}) S_e}{(1 + \alpha_{cb}) z_{22e}} \doteq \dfrac{S_e}{z_{22e}}$	$-(1 - \mu_{bc}) y_{11e} \doteq -y_{11e}$ $-(1 + \alpha_{cb}) y_{11e}$ $\dfrac{S_c}{z_{22e}} = \dfrac{1}{z_{22e}} + \alpha_{cb} y_{11e}$

	COMMON EMITTER	COMMON BASE	COMMON COLLECTOR
Other Parameters $\alpha_{12} = \dfrac{1}{\alpha_{21}}\left(1 - \dfrac{1}{S}\right)$ $\mu_{21} = \dfrac{1}{\mu_{12}}\left(1 - \dfrac{1}{S}\right)$	$\dfrac{1}{\alpha_{cb}}\left(1 - \dfrac{1}{S_e}\right)$ $\dfrac{1}{\mu_{bc}}\left(1 - \dfrac{1}{S_e}\right)$	$\alpha_{ec} = \dfrac{-\alpha_{cb} S_e}{1 + (1 + \alpha_{cb}) S_e}$ $\mu_{ce} \doteq -\dfrac{1}{\mu_{bc}}\left(1 - \dfrac{1}{S_e}\right)$	$\alpha_{be} = \dfrac{-1}{1 + \alpha + \dfrac{1}{y_{11e} z_{22e}}}$ $\mu_{eb} = \dfrac{1}{1 - \mu_{bc} + \dfrac{1}{(1 + \alpha_{cb}) y_{11e} z_{22e}}}$
Input Impedance $= Z_{in}$ $= \dfrac{1}{y_{11}} - \dfrac{\mu_{12}\alpha_{21}}{1 + \dfrac{Z_L}{z_{22}}} Z_L$	$Z_{in} = \dfrac{1}{y_{11e}} - \dfrac{\mu_{bc}\alpha_{cb}}{1 + \dfrac{Z_L}{z_{22e}}} Z_L$ $\doteq \dfrac{1}{y_{11e}} - \mu_{bc}\alpha_{cb} Z_L;\ Z_L << z_{22e}$	$Z_{in} = \dfrac{1}{(1 + \alpha_{cb}) y_{11e}};\ Z_L << z_{22e}$	$Z_{in} = \dfrac{1}{y_{11e}} + (1 + \alpha_{cb}) Z_L;$ $Z_L << z_{22e}$ [illegible]
Output Impedance $= Z_o$ $= \dfrac{1}{\dfrac{1}{z_{22}} - \dfrac{\mu_{12}\alpha_{21}}{Z_g + \dfrac{1}{y_{11}}}}$ $= \dfrac{z_{22}}{S} \quad Z_g < \dfrac{1}{y_{11}}$	$Z_o = \dfrac{1}{\dfrac{1}{z_{22e}} - \dfrac{\mu_{bc}\alpha_{cb}}{Z_g - \dfrac{1}{y_{11e}}}}$ $\doteq \dfrac{z_{22e}}{S_e} \quad Z_g < \dfrac{1}{y_{11e}}$	$Z_o \doteq \dfrac{z_{22e}}{\dfrac{1}{1 + \alpha_{cb}} + S_e};$ $Z_g < \dfrac{1}{y_{11e}(1 + \alpha_{cb})}$	$Z_o \doteq \dfrac{z_{22e}}{1 + \alpha_{cb} y_{11e} Z_{22e}}$ $\lvert \mu_{bc} \rvert < 1,\ \lvert \alpha_{cb} \rvert > 1$
Voltage Gain $= K_V$ $= \dfrac{-y_{11} Z_L}{S - \dfrac{Z_L}{z_{22}}}$ $\doteq -\dfrac{y_{11} Z_L}{S},$ if $Z_L << z_{22}$	$K_V = \dfrac{-y_{11e} Z_L}{S_e - \dfrac{Z_L}{z_{22e}}}$ $\doteq -\dfrac{y_{11e} Z_L}{S_e}$	$K_V = \dfrac{-y_{11e} Z_L}{S_e + \dfrac{1}{1 + \alpha_{cb}} - \dfrac{Z_L}{z_{22e}(1 + \alpha_{cb})^2}}$ $\doteq \dfrac{-y_{11e} Z_L}{S_e + \dfrac{1}{1 + \alpha_{cb}}}$	$K_V \doteq \dfrac{-y_{11e} Z_L}{1 + \alpha_{cb} y_{11e} z_{22e}}$

(Continued on p 194)

Cinch MICRO CONNECTORS

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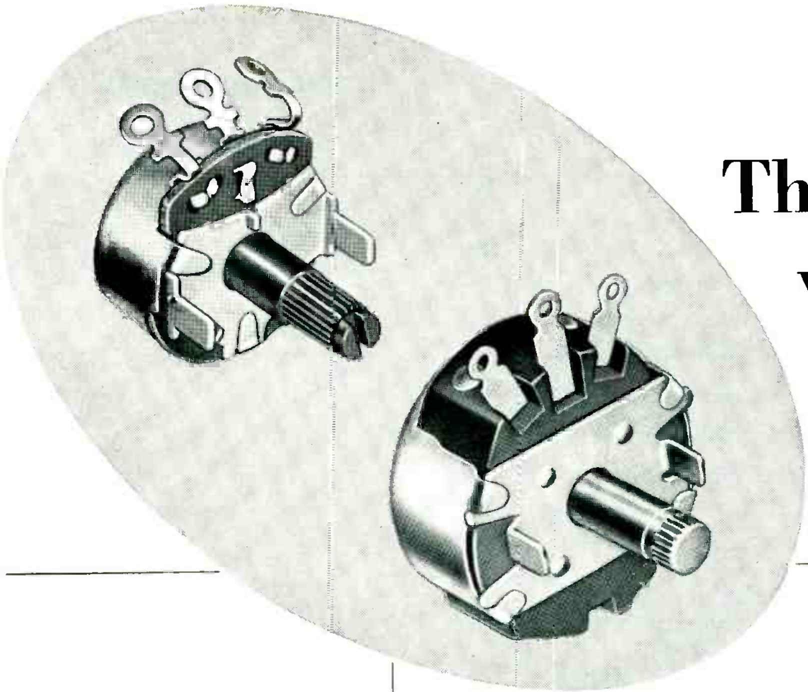
Transistor Equations Using *h*-Parameters

(Continued from p 192)

	COMMON EMITTER	COMMON BASE	COMMON COLLECTOR
Current Gain $= K_i$ $= \dfrac{\alpha_{21}}{1 + \dfrac{Z_L}{z_{22}}}$	$K_i = \dfrac{\alpha_{cb}}{1 + \dfrac{Z_L}{z_{22e}}}$	$K_i = \dfrac{-\alpha_{cb}}{1 + \alpha_{cb} + \dfrac{Z_L}{z_{22e}}}$	$K_i = \dfrac{-(1 + \alpha_{cb})}{1 + \dfrac{Z_L}{z_{22e}}}$
Power Gain $= K_p = 4R_gR_L \left[\dfrac{\alpha_{21}}{\left(Z_g + \dfrac{1}{y_{11}}\right)\left(1 + \dfrac{Z_L}{z_{22}}\right) - \mu_{12}\alpha_{21}Z_L}\right]^2$	$K_p = 4R_gR_L \left[\dfrac{\alpha_{cb}}{\left(Z_g + \dfrac{1}{y_{11e}}\right)\left(1 + \dfrac{Z_L}{z_{22e}}\right) - \mu_{bc}\alpha_{cb}Z_L}\right]^2$	$K_p = 4R_gR_L \left[\dfrac{\alpha_{cb}}{\left(Z_g + \dfrac{1}{(1 + \alpha_{cb})y_{11e}}\right)\left(1 + \alpha_{cb} + \dfrac{Z_L}{z_{22e}}\right) + \dfrac{S_eZ_L}{y_{11e}z_{22e}}}\right]^2$	$K_p = 4R_gR_L \left[\dfrac{1 + \alpha_{cb}}{\left(Z_g + \dfrac{1}{y_{11e}}\right)\left(1 + \dfrac{Z_L}{z_{22e}}\right) + \alpha_{cb}Z_L}\right]^2$

Equations listed above are applicable to both high and low-frequency operation. For the low-frequency case only, substitute g_{11e}, α_{cbo}, μ_{bco}, r_{22e}, and S_{eo} for y_{11e}, α_{cb}, μ_{cb}, z_{22e} and S_e respectively as shown in the equations that follow

Matched Input Resistance $=$ $R_{im} = \dfrac{\sqrt{S_o}}{g_{11}}$	$R_{im} = \dfrac{\sqrt{S_{eo}}}{g_{11e}}$	$R_{im} = \dfrac{\sqrt{S_{eo}}}{g_{11e}} \dfrac{1}{\sqrt{1 + \alpha_{cbo}}}$	$S_{co} = 1 + (1 + \alpha_{cbo})(1 - \mu_{bco})g_{11e}r_{22e} \doteq \alpha_{cbo}g_{11e}r_{22e}$ $R_{im} = \dfrac{\sqrt{S_{co}}}{g_{11e}}$
Matched Output Resistance $= R_{om} = \dfrac{r_{22}}{\sqrt{S_o}}$ Ratio $\dfrac{R_{om}}{R_{im}} = \dfrac{r_{22}}{r_{11}} = \dfrac{r_{22}g_{11}}{S_o}$	$R_{om} = \dfrac{r_{22e}}{\sqrt{S_{eo}}}$ $\dfrac{R_{om}}{R_{im}} = \dfrac{r_{22e}g_{11e}}{S_{eo}}$	$R_{om} = \dfrac{r_{22e}}{\sqrt{S_{co}}}\sqrt{1 + \alpha_{cbo}}$ $\dfrac{R_{om}}{R_{im}} = \dfrac{r_{22e}g_{11e}}{S_{co}}(1 + \alpha_{cbo})$	$R_{om} = \dfrac{r_{22e}}{\sqrt{S_{co}}}$ $\dfrac{R_{om}}{R_{im}} = \dfrac{r_{22e}g_{11e}}{S_{co}} \doteq \dfrac{1}{\alpha_{cbo}}$
Matched Voltage Gain $=$ $K_{Vm} = \dfrac{-\alpha_{21o}g_{11}r_{22}}{S_o + \sqrt{S_o}}$	$K_{Vm} = \dfrac{-\alpha_{cbo}g_{11e}r_{22e}}{S_{eo} + \sqrt{S_{eo}}}$	$K_{Vm} = \dfrac{\alpha_{cbo}(1 + \alpha_{cbo})g_{11e}r_{22e}}{1 + (1 + \alpha_{cbo})S_{co} + \sqrt{1 + (1 + \alpha_{cbo})S_{co}}}$ $\doteq \dfrac{\alpha_{cbo}g_{11e}r_{22e}}{S_{co} + \sqrt{\dfrac{S_{co}}{1 + \alpha_{cbo}}}}$	$K_{Vm} = \dfrac{(1 + \alpha_{cbo})g_{11e}r_{22e}}{S_{co} + \sqrt{S_{co}}}$
Matched Current Gain $=$ $K_{im} = \dfrac{\alpha_{21o}}{1 + \dfrac{1}{\sqrt{S_o}}}$	$K_{im} = \dfrac{\alpha_{cbo}}{1 + \dfrac{1}{\sqrt{S_{eo}}}}$	$K_{im} \doteq \dfrac{-\alpha_{cbo}}{(1 + \alpha_{cbo})\left(1 + \sqrt{\dfrac{1}{\alpha_{cbo}S_{co}}}\right)}$	$K_{im} = \dfrac{-(1 + \alpha_{cbo})}{1 + \dfrac{1}{\sqrt{S_{co}}}}$
Matched Power Gain $=$ $K_{pm} = \dfrac{g_{11}r_{22}\alpha_{21o}^2}{S_o\left(1 + \dfrac{1}{\sqrt{S_o}}\right)^2}$	$K_{pm} = \dfrac{g_{11e}r_{22e}\alpha_{cbo}^2}{S_{eo}\left(1 + \dfrac{1}{\sqrt{S_{eo}}}\right)^2}$	$K_{pm} \doteq \dfrac{g_{11e}r_{22e}\alpha_{cbo}^2}{\dfrac{S_{co}}{\alpha_{cbo}}\left(1 + \sqrt{\dfrac{1}{\alpha_{cbo}S_{co}}}\right)^2}$	$K_{pm} = \dfrac{g_{11e}r_{22e}(1 + \alpha_{cbo})^2}{S_{co}\left(1 + \dfrac{1}{\sqrt{S_{co}}}\right)^2}$



These tab-mounted variable controls can trim your assembly costs

Looking for cost-cutting ideas? Mallory bushingless tab-mounted controls, either carbon or wire-wound, may be just what you need. They save you money in several ways:

Easier mounting: just twist the tabs, and the control is installed on the chassis. Extra built-in *stabilizing points* increase rigidity of mounting . . . prevent rocking.

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Ideal for service adjustments in television receivers, these controls afford the high standards of Mallory performance at economical price. Both carbon and wire-wound types are available in choice of ratings, with or without attached switch. The carbon controls offer additional economies: an optional phenolic shaft at lower cost than steel, and a rotational stop that gives the effect of a fixed and variable resistor in a single unit.

For complete information, write today for the new Mallory Technical Bulletin.

Specifications:

	Carbon Controls	*Wire-Wound Controls*
Resistance:	200 ohms to 10 megohms	3 to 15,000 ohms
Tolerance:	+30% standard; ±20% available	+10% (closer tolerance on request)
Wattage:	Linear: ½ watt Other tapers: ¼ watt	2 watts
Size:	15/16″ dia., 17/32″ deep	1 19/64″ dia., 5/8″—.640″ max.
Tapers:	Linear, logarithmic, reverse logarithmic	Linear (standard): others on request
Shaft:	Steel or phenolic	Steel
Mounting:	Two mounting lugs on 7/16″ radius	

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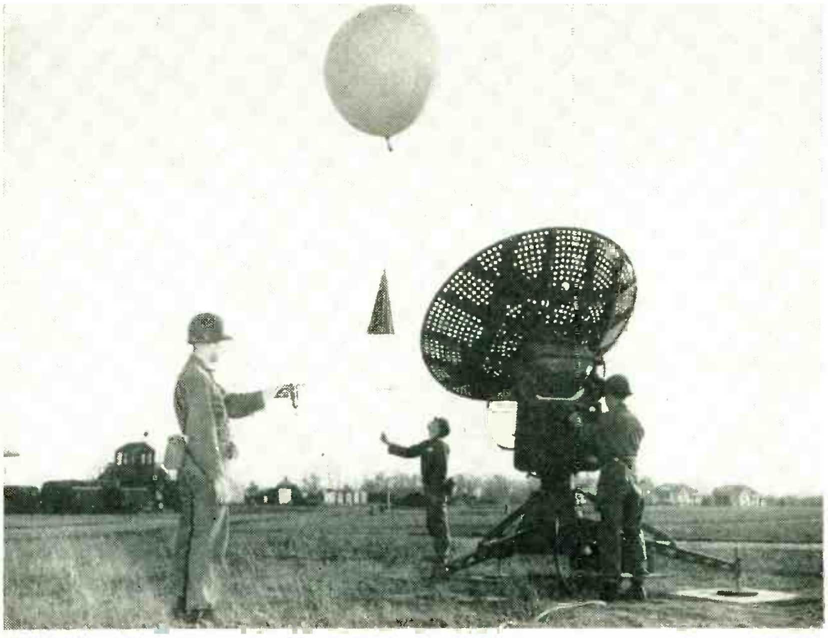
ELECTRONS AT WORK

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS

featured in this issue:



Rawinsonde Probes Troposphere

Signal Corps personnel at Fort Monmouth, N. J. release sounding balloon equipped with parachute and radiometerograph. Radar antenna at right follows the free balloon to show wind velocity and direction while radio sounding equipment sends back signals to indicate altitude, temperature and relative humidity. Although most equipment released on east coast is lost over the Atlantic, the parachute protects individuals and ocean craft from injury

Automatic Goniophotometer Measures Gloss

A TYPE OF GLOSS known as distinctness-of-image gloss (DIG) controls the sharpness of images seen in a reflecting surface. Measurement of this characteristic has been obtained with an instrument that scans rapidly over a small range of angles centered on the angle of specular reflection. By electronic means, the maximum slope of the goniophotometric curve is measured by a meter deflection. Results with the instrument correlate well with judgements of trained observers.

The mechanical layout of the device is shown in Fig. 1. Light from lamp S passes through a slit and is reflected from test sample X to pass through simple lens L and then imaged on motor-driven disk D. Transmitted light falls on phototube P. Output is amplified and differentiated before going to voltmeter equipment where rectified d-c is registered on a microammeter.

Figure 2A represents the function and its time derivative for a perfect reflector. Fig. 2B shows the typical curves for a glossy paint sample. Distortion of the curves caused by varying frequency response is not sufficient to affect results seriously.

Circuit of the experimental equipment, shown in Fig. 3, indicates that the photocurrent develops a voltage across the tapped resistor in the photocathode circuit, a portion of which is selected and amplified by the first type 6AU6 tube. Output is either attenuated by the R_3-R_2 network by closing the switch in the right direction or differentiated

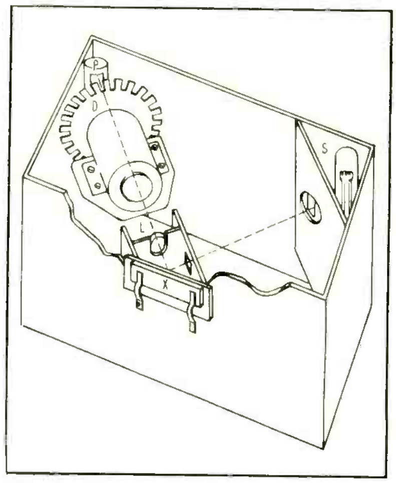
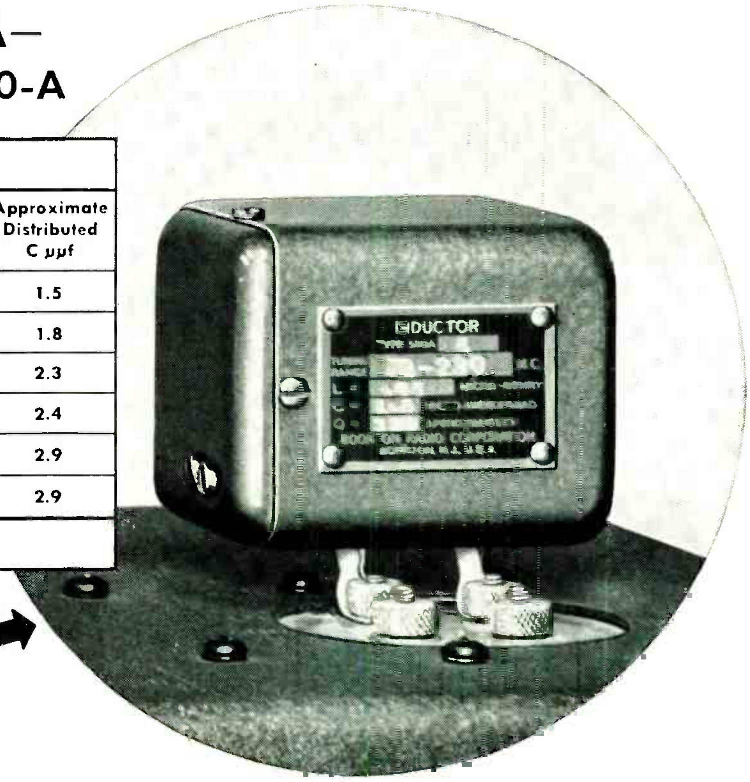


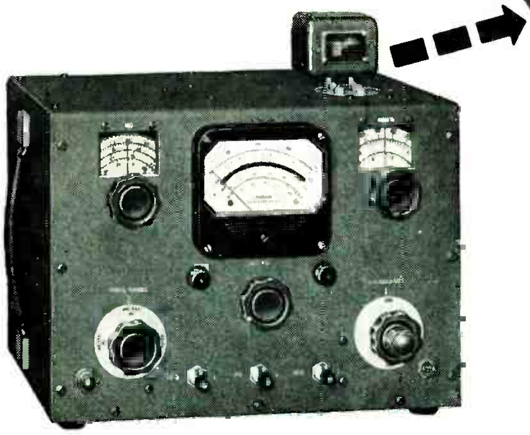
FIG. 1—Mechanical detail of the goniophotometer. Test sample is placed at X. Reflected light passing through rotating shutter D is received by phototube P

NEW Q Meter Inductors for measurements up to 260 mc!

INDUCTORS Type 590-A— accessories to Q Meter Type 190-A

TYPE 590-A INDUCTORS					
Type	Inductance μh	Capacitance μμf	Approximate Resonant Freq. mc	Approximate Q	Approximate Distributed C μμf
590-A1	0.05	8.0 — 95.0	70 — 230	320	1.5
590-A2	0.1	10 — 100	50 — 160	350	1.8
590-A3	0.25	8.0 — 80.0	30 — 100	310	2.3
590-A4	0.5	7.5 — 80.0	25 — 70	340	2.4
590-A5	1.0	7.5 — 65.0	20 — 50	300	2.9
590-A6	2.5	9.0 — 25.0	20 — 30	300	2.9
PRICE: $10.00 each F.O.B. BOONTON, N. J.					





Q METER Type 190-A

This new 190-A Q Meter measures an essential figure of merit of fundamental components to better overall accuracy than has been previously possible. The VTVM, which measures the Q voltage at resonance, has a higher impedance. Loading of the test component by the Q Meter and the minimum capacitance and inductance have been kept very low.

SPECIFICATIONS—TYPE 190-A

FREQUENCY RANGE: 20 mc. to 260 mc.

RANGE OF Q MEASUREMENT:

Q indicating voltmeter	50 to 400
Low Q scale	10 to 100
Multiply Q scale	0.5 to 3.0
Differential Q scale	0 to 100
Total Q indicating range	5 to 1200

PERFORMANCE CHARACTERISTICS OF INTERNAL RESONATING CAPACITANCE: Range—7.5 mmfd. to 100 mmfd. (direct reading).

POWER SUPPLY: 90-130 volts — 60 cps (internally regulated).

Type 190-A Price: $625.00 F.O.B. Factory

Inductors Type 590-A are designed specifically for use in the Q Circuit of the Q Meters Type 170-A and 190-A for measuring the radio-frequency characteristics of condensers, resistors, and insulating materials. They have general usefulness as reference coils and may also be used for periodic checks to indicate any considerable change in the performance of the Q Meters.

Each inductor Type 590-A consists of a high Q coil mounted in a shield and is provided with spade lugs for connection to the coil terminals of the Q Meters. The shield is connected to the lugs which connect to the Low Coil terminal in order to minimize any changes in characteristics caused by stray coupling to elements or to ground.

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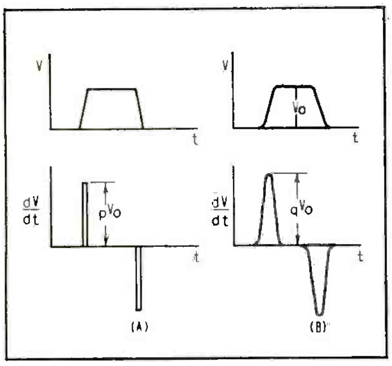


FIG. 2—Function and time derivative for perfect reflector (A) and for glossy paint sample (B)

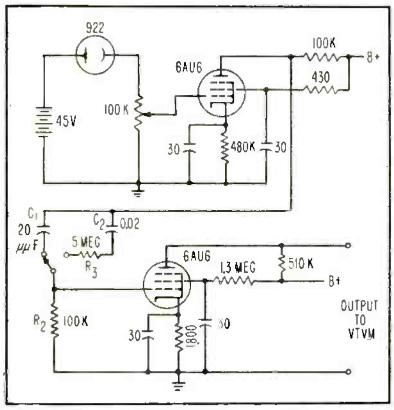


FIG. 3—Basic circuit of the gloss-measuring device. in the left position, the phototube signal is differentiated

by network C_1R_2 by closing it to the left.

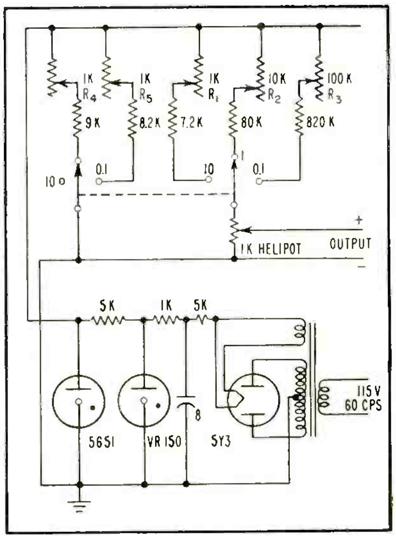
Output from either network is amplified by the second 6AU6 and the resultant voltage measured by the vacuum-tube voltmeter.

In making measurements, a suitable standard of gloss is inserted (such as a flat, polished piece of black glass or a front-coated aluminum mirror), the vtvm set to zero and the lamp voltage increased until the differentiated voltage reaches a certain amplitude. The standard is replaced by the sample, the lamp voltage readjusted and the value of DIG read on the meter.

A description of the instrument and its use, published in the *Canadian Journal of Technology*, has been abstracted here by permission of one of the authors, W. E. K. Middleton of the National Research Council, Ottawa, Canada.

Test Voltage Reference

MORE VERSATILE than the usual standard cell, an adjustable voltage reference for which the circuit is shown in the diagram gives 0.1, 1.0 and 10 volts full scale with an



Circuit of the adjustable voltage reference employing two gas tubes

accuracy of 0.5 percent of full scale, the voltage being continuously variable.

Output from the rectifier is maintained constant at 150 volts by means of the type VR150. A second voltage regulator, type 5651 maintains a very stable voltage across its terminals of 87 volts.

Calibration resistors R_1, R_2 and R_3 are used to set the scales accurately. Resistors R_4 and R_5 maintain

Monitor Measures Intensity of Radioactive Concrete

Research technician at left checks activity near opening of hollow concrete cylinder as operator inserts tube of chemical solution that decomposes at a known rate for calibration purposes. Block was constructed at Argonne National Laboratory of cement and radioactive fission products from nuclear reactor and will be used in Department of Food Technology, M.I.T.

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LIQUID-LEVEL GAUGE WEARS 7 LEAGUE BOOTS

Taking inventory was an oil-industry headache until the Shand & Jurs Company of Berkeley, California developed its Electronic Precision Remote-Reading Tank Gauge System... relying on HELIPOT* precision potentiometers for translating critical measurements into voltages which are transmitted to an indicator located miles away.

Tank-gauging starts with a float riding on vertical guides. A perforated metal tape runs up from the float...over a sprocket-wheel...and down to a counterweight.

The sprocket-wheel, through a gear train, drives two HELIPOTS. The shaft of the first... a Model A, 10-turn unit... rotates 3600° as the float moves from the bottom of the tank to the top. The shaft of the other... a Model F, continuous-rotation unit... makes a full turn for each foot the float moves.

The voltage outputs of the two HELIPOTS are conducted to the remote station where either can be fed to the circuit of a Brown Instrument Co. self-balancing Wheatstone bridge.

The voltage of the Model A HELIPOT is read directly in feet... that of the Model F HELIPOT in 1/8" increments. Inventory of any number of tanks can be made quickly... by successively switching the outputs of their HELIPOTS into the circuit of the indicator.

Operating on a tank containing petroleum vapor, the HELIPOTS must be housed in an explosion-proof chamber. To overcome the problem of moisture condensation, the HELIPOTS operate completely immersed in oil... which enters the HELIPOTS themselves through holes in their housings. Condensation is drained periodically from the bottom of the chamber. Identical HELIPOTS, laboratory-tested while similarly immersed, showed negligible wear of coil or slider contact after 2 million revolutions.

Application Data... For complete details on this and other applications, write for Data File No. 402

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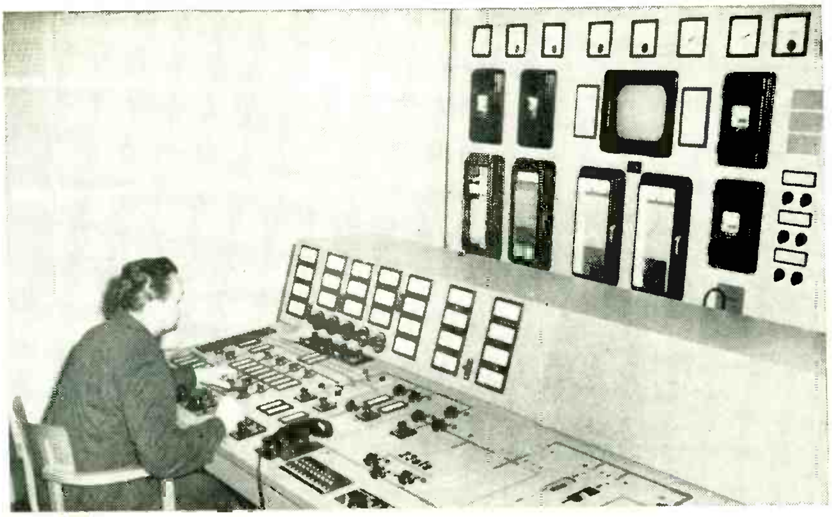
a constant drain from the power supply when switching to the 1 and 0.1-volt ranges.

Information on this circuit has been furnished by General Precision Laboratory, Inc.

Television Aids Turbine Control

TELEVISION VIEWING screen (top center) in newly installed control room of giant Reuter power plant in West Berlin, Germany, enables operator to watch distant turbines and other machinery. →



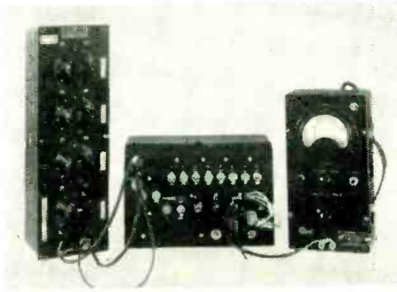
Matching Resistors at A-C

BY CONRAD JOSIAS

Engineer
Airborne Instruments Laboratory, Inc.
Mineola, N. Y.

TO CONTROL the quality of noninductive wirewound resistors in production and to select them for applications presents a problem in instrumentation. A matching technique has been developed that uses inexpensive equipment for tests that can be performed by unskilled operators.

A bridge system utilizes two very low-impedance legs in the form of an accurately center-tapped computer reference transformer. The technique is reciprocal in nature so that by using relatively coarse components (one-percent carbon resistors), it is possible to bridge-select a transformer having an excellent phase characteristic and a center tap not more than 0.01 percent in error. The transformer introduces no amplitude error in the ratio match. However, it is necessary to take into account the inherent quadrature voltage that appears at the null point of the bridge resulting from imperfect phase qualities of the transformer under test.



Test set and auxiliary equipment used in selecting matched pairs of resistors

When the unknown pair of resistors R_1 and R_2, to be matched are nominally equal, the equipment operates as a 1-to-1 bridge as shown in Fig. 1A. At the null as indicated by the meter

$$R_1/R_2 = 1 + \epsilon \qquad (1)$$

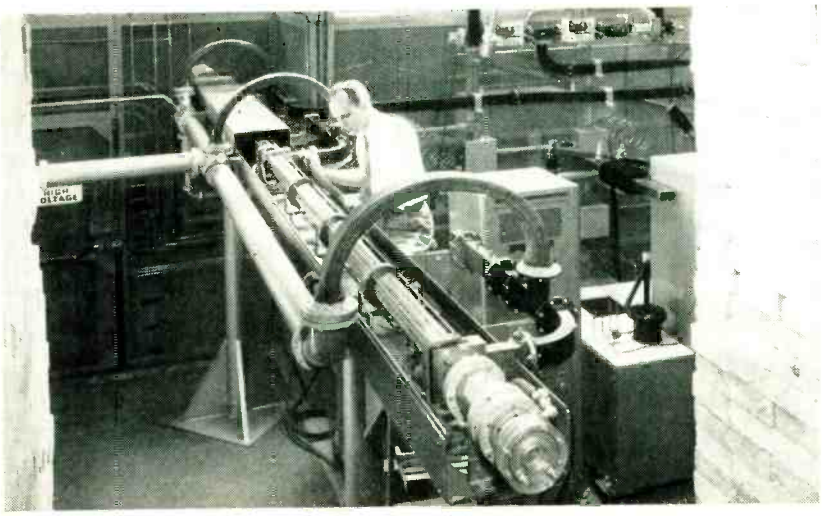
where

$$\epsilon = [(R_{X1} + R_{X2}) - (R_{Y1} + R_{Y2})]/2R_1$$

and subscripts $X1$ and $Y1$ indicate the values for null with the reversing switch in its first position, the $X2$ and $Y2$ indicate the values for null with the switch in its second position. The accuracy with which resistors were to be matched by this bridge was such that $\epsilon \leqq 0.0001$.

The reversing switch eliminates the amplitude error from the transformer and permits the use of nonprecision resistors for R_X and R_Y. For ϵ as low as 0.0001, carbon potentiometers and a multimeter can be used.

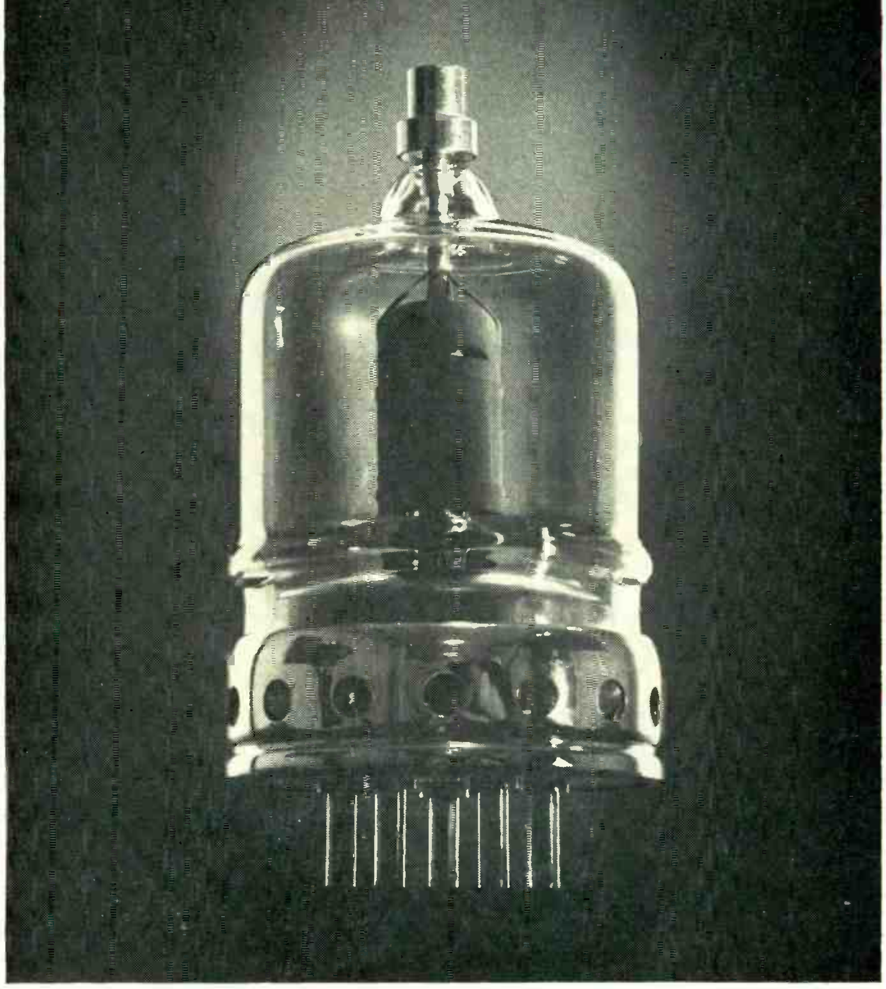
Should the meter measurement of the potentiometers be in error by 10 percent, an actual ratio of $R_1/R_2 = 1.0001$ might be measured as



Atom Smasher to Fight Cancer

Microwave linear accelerator built by High Voltage Engineering Corp. will be installed at Argonne Cancer Research Hospital. It is based upon designs from Stanford University and develops 50 million volts. Powered by two special klystrons, this linear accelerator launches bursts of electrons onto traveling radar waves. As electrons travel a 16-foot waveguide they reach a speed approximating that of light and weigh 100 times more than when they started. At the end of the guide, the high-voltage electrons pass through a thin aluminum window to be used for cancer research

TIME-TRIED TETRODE



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MODERN in every respect—with exclusive Sintercote black-body high-dissipation anode and emission-free grids—the Los Gatos 4D21/4-125A provides a new source of supply for a widely-applied tetrode type. Check Los Gatos for your requirements in other types with emphasis on long service life.

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1.0001 ± 0.00001, which is a workable accuracy. With this 1-to-1 measurement, if components of the same construction are used, it is possible to match resistors up to about a megohm without difficulty in reactive mismatch.

For matching resistor pair R_1 and R_1, where $a > 1$, the bridge shown in Fig. 1B is used. Assuming an ideal transformer, perfectly balanced in phase and amplitude

$$a = 1 + (1/b) + (R_2/R_1) \qquad (2)$$

Leg bR_2 is a bank of equal resistances. By paralleling various numbers of these resistors, the test set can be arranged to measure a wide variety of ratios. In one model of the test set, shown in the photograph, a row of toggle switches controls the number of standard resistors paralleled to form bR_2.

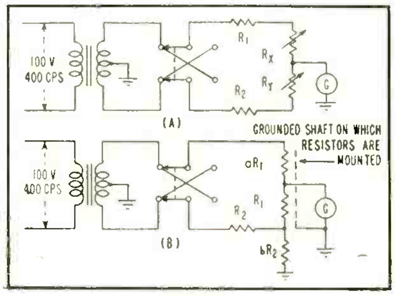

FIG. 1—Comparison bridge (A) for nominally equal resistors and general-purpose ratio-measuring bridge (B) for nonequal resistors

By using this mode of operation, the term $1/b$ becomes an integer whereas in Eq. 2 the term $1/b$ need not be an integer. For a workable bridge, a balancing resistor R_x must be inserted somewhere and new equations evolved. Utilizing the reversing switch and R_x in series with any of the four legs, the measured ratio a, in each case, as determined by the position of the null is given in Table I where $R_x = (R_{x1} + R_{x2})/2$ and the subscripts have the meaning as before.

With resistor ratios from 2 to 7 (not necessarily integral) it is often possible to keep measurement inaccuracies below 0.01 percent. Ratios approaching 10 are often difficult to measure to better than 0.05 percent, however.

Proper reactive balances must be obtained to achieve accurate measurement of resistance ratios. Should the null contain excess quadrature

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TABLE A
BASIC PHYSICAL CONSTANTS OF COMMON MAGNETIC MATERIALS

Trade Name	% Ni	% Fe	Other	Grain Structure	Satur. Flux Density Gausses	Resistivity Microhm-Cm	Curie Point °C	Dens. Grams per cc
Hy Mu 80	79	17	4 Mo	"random"	8,700	57	420	8.72
48 Alloy	48	52	....	"random"	16,000	45	500	8.3
Orthonol	50	50	....	oriented	15,500	45	500	8.25
Magnesil	..	97	3 Si	oriented	20,000	48	700	7.65

TABLE B
TRADE NAMES OF SIMILAR MATERIALS

Hy-Mu 80	48 Alloy	Orthonol	Magnesil
4-79 Permalloy	Carpenter 49	Orthonik	Armco Oriented T
Mo-Permalloy	Allegheny 4750	Permeron	Hypersil
Mu Metal*	Hypernik	Deltamax	Orthosil
		Hypernik V	Silectron

Typical of the unusual scope of the material contained in Catalog TWC-100 are Tables A and B, reproduced from Page 4 of "Performance-Guaranteed Tape Wound Cores."

GET THE COMPLETE STORY

A wealth of new and unusual material on Tape Wound Cores is available to you in Catalog TWC-100, "Performance-Guaranteed Tape Wound Cores." Tables A and B of the catalog, reproduced on this page, present a striking illustration of material not to be found compiled together elsewhere.

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voltage, the balance setting of R_x will be far from accurate.

For some low-resistance resistors that are slightly inductive, paralleling high-impedance noninductive windings sometimes produces the desired capacitive effect. After the resistors are mounted on the bridge, capacitance can be trimmed to obtain a balance minimum of the proper magnitude, thereby completing the ratio test. A capacitor is added in parallel to the appropriate bobbin making the pair ready for installation.

Table I—Equations of Matching Ratio for Series Combinations of R_X

R_X in series with	a
aR_1	$1+(1/b)+(R_2-R_X)/R_1$
R_1	$(1+1/b)(1+R_X/R_1)+R_2/R_1$
R_2	$1+(1/b)+(R_X/bR_2)+(R_2+R_X)/R_1$
bR_2	$1+(R_2/R_1)+R_2/(bR_2+R_X)$

The capacitive trimming has made possible the measurement of resistance at a-c. At the same time the trimming has compensated for distributed capacitance and resistor standards in the bridge. Final trimming is accomplished in the amplifier itself which has a different array of parasitic capacitance than the bridge. The trimming is finished when the phase of the null voltage is aligned with the phase of the input.

Air-Sea Rescue System

A RADIO SEARCH system using a cathode-ray indicator to show the location of the person in distress also provides for two-way communication when the rescuing plane or ship draws near the position.

The equipment carried by wrecked personnel consists of a radio-beacon transmitter with antenna, speech modulator and receiving unit. The unit uses two tubes, one for beacon and one for voice transmitter-receiver.

To use the transmitter the wrecked person removes the protective cover from the rolled self-erecting, flexible metal-tape antenna. The length of the antenna is 62 percent of 243-mc wavelength,

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which has been found to be optimum for land and sea operations.

When operating as a beacon the equipment transmits a coded 243-mc pulse generated in an optimized squegging oscillator controlled to provide groups of pulses at a low pulse-repetition frequency. Details of this pulsing are shown in Fig. 1. Each beacon has a different pulse spacing making it possible for the rescuer to tell them apart.

The peak power output of approximately 16 watts gives the beacon unit a maximum range of 66 miles to a rescue aircraft at 10,000 feet altitude, and 6 miles to a rescue ship with a 30 to 40-foot receiving antenna. These ranges are, of course, also determined by sensitivity of the rescue receiver. Battery capacity is adequate to maintain this signal for 20-hours continuous duty.

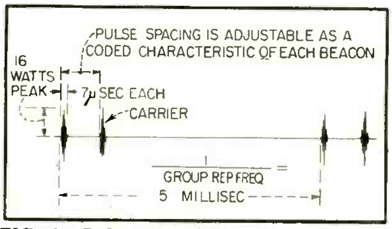

FIG. 1—Pulse group signal transmitted by SARAH rescue equipment. Spacing of pulses in group is variable from 15 to 300 μsec

When the wrecked person is within visual or audible distance of the spotting or rescue aircraft or ship, he can operate a three-position switch to transmit voice. Modulation is by pulse-repetition-frequency variation of a 12,000-pps signal.

Battery capacity is adequate for 19 hours of beacon operation and 1 hour of voice transmit-receive operation.

With the selector switch in the receive position, amplitude modulated c-w from rescue craft can be received by means of a superrengenerative receiver with a squegging rate of about 30 kilocycles. The carrier frequency is 243 megacycles.

The receiver presents a cathode-ray indication of the search area during the search phase shown in Fig. 2. Any beacons within the region covered by the receiving antenna appear as spikes on a ver-

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Self-Contained Normal Surface Illuminator. Built-in 1500-watt light source provides maximum surface illumination to inspect surface details, recesses, and blind holes.

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Bright Screen Image. The 500-watt light source for shadow projection provides sharp, easy-to-read screen image across the full 30-inch diameter.

Built-In Helix Table. Worktable rotates 15° off center for compounding helix angles.

Direct-Reading Rotary Screen. Graduated to 2′ of arc. Angular measurement is read directly from a dial without vernier. Dial may be zeroed, eliminating lost time in aligning protractor ring.

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Uni-Strut Assembly. Provides maximum rigidity. Projection lenses and mirrors sturdily mounted on a single member.

Compact Design. Floor space required for the Kodak Contour Projector, Model 30, is approximately 1/5 less than that required for other 30-inch projectors.

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tical reference trace of a c-r tube. By time sharing methods, a right and left antenna on the aircraft are arranged to display beacon spikes either to the right or left of the vertical reference trace. Directional information is thereby obtained. The right and left antenna patterns are inclined forward, and overlap ahead to provide a means for homing on the beacon.

When the first pulse from a beacon is received a linear vertical trace is initiated on the cathode-ray

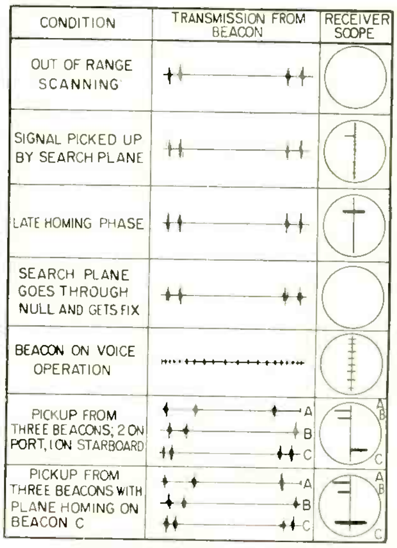

FIG. 2—Beacon-unit transmission, and indications on receiver crt for various operating conditions

tube. The second pulse deflects the trace either to the right or left, depending on which antenna has received the signal. Since the beacon pulses are transmitted with a fixed, characteristic time spacing of group pulses, succeeding pulse groups rewrite the spike at the same place on the cathode-ray tube. The time-sharing frequency being about 30 cycles per second and the group-repetition frequency being about 200 groups per second, each spike is rewritten approximately 3 times in its half of the time-sharing cycle

As the aircraft flies over the beacon, the beacon signal will suddenly vanish, due to the vertical radiation pattern characteristic of the beacon antenna. By this method a fix is obtained. The width of the null will naturally vary with the altitude of the homing antenna.

When the beacon is switched for voice transmission, the cathode-ray presentation indicates a number of

Ultra-Stable Microwave Oscillator

MODEL 804

The LFE Model 804 Microwave Oscillator provides a source of highly stabilized microwave frequencies suitable for use as a local oscillator for microwave measurements, or in many other applications where a high degree of stability is required, such as Q measurements, SWR measurements and general narrow band design work. A dial accurately calibrated directly in frequency is an important feature. The main elements of the unit are a klystron oscillator, a stabilizing monitor loop which consists of a calibrated dual-mode reference cavity, a feedback amplifier and a self-contained power supply. Means are provided for modulating the oscillator.

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Frequency Coverage
8,500 – 10,000 Mc – X-Band

Dial Calibration
Calibrated directly in frequency—
1 Mc per division

Frequency Stability
Short Term Deviation – less than one part in 10^8
Long Term Drift – negligible after complete warm-up

Modulation
Can be modulated 25% when stabilized;
100% modulation possible when stabilization is removed

Power Output
80 – 100 milliwatts
Output flange – UG 40/U

Power Consumption
160 watts

Size
12-7/32" x 19" front panel, 19-1/4" deep, cabinet or rack mounting

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equally spaced spikes produced by the 12,000-pps unmodulated carrier.

When the beacon goes on receive, the cathode-ray screen displays a number of small readily identifiable spikes indicating that the wrecked person is ready for voice reception.

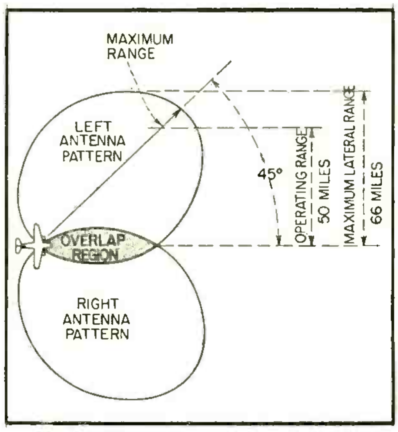

FIG. 3—Pattern of antennas on search plane. Overlap region in center is used for homing on beacon

The aircraft search and homing antenna is an elementary parasitic type having a driven dipole and one director. It has a directivity pattern as shown in Fig. 3. The overlapping of the right and left lobes from the two antennas makes homing possible since when the beacon is within a few degrees of dead ahead, spikes are shown on both sides of the crt vertical trace. When the spikes are exactly equal in length, the aircraft is headed directly for the beacon.

Aboard a rescue vessel a servo positioned Adcock homing array is employed.

Mixture Consistency Recorder

THE POWER required to drive a mixer agitator is a function of the consistency of the mixture. By installing power-measuring equipment on a mixing or blending operation, it is possible to use the power measurement to regulate and record the consistency of the mixture.

The equipment consists of two components, a three-phase transformer-thermal converter assembly and an electronic potentiometer recorder.

The transformer and thermal-converter assembly generate a d-c potential directly proportional to

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the power consumed by the motor. This emf is applied to the electronic potentiometer, which continuously records it.

The transformer and thermal-converter consists of heaters, thermocouples and a network of transformers for both potential and current input as shown in Fig. 1. Although heat generated in a resistance is proportional to the square of the current flowing through it,

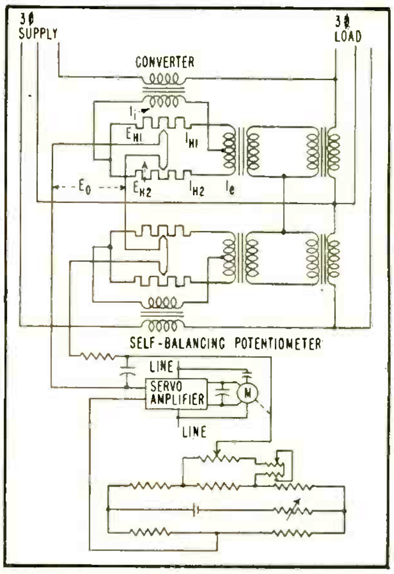

FIG. 1—Circuit of dough-consistency recorder. Thermocouples measure power consumed by three-phase motor driving agitator to indicate consistency

the output of this device is a linear function of the power being measured. This is accomplished by using a circuit that provides for cancellation of all squared terms leaving only a term proportional to the product of the in-phase voltage and current. In Fig. 1, the output to the potentiometer is equal to $E_{H1} - E_{H2}$. (1)

Thermocouples with output linear with temperature will generate voltage that will be a constant K times temperature T.

$$E_{H1} = K_1 T_{H1} \quad (2A)$$
$$E_{H2} = K_1 T_{H2}. \quad (2B)$$

Heat generated in a resistance is proportional to the square of the current flowing through it.

$$T_{H1} = K_2 I_{H1}^2 \quad (3A)$$
$$T_{H2} = K_2 I_{H1}^2 \quad (3B)$$

Combining the two sets of equations

$$E_{H1} = K_3 I_{H1}^2 \quad (4A)$$
$$E_{H2} = K_3 I_{H2}^2 \quad (4B)$$

The current flowing through the

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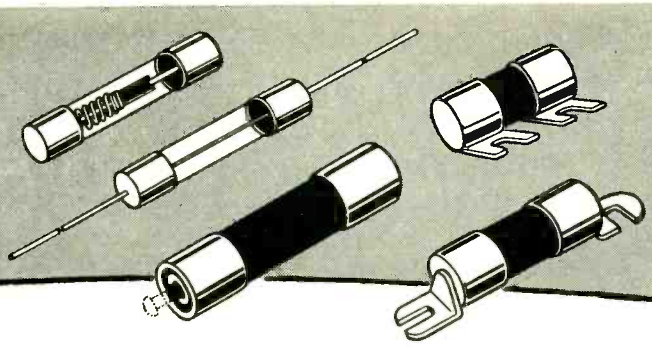

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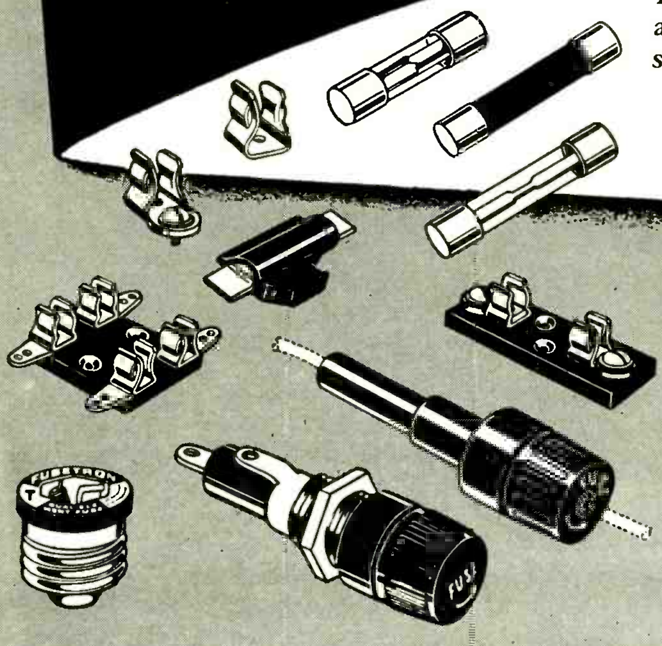

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heating elements is the algebraic sum of the current from the current and potential transformers.

$$I_{H1} = I_e + \tfrac{1}{2}I_i \qquad (5A)$$

$$I_{H2} = I_e - \tfrac{1}{2}I_i \qquad (5B)$$

Squaring Eq. 5

$$I_{H1}^2 = I_e^2 + I_eI_i + \frac{I_i^2}{4} \qquad (6A)$$

$$I_{H2}^2 = I_e^2 + I_eI_i + \frac{I_i^2}{4} \qquad (6B)$$

Combining Eq. 4 and 6

$$E_{H1} = K_3\left(I_e^2 + I_eI_i + \frac{I_i^2}{4}\right) \qquad (7A)$$

$$E_{H2} = K_3\left(I_e^2 - I_eI_i + \frac{I_i^2}{4}\right) \qquad (7B)$$

Combining Eq. 1, 7A and 7B

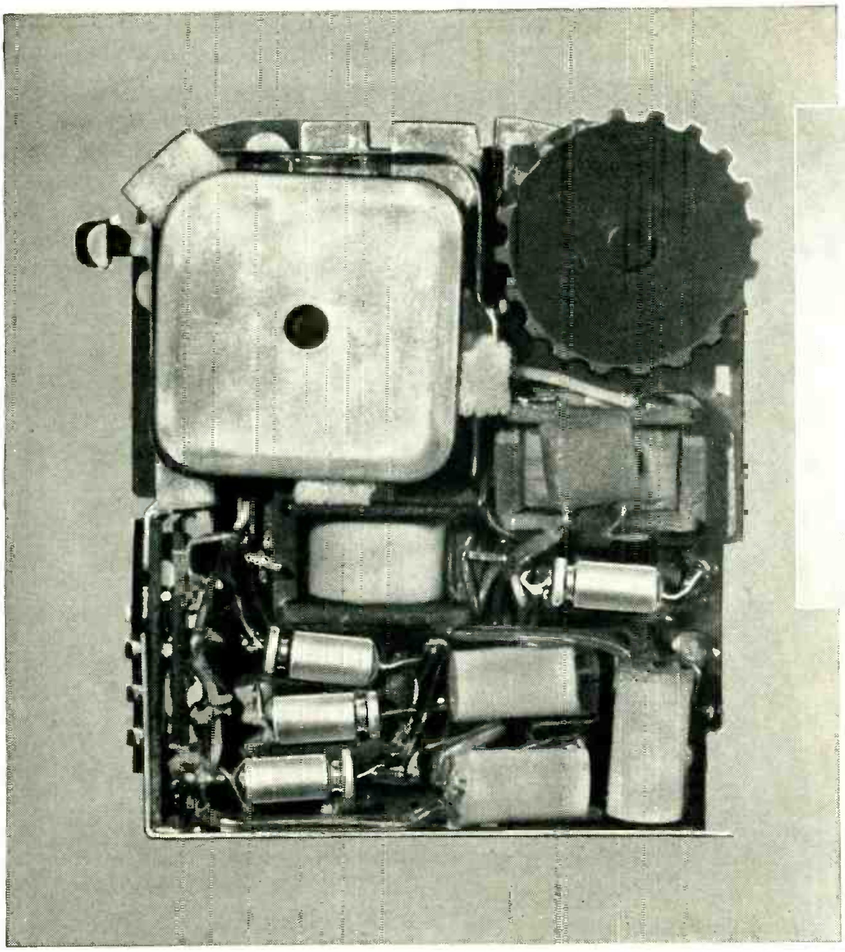
$$E_o = 2K_3I_eI_i \qquad (8)$$

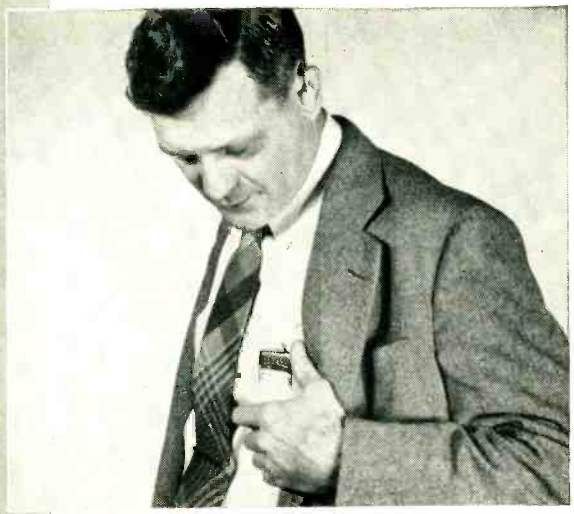
The recorder used is the Brown electronic strip-chart potentiometer. The input circuit differs slightly from that used in a millivoltage measuring instrument in order to eliminate the rapid power fluctuations caused by the mixing arms entering and leaving the mixture. The resultant record is a graph of consistency.

Transducers for Ultrasonic Drilling

A PRACTICAL limit to the maximum cutting rates obtainable from a transducer used for ultrasonic drilling is set by the danger of fatiguing the material of the transducer under high alternating stresses set up in it. However, by careful design of transducer-to-drill bit couplings it is possible to produce more intense vibrations at the tip than those obtainable at the transducer face. This is achieved by using a step-up velocity transformer in the form of a tapered stub of metal. If properly designed, large oscillatory amplitudes, many times those at the transducer face, can be obtained at the free end. It is then feasible to operate the transducer at extremely low power levels and still obtain large motions at the drill.

To obtain maximum drilling rates, the tool must be made to move with as large an oscillatory amplitude as possible, the velocity at the tip being much less important than the displacement. This means that a low operating fre-





Four G-E Micro-miniature Tantalytic capacitors easily fit into small space provided in this new all-transistor hearing aid. Man above adjusts volume control.

Other applications now being investigated:

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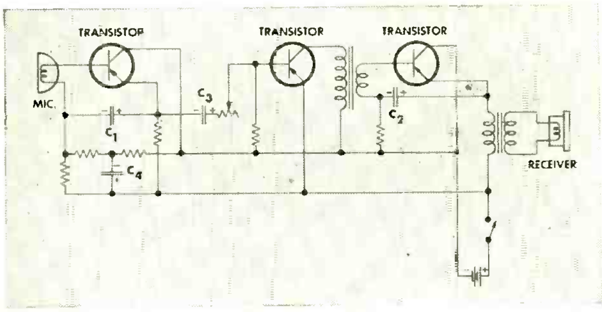
How Tantalytic Capacitors Are Used In Miniaturized Hearing Aids

Four G-E Micro-miniature Tantalytic capacitors are used in this new all-transistor hearing aid. These high-capacitance, small-size units are necessary due to the low-impedance characteristics of transistors, as compared with the vacuum tubes formerly used. Ceramic and paper dielectric capacitors cannot supply sufficient capacitance in the small size desired, according to hearing aid design engineers.

Pictures, circuit diagram, application information courtesy Sonotone Corp.



Simplified schematic diagram of Sonotone all-transistor hearing aid, showing location of G-E Micro-miniature Tantalytic capacitors.

Operating at a battery voltage of 2.5 volts, this hearing aid uses two units rated at 2 microfarads each for by-pass, C_1 and C_2 (see diagram). They give a low-impedance signal path from the source to the input of the transistor. Two 1-microfarad units, C_3 and C_4, are used for coupling and filtering respectively, where their low leakage current of .18 microamperes/uf/volt at 25 deg. C is especially important.

G-E Micro-miniature Tantalytics can be obtained in ratings up to 20 volts, or, up to 8 uf in a $\frac{5}{16}$-in. long by $\frac{1}{8}$-in. dia. case size, higher capacitance in a $\frac{1}{2}$-in. long by $\frac{1}{8}$-in. dia. case size. Capacitance tolerance is -0% to $+100\%$.

For more information about G-E Micro-miniature Tantalytic capacitors, contact your G-E Apparatus Sales Office or write for bulletin GEA-6065 to General Electric Company, Section 442-15, Schenectady 5, New York.

GENERAL ELECTRIC

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quency is an advantage since the lower the frequency the lower the input power required to produce the same amplitude. However, from the viewpoint of convenience in operation there is an advantage in keeping the frequency ultrasonic. The most efficient practical vibrator is a magnetostriction transducer resonant at around 20 kc.

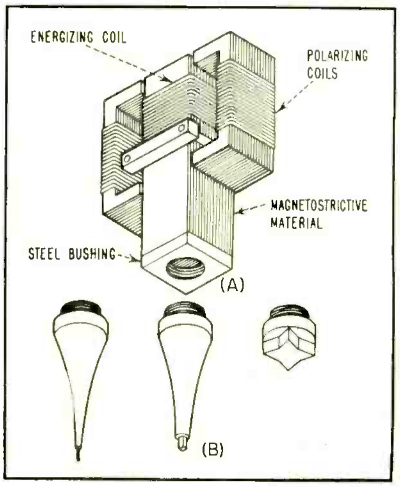

FIG. 1—Magnetostrictive transducer (A) and velocity step-up transformers (B) for obtaining high-amplitude oscillations from low-power oscillator

Figure 1 illustrates the essential features of an ultrasonic-drill transducer. The transducer consists of a stack of nickel laminations. A steel bushing tapped to serve as a tool holder is attached to the lower end of the stack. The transducer is clamped rigidly at its center and the upper half carries the energizing coil wound on a form, which, to avoid mechanical damping, does not make physical contact with the transducer.

A signal at the resonant frequency of the transducer is applied from a conventional oscillator and amplifier combination. Output from the amplifier is matched to the transducer load, which can be varied by adjusting the number of turns of wire on the energizing coil. In addition to the alternating drive field a d-c polarizing, field is required. This signal should be large enough to give a flux density approaching saturation of the transducer material. This is most conveniently obtained by completing the magnetic circuit of the transducer by means of high-permeability laminations close to, but not

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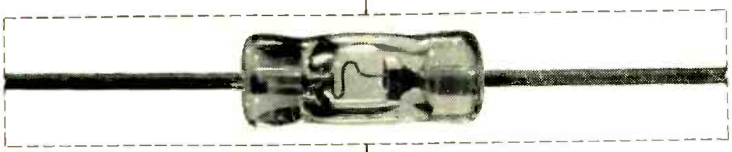

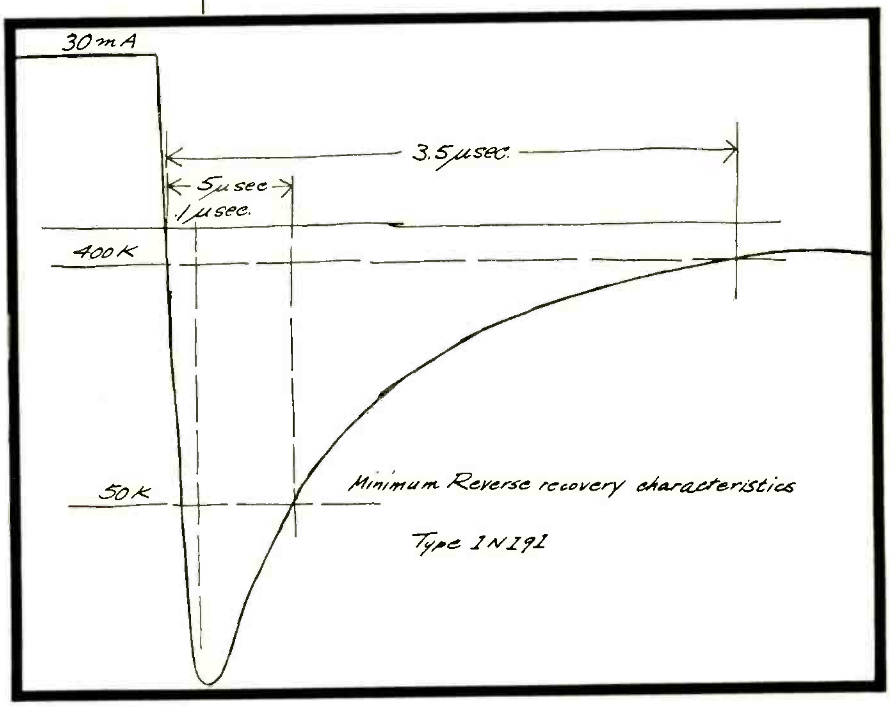

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Type 1N192
50 K Ω @ 0.5 μsec and 200 K Ω @ 3.5 μsec maximum.

To measure pulse recovery for both types, diodes are pulsed at 30 mA in the forward direction and then a back voltage of —35 volts is applied.

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touching, the transducer.

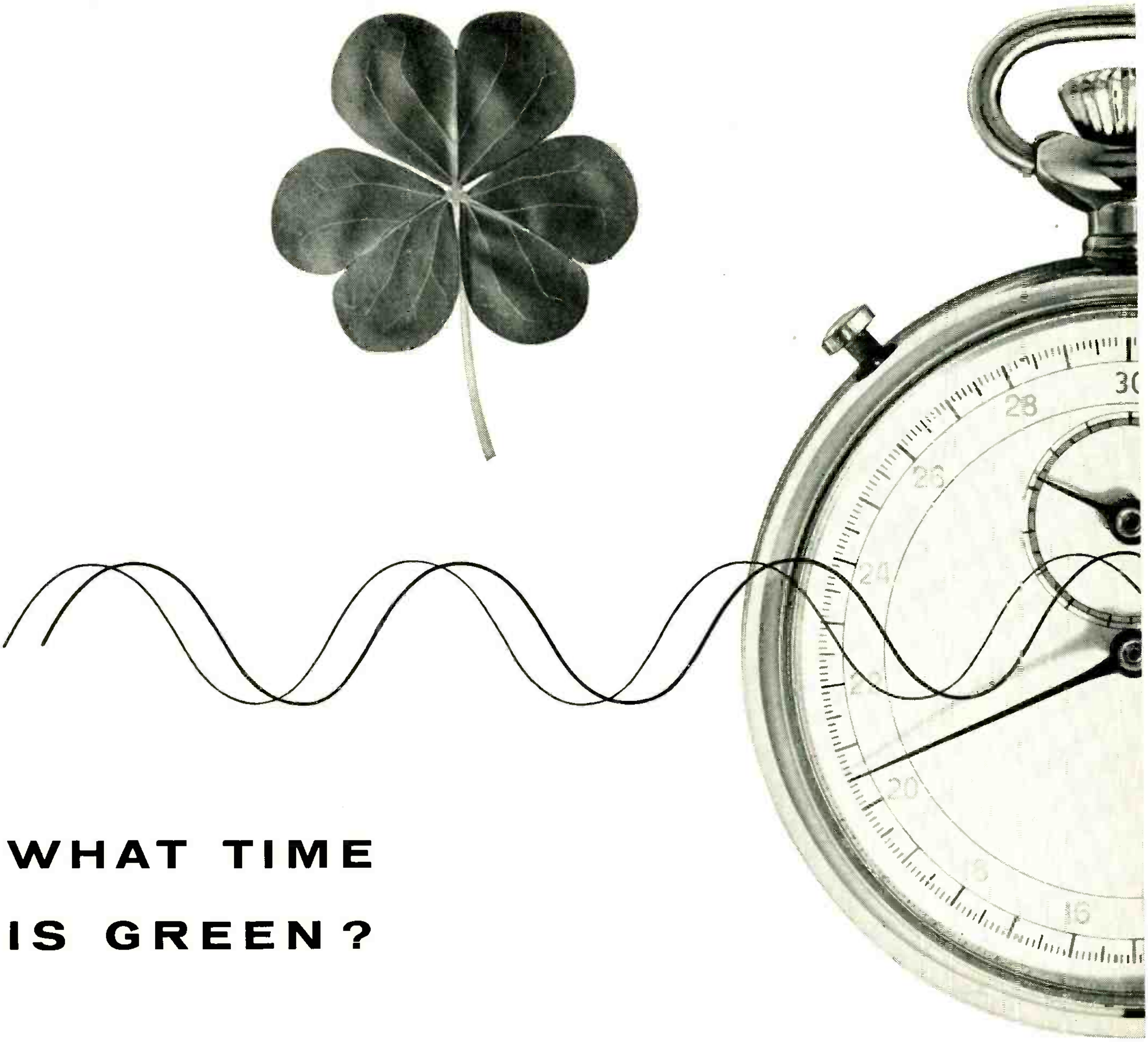
Vibrations obtained at the transducer face are amplified by transmission down an exponentially tapered brass stub acting as a resonant velocity transformer. The drilling tip is screwed or soldered to the end of the stub. For efficient operation, the tip must be about the same size as the end dimensions of the stub. Consequently, to accommodate a large range of sizes it is convenient to provide a range of matching transformers having different transformation ratios and different end diameters as shown in Fig. 1B.

Cutting rate is roughly proportional to the square of the oscillatory tip amplitude and therefore proportional to the electrical power supplied, so that by driving the transducer harder proportionately greater drilling speeds may be obtained. This article has been abstracted from a paper entiled "A High-Frequency Reciprocating Drill" by E. A. Neppiras, in the *Journal of Scientific Instruments*, March 1953.

Pulse Power Supply for Precipitators

In electric precipitators maximum particle collection is obtained when the electrical forces acting on the particles are made as large as possible. Collection efficiency depends on both the magnitude and the shape of the applied voltage wave. Maximum operating voltages are limited by sparking in the precipitator. Steady voltage has a relatively low sparking value and is unsuited for most precipitator applications. Both full-wave and half-wave unfiltered or pulsating rectified voltages have higher sparking values and are much more stable in operation but their characteristics are arbitrarily limited by the 60-cycle alternating voltage from which they are derived. The pulse method, on the other hand, is designed so that both the duration and frequency of the current pulses supplied are subject to precise adjustment and control.

The pulse equipment comprises a high-voltage high-power pulse



WHAT TIME IS GREEN?

In color television, the colors on the screen are determined in a special way. A reference signal is sent and then the color signals are matched against it. For example, when the second signal is out of step by 50-billionths of a second, the color is green; 130-billionths means blue.

For colors to be true, the timing must be exact. An error of unbelievably small size can throw the entire picture off color. A delay of only a few billionths of a second can make a yellow dress appear green or a pale complexion look red.

To ready the Bell System's television network for color transmission, scientists at Bell Telephone Laboratories developed equipment which measures wave delay to one-billionth of a second. If the waves are off, as they wing their way across the country, they are corrected by equalizers placed at key points on the circuit.

This important contribution to color television is another example of the pioneer work done by Bell Telephone Laboratories to give America the finest communications in the world.

To keep colors true in television, signals must be kept on one of the world's strictest timetables. Equalizers that correct off-schedule waves are put into place at main repeater stations of the transcontinental radio-relay system.

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generator, capable of supplying high-voltage pulses of the order of 100 μsec duration at a frequency of several hundred pulses per second, which in turn may be commutated to as many as four or more precipitator sections. The method provides higher peak voltages and increased precipitator efficiency with inherent current-limiting action during precipitator spark-over.

The basic circuit is that of the line-type pulser in which energy is accumulated in a capacitor over relatively long periods and then discharged rapidly into the load, so that the output consists of a series of uniformly spaced high-power pulses.

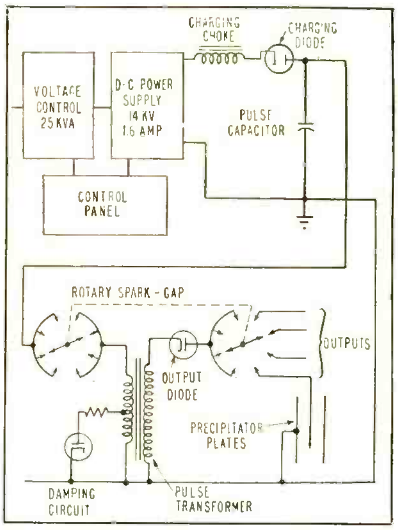

FIG. 1—Pulsed power supply for electrostatic precipitator. Rotary spark gap distributes pulses to a number of precipitator plates

A schematic diagram of the pulser set is shown in Fig. 1. The set is rated at 70-kv peak voltage, 300-milliampere average current, 15-kw average power, 480-cycle pulse frequency, and 150-microsecond pulse duration. Four commutated outputs are provided which permit operation of four separate high-tension precipitator sections from one set. The electrical operation of the pulser is characterized by an over-all efficiency of about 70 percent, and by a flexibility of power output, pulse frequency, and pulse duration. Pulse frequency is varied by means of a variable speed motor driving the rotary spark gap. Precipitator sparking is reflected in the pulse circuit by a momentary increase in the pulse discharge current, but with proper adjustment

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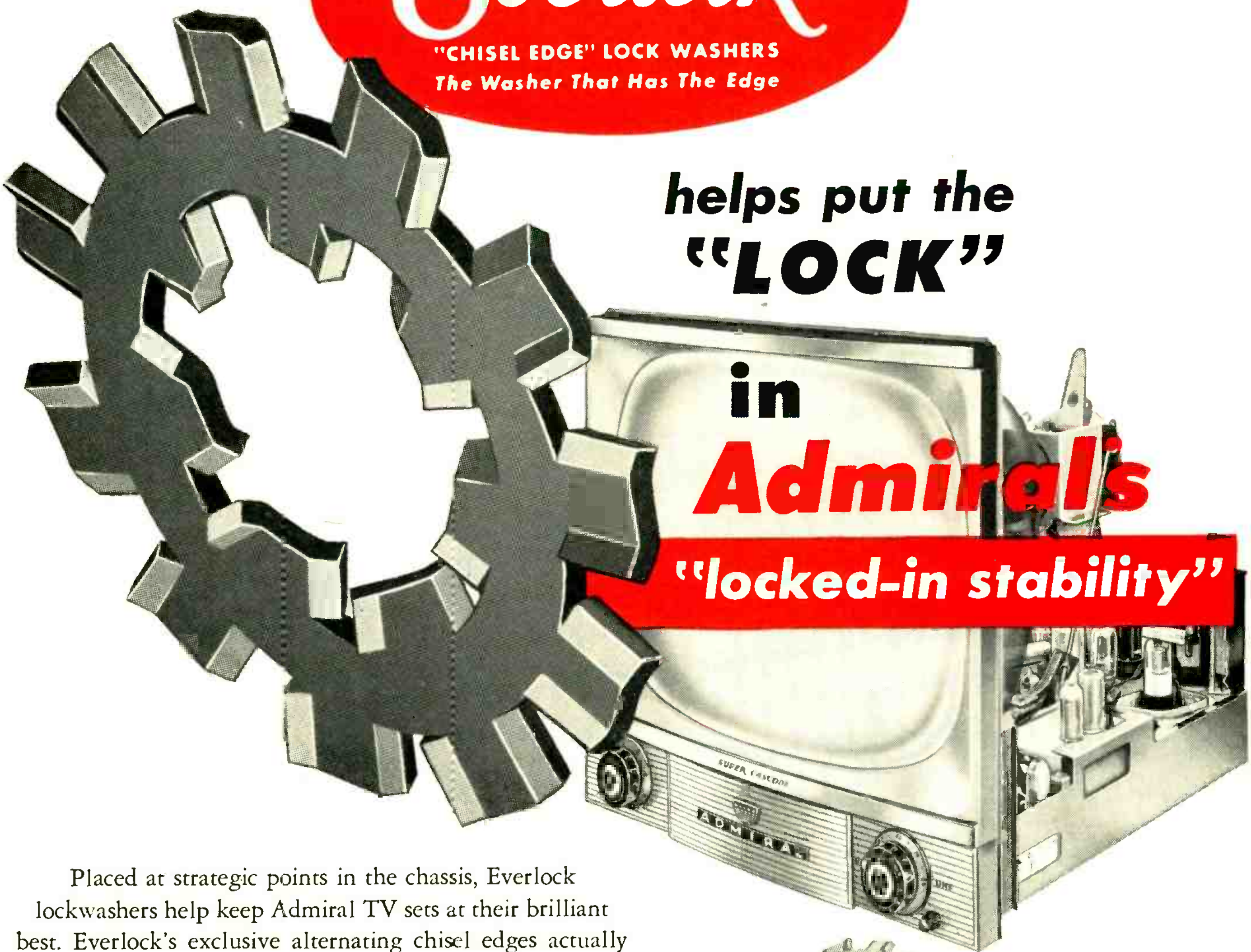

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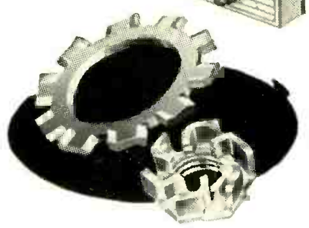

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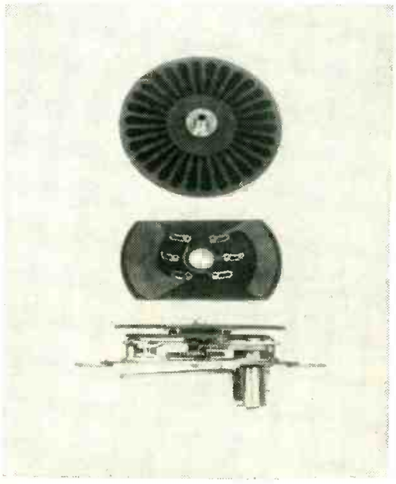
this produces little or no effect in the charging circuits.

This article has been abstracted from "Electrostatic Precipitator Pulse Power Supply" by H. J. White, *Electrical Engineering*, March 1953 p 236.



Rotor (top) stator (center) and reciprocating drive mechanism (bottom) for the miniature electrostatic generator used in nuclear radiation detector

Printed Electrostatic Generator

ALPHA SURVEY METERS using the air proportional counter can be operated from a storage capacitor power supply. The probe requires 2,000 volts at a current of not more than 10^{-12} ampere. Such a capacitor used in a Navy radiation survey instrument requires occasional recharging to make up leakage loss of about 100 volts.

To avoid use of special batteries or a power supply that would add complexity to existing electronic equipment, a miniature electrostatic source of high voltage has been developed by the National Bureau of Standards. Operation of the generator depends upon the ability of one charged body to induce a charge on another body close by.

The generator consists of a stator of two field plate conductors and a rotor with a number of pairs of conducting sectors. Printed circuit techniques are used to apply conducting areas to the flat insulating plates of the rotor and stator.

Several sets of brushes transfer electrical charge between the components of the system and the capacitor. The attached reciprocal

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COMMUNICATION ACCESSORIES COMPANY Hickman Mills, Missouri

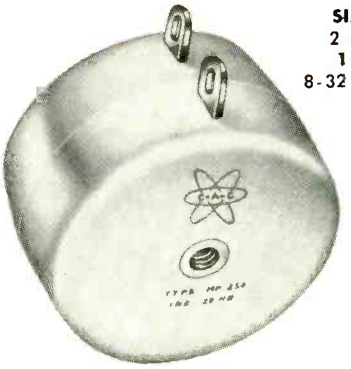
SIZE
1-1/16 OD
1/2 H
6-32 MTG.

TYPES	Q max.	Freq.
MP206	140	14 KC
MP848	185	35 KC
MP603	170	60 KC
MP073	265	250 KC

SIZE
1-5/16 OD
23/32 H
6-32 MTG.

TYPES	Q max.	Freq.
MP930	160	8 KC
MP395	225	25 KC

SIZE
2 OD
1 H
8-32 MTG.



TYPE	Q max.	Freq.
MP254	210	6 KC

M P TOROIDS

MP (Molded Plastic) units are the result of a long development program. CAC MP toroids have repeatedly passed all tests for MIL-T-27, Grade 1, Class A without exception. Most compact design—may be stacked—mounted by center bushing—absorbs mounting pressures—sturdy silver plated terminals—arrangements available up to 5 terminal connections—standard inductance values listed below shipped from stock—special inductances and configurations supplied promptly on request.

STOCKED VALUE TABLE

MP206

IND.	PART. No.
5.0 MH	MP-206-1–
6.0 MH	MP-206-2–
7.2 MH	MP-206-3–
8.6 MH	MP-206-4–
10 MH	MP-206-5–
12 MH	MP-206-6–
15 MH	MP-206-7–
17.5 MH	MP-206-8–
20 MH	MP-206-9–
24 MH	MP-206-10–
30 MH	MP-206-11–
36 MH	MP-206-12–
43 MH	MP-206-13–
50 MH	MP-206-14–
60 MH	MP-206-15–
72 MH	MP-206-16–
86 MH	MP-206-17–
100 MH	MP-206-18–
120 MH	MP-206-19–
150 MH	MP-206-20–
175 MH	MP-206-21–
200 MH	MP-206-22–
240 MH	MP-206-23–
300 MH	MP-206-24–
360 MH	MP-206-25–
430 MH	MP-206-26–
500 MH	MP-206-27–
600 MH	MP-206-28–
720 MH	MP-206-29–
860 MH	MP-206-30–
1.00 HY	MP-206-31–
1.20 HY	MP-206-32–
1.50 HY	MP-206-33–
1.75 HY	MP-206-34–
2.00 HY	MP-206-35–
2.40 HY	MP-206-36–
3.00 HY	MP-206-37–

MP848

IND.	PART. No.
2.0 MH	MP-848-1–
2.4 MH	MP-848-2–
3.0 MH	MP-848-3–
3.6 MH	MP-848-4–
4.3 MH	MP-848-5–
5.0 MH	MP-848-6–
6.0 MH	MP-848-7–
7.2 MH	MP-848-8–
8.6 MH	MP-848-9–
10 MH	MP-848-10–
12 MH	MP-848-11–
15 MH	MP-848-12–
17.5 MH	MP-848-13–
20 MH	MP-848-14–
24 MH	MP-848-15–
30 MH	MP-848-16–
36 MH	MP-206-17–
43 MH	MP-848-18–
50 MH	MP-848-19–
60 MH	MP-848-20–
72 MH	MP-848-21–
86 MH	MP-848-22–
100 MH	MP-848-23–
120 MH	MP-848-24–
150 MH	MP-848-25–
175 MH	MP-848-26–
200 MH	MP-848-27–
240 MH	MP-848-28–
300 MH	MP-848-29–
360 MH	MP-848-30–
430 MH	MP-848-31–
500 MH	MP-848-32–

MP930

IND.	PART. No.
5.0 MH	MP-930-1–
6.0 MH	MP-930-2–
7.2 MH	MP-930-3–
8.6 MH	MP-930-4–
10 MH	MP-930-5–
12 MH	MP-930-6–
15 MH	MP-930-7–
17.5 MH	MP-930-8–
20 MH	MP-930-9–
24 MH	MP-930-10–
30 MH	MP-930-11–
36 MH	MP-930-12–
43 MH	MP-930-13–
50 MH	MP-930-14–
60 MH	MP-930-15–
72 MH	MP-930-16–
86 MH	MP-930-17–
100 MH	MP-930-18–
120 MH	MP-930-19–
150 MH	MP-930-20–
175 MH	MP-930-21–
200 MH	MP-930-22–
240 MH	MP-930-23–
300 MH	MP-930-24–
360 MH	MP-930-25–
430 MH	MP-930-26–
500 MH	MP-930-27–
600 MH	MP-930-28–
720 MH	MP-930-29–
860 MH	MP-930-30–
1.00 HY	MP-930-31–
1.20 HY	MP-930-32–
1.50 HY	MP-930-33–
1.75 HY	MP-930-34–
2.00 HY	MP-930-35–
2.40 HY	MP-930-36–
3.00 HY	MP-930-37–
3.60 HY	MP-930-38–
4.30 HY	MP-930-39–
5.00 HY	MP-930-40–
6.00 HY	MP-930-41–
7.20 HY	MP-930-42–
8.6 HY	MP-930-43–
10.0 HY	MP-930-44–
12.0 HY	MP-930-45–
15.0 HY	MP-930-46–
17.5 HY	MP-930-47–

MP395

IND.	PART. No.
5.0 MH	MP-395-1–
6.0 MH	MP-395-2–
7.2 MH	MP-395-3–
8.6 MH	MP-395-4–
10 MH	MP-395-5–
12 MH	MP-395-6–
15 MH	MP-395-7–
17.5 MH	MP-395-8–
20 MH	MP-395-9–
24 MH	MP-395-10–
30 MH	MP-395-11–
36 MH	MP-395-12–
43 MH	MP-395-13–
50 MH	MP-395-14–
60 MH	MP-395-15–
72 MH	MP-395-16–
86 MH	MP-395-17–
100 MH	MP-395-18–
120 MH	MP-395-19–
150 MH	MP-395-20–
175 MH	MP-395-21–
200 MH	MP-395-22–
240 MH	MP-395-23–
300 MH	MP-395-24–
360 MH	MP-395-25–
430 MH	MP-395-26–
500 MH	MP-395-27–

MP254

IND.	PART No.
20 MH	MP 254-1–
24 MH	MP 254-2–
30 MH	MP 254-3–
36 MH	MP 254-4–
43 MH	MP 254-5–
50 MH	MP 254-6–
60 MH	MP 254-7–
72 MH	MP 254-8–
86 MH	MP 254-9–
100 MH	MP 254-10–
120 MH	MP-254-11–
150 MH	MP 254-12–
175 MH	MP 254-13–
200 MH	MP 254-14–
240 MH	MP 254-15–
300 MH	MP 254-16–
360 MH	MP 254-17–
430 MH	MP 254-18–
500 MH	MP 254-19–
600 MH	MP 254-20–
720 MH	MP 254-21–
860 MH	MP 254-22–
1.00 HY	MP 254-23–
1.20 HY	MP 254-24–
1.50 HY	MP 254-25–
1.75 HY	MP 254-26–
2.00 HY	MP 254-27–
2.40 HY	MP 254-28–
3.00 HY	MP 254-29–
3.60 HY	MP 254-30–
4.30 HY	MP 254-31–
5.00 HY	MP 254-32–
6.00 HY	MP 254-33–
7.20 HY	MP 254-34–
8.60 HY	MP 254-35–
10.0 HY	MP 254-36–
12.0 HY	MP 254-37–
15.0 HY	MP 254-38–
17.5 HY	MP 254-39–
20.0 HY	MP 254-40–
24.0 HY	MP 254-41–
30.0 HY	MP 254-42–
36.0 HY	MP 254-43–

IN ORDERING...
Add suffix "A" to above numbers for clear bushing
Add suffix "B" to above numbers for tapped bushings
Replace "MP" prefix with "HS" for metal encased toroids (see back page for description).

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driving system (illustrated) enables the rotor to be driven at speeds as high as 6,000 rpm.

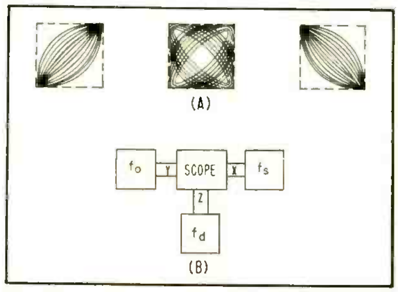
Unique polarity of output voltage is established by means of a small external bias voltage to precharge the generator. This voltage is readily available from associated electronic equipment.

The unit illustrated, which is about three inches in its widest diameter, will charge a 0.02-μf capacitor to two kilovolts in about 15 seconds using only hand power.

CRO Measurement Of Beat Frequencies

By GEORGE PRELL
Special Devices Division
Askania Regulator Company
Chicago, Ill.

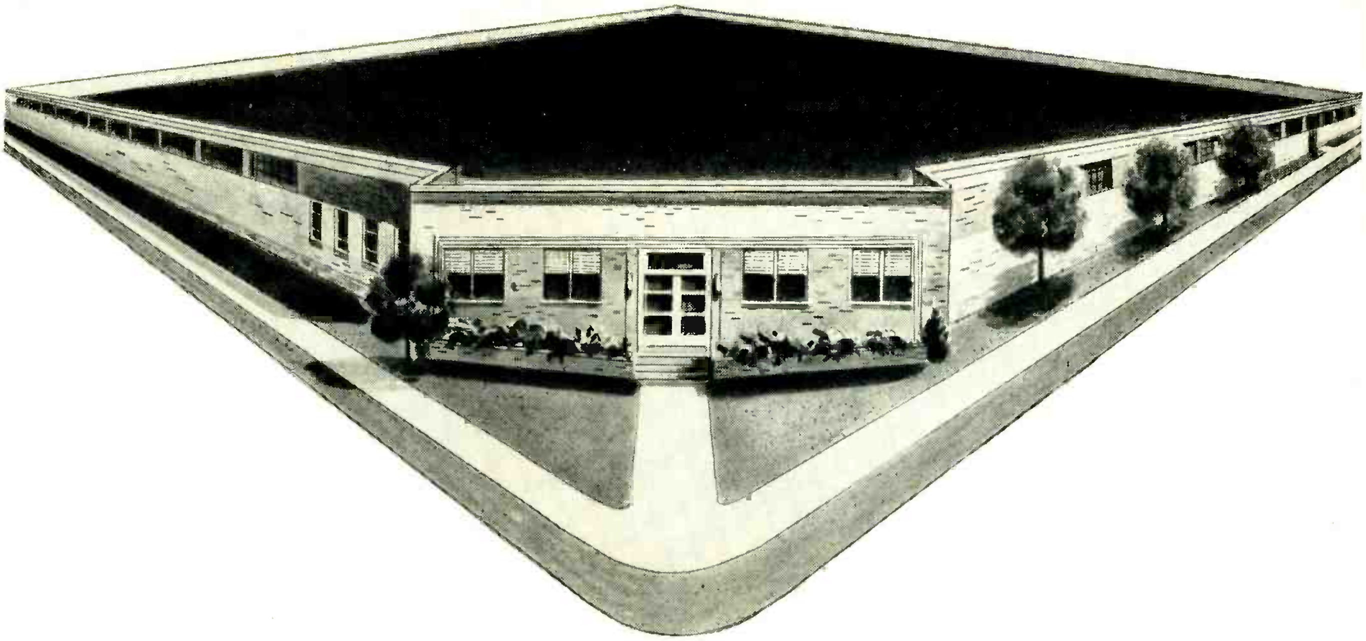
THE METHOD described here is essentially a combination of common Lissajous and beat frequency techniques using an oscilloscope for detection and display. If a signal of fixed frequency f_s is applied to the horizontal plates and a signal of unknown frequency f_o is applied to the vertical plates a meaningless shaded rectangular pattern will result unless the frequencies have some rational relationship.



Oscilloscope patterns (A) obtained by applying a difference frequency to the Z axis as in (B)

If an interpolation signal of frequency f_D equal to the difference $|f_s - f_o|$ is applied to the Z axis with sufficient amplitude to blank the picture during the negative half cycle, a stationary pattern will result whose shape depends on the phase relationship between f_D and $|f_s - f_o|$. By this method, the frequency f_o may be measured to an accuracy limited only by the accuracy of f_s and f_D and the patience of the observer in detecting movement of the pattern.

This method was used to measure the bandwidth of a tuned circuit at 4,000 cps, and resulted in a considerable increase in accuracy over the



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Lissajous method with a tunable oscillator.

PERTINENT PATENTS

THE DIVERSITY of the electronic technique is demonstrated in the wide range of applications from which the patents, listed below, have been selected.

Audio Amplifier

A recent British patent 688,273 for "Improvements in or Relating to Vacuum Tube Amplifiers" has been granted to W. H. Coulter of Chicago, Ill.

The improvements are in what have now become known as single-ended push-pull amplifiers.

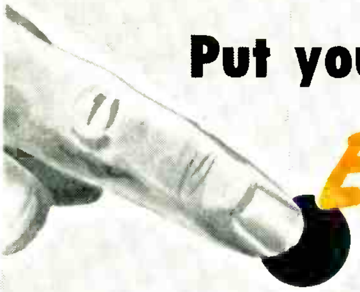
The circuits of the invention for which the British patent was granted are shown in Fig. 1.

In the circuit of Fig. 1A two amplifier tubes are connected in series across a source of power. Coulter has proposed a terminology for these tubes that clearly sets forth which tube is involved in any discussions of such circuits.

The upper tube, having its plate connected to the B+ terminal is termed the free-anode tube and the lower tube having its cathode connected to the B— terminal as the free-cathode tube. The output load is connected between the junction of the series connected tubes and the B— terminal.

As is generally known, the principle of operation of the single-ended push-pull amplifier employs signals applied in push-pull to the grids of the series-connected amplifiers. The invention here discloses means of applying signals in push-pull to the two grids of the series-connected amplifiers while the output is single ended at the junction of the series tubes.

A single-ended signal is applied to the free-anode amplifier. A potentiometer R_1 connected across the input circuit is employed to permit applying an attenuated signal to a triode phase-inverter stage so that it, in turn, drives the free-cathode amplifier with a signal 180 deg out of phase with that driving the free-anode amplifier. The phase-inverter cathode is returned to ground on B— through a potentiometer R_2. The resistance of R_2 is



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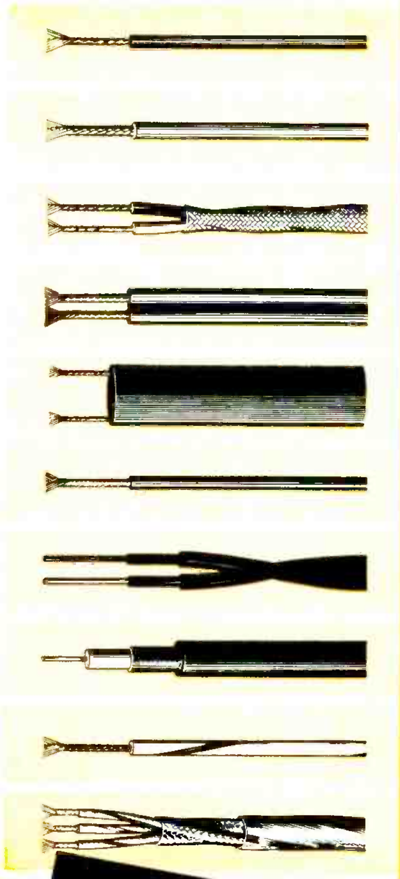

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very much greater than the load impedance so as to have no appreciable effect on the load. Adjustment of R_2 is made to cancel the degenerative effect of the free-anode amplifier due to any signal voltage appearing across the load. When R_1 and R_2 are properly adjusted, signals on the grids of V_2 and V_3 are exactly equal and of opposite phase relation.

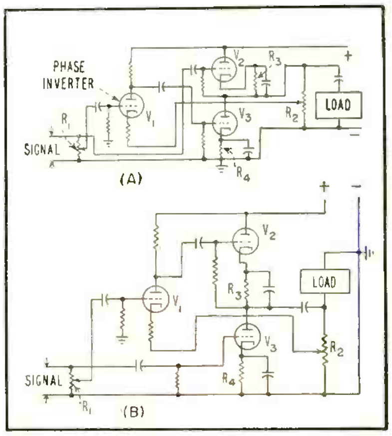

FIG. 1—Basic circuit of the series-tube amplifier (A) and alternative circuit (B) with R_2 across load only

Figure 1B shows the circuit in which the signals fed to top and bottom tubes of the same amplifier are reversed. Resistor R_2 in Fig. 1B is across the load only. In Fig. 1A, R_2 is across both the load and output blocking capacitor. In Fig. 1A it can be seen that R_2 is essentially in parallel with the free-cathode tube, whereas in the circuit of Fig. 1B it is essentially in parallel with the load. While independent cathode-bias resistors R_3 and R_4 are shown for each of the series connected amplifier tubes, bias may be obtained by other means.

The inventor points out that the circuits are useful in class-AB and class-B amplifiers because the capacitor in the load circuit supplies current during cutoff.

The major advantage of single-ended push-pull amplifiers such as that disclosed in this invention is their utility in directly driving load speakers of low impedance without need for an output transformer.

A U. S. patent 2,659,775 has been issued to Coulter for the same invention under the title "Amplifier Circuit Having Series-Connected Tubes." In Fig. 2 the basic additional circuit patented is shown and below, the circuit including an

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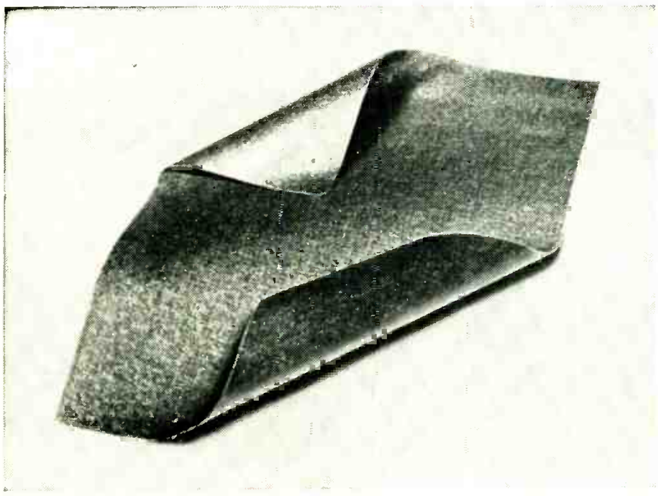

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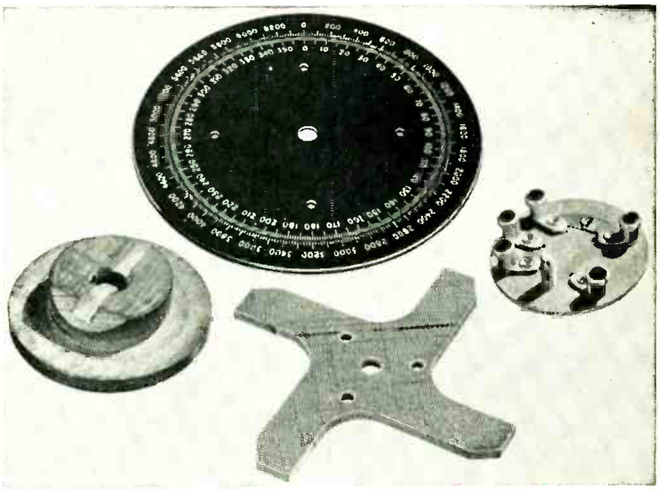

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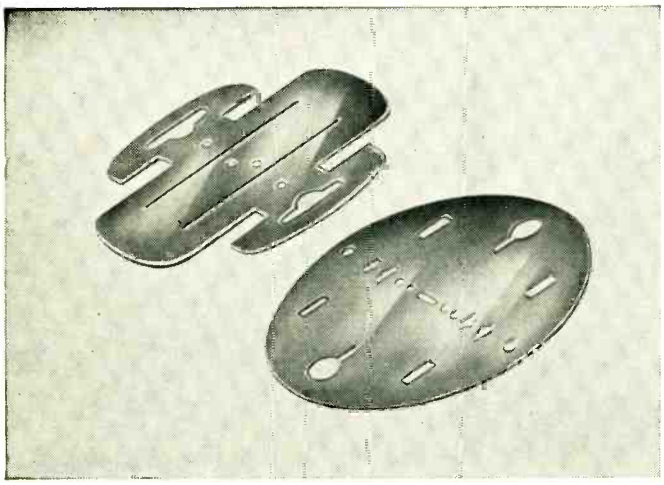

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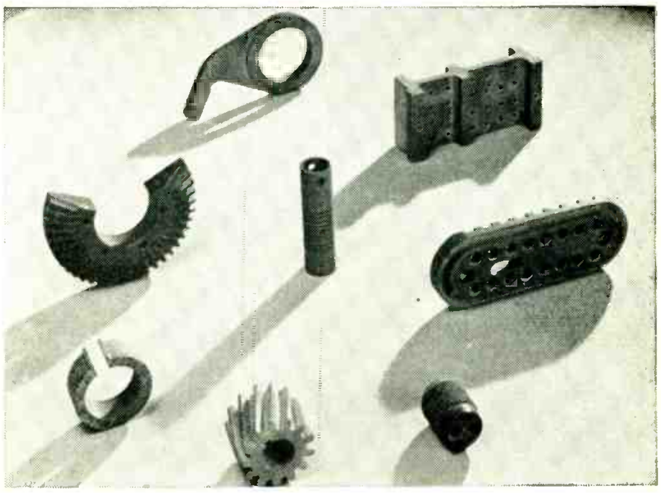

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input connection incorporating a split secondary transformer is shown.

These circuits are probably familiar to audio enthusiasts as the single-ended push-pull amplifier.

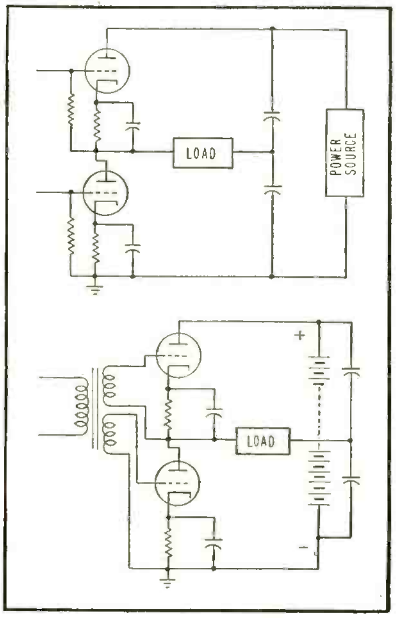


FIG. 2—Basic additional circuit of series-tube amplifier and split-secondary input transformer (below)

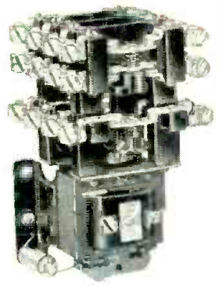
Basically, what is involved in the U. S. patented circuits in addition is the arrangement of a load circuit at the midpoints of both the series tube connection and the plate power voltage connection.

The signal applied to the upper tube between its grid and cathode is of opposite phase to that applied between grid and cathode of the lower tube. Hence, there is a push-pull input signal and single-ended output load.

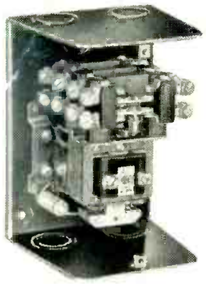
TV Synchronizing

For those who have watched television programs wherein speakers are seen simultaneously on both coasts of this country engaged in conversation with the image of each of them occupying half the tv screen, it has seemed only short of miraculous that the sync generators are kept in step. It is even more remarkable when special effects such as lap dissolves and video wipes are effected between the local and remote stations.

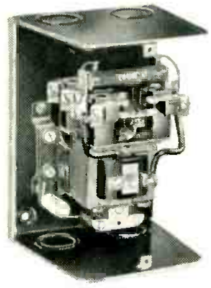
A patent recently issued to R. C. Abelson of Chattanooga, Tennessee, for a "Synchronizing System" describes a means for synchronizing the local and remote sync genera-



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

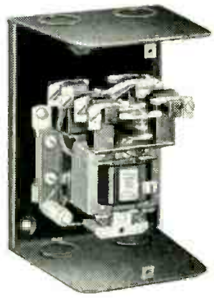


Type BX-44 A-C Relays
4 Normally open & 4 normally closed contacts.

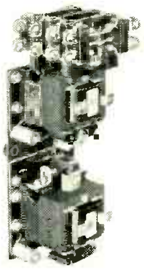


Type BA Thermostat Relays
For 3-wire gauge type thermostats with slow-moving contact elements.

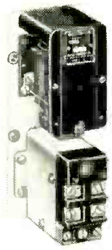
Type CL Low Coil Current Relays
For pilot controls, like oil burners or stokers, which can handle only small relay coil currents.



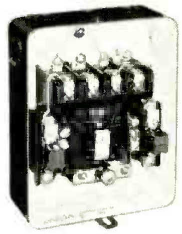
Hum-free Permanent Magnetic Type Relay
Requires no coil current to keep contact closed.



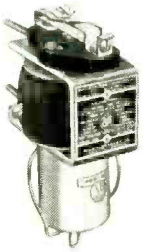
Hum-free Latch Relays
For quiet applications.



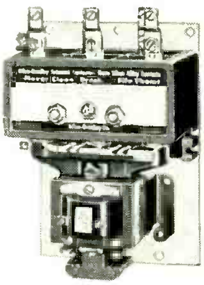
Bul. 849 Pneumatic Timers
Adj. 1/6 sec to 3 minutes.



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.



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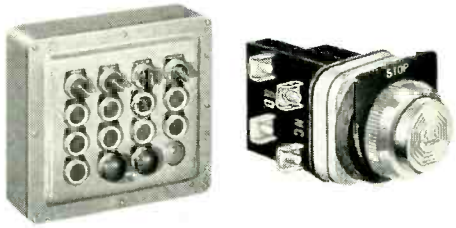

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tors of tv broadcasting equipments. Patent 2,655,556 is assigned to Radio Corporation of America.

In Fig. 3 is shown a schematic and block diagram of the circuit involved where the present invention is applied to conventional tv sync generator systems. Here it can be seen that a master oscillator at 31,500 cycles is utilized through various count-down devices to provide the 15,750-cps horizontal and

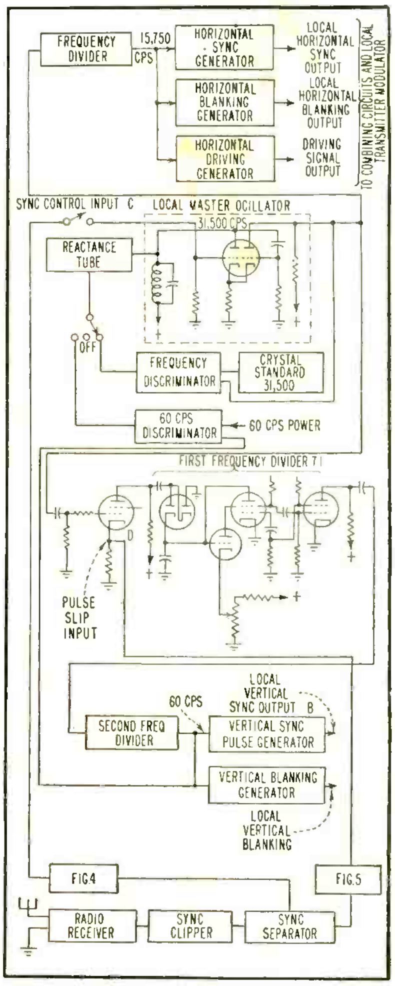

FIG. 3—Elements of the synchronizing generator remote control

60-cps vertical synchronizing signals. A frequency controlling means for the 31,500-cps oscillator is shown. The control may be from a crystal frequency standard or from the 60-cycle power line. Additionally there is an input of terminal *C* for the sync control signals provided in the practice of this invention.

In Fig. 4 and Fig. 5 are shown the sync gating circuits through which remote sync signals and local sync signals are mixed and gated to be fed to and control the 31,500-

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cps generator and what is termed the slip-pulse input circuit of the first frequency divider for the 60

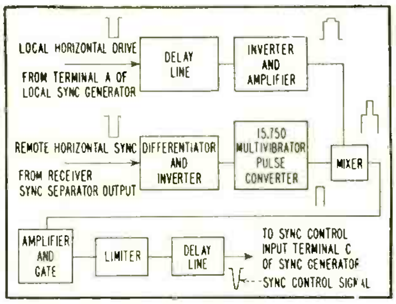


FIG. 4—Sync gating circuits (see Fig. 3)

cycle generator chain. The blocks of Fig. 4 and 5 represent fairly familiar circuitry for the tv engineer.

Figure 6 is a plot of a series of waveforms to illustrate the vertical signal control operation. Here it can be seen that at (A) the local

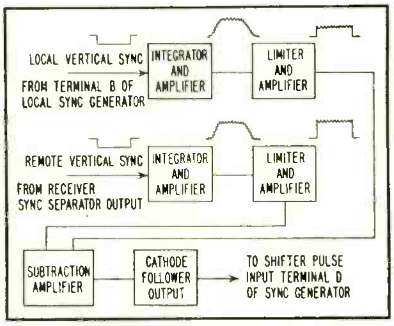


FIG. 5—Sync gating circuits (see Fig. 3)

and remote vertical signals are not coincident. The condition here shown is as the signals appear at the output of the subtraction amplifier of Fig. 5. The local pulse is the slip-pulse signal. It is applied at point *D* of Fig. 3. The amplitude of the local or slip pulse is made great enough to substantively interfere with the master-oscillator pulses being applied to the first frequency

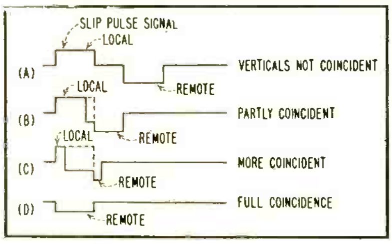
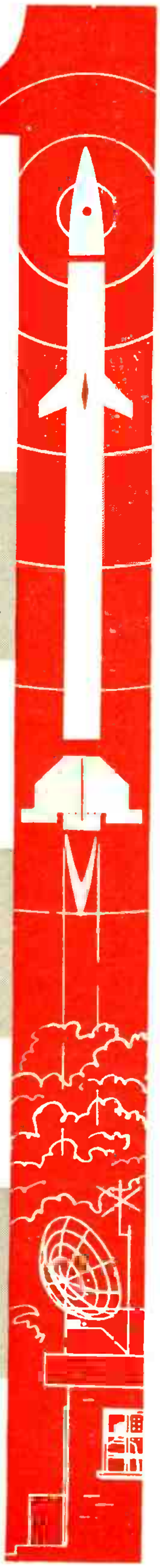


FIG. 6—Progression of sync coincidence

divider so as to require an appropriately greater number of pulses to reach the firing threshold of the first 7-to-1 frequency divider. Thus the dividing ratio will be altered to



IN 1

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These compact, rugged FM/FM telemetering packages are available for many types of applications. Numerous models of plug-in subcarrier oscillators and associated components are available as standard equipment to provide for maximum versatility and efficiency.

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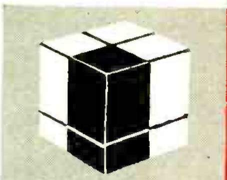
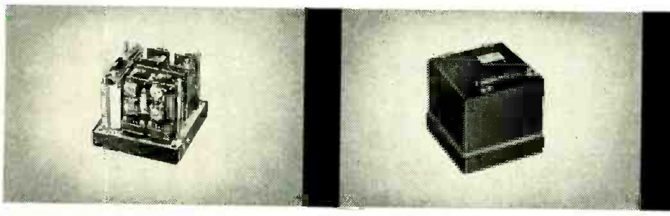
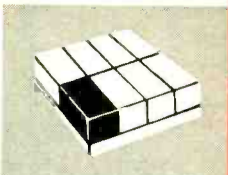


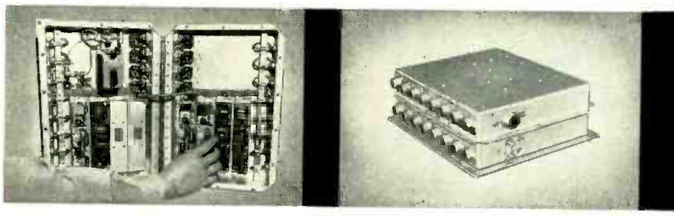


Compact Four Band Telemeter, Models TATP-3 and TATP-4

These packages, each incorporating four plug-in subcarrier oscillators, when used with a power supply and RF transmitter, form a compact, rugged system for telemetering various functions. Each package contains its own voltage regulator and calibration relays. The packages may be combined to form an 8 or 12 band system. Each package measures approximately 4.5'' in each dimension and weighs approximately 3 pounds including oscillators. Standard power supplies are available for operating up to 3 packages and a 2 watt RF transmitter. The model TATP-3 operates in any 4 of the RDB bands below 22 kc; the TATP-4 in any 4 of the bands from 22 kc up.

RECTANGULAR CONFIGURATION

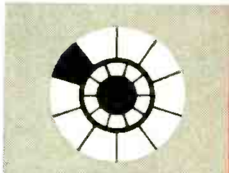


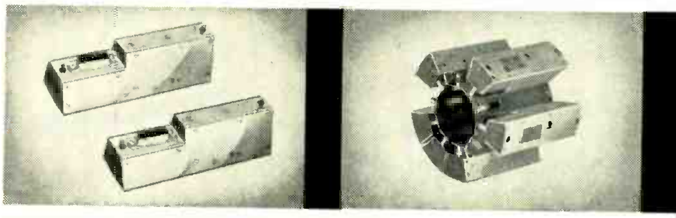


Universal Eight Band Telemeter, Model TATP-2

Operates on any eight RDB bands from 1.7 to 70 kc permitting any combination of 8 resistance, voltage or inductance type measurements to be made by merely plugging in the proper subcarrier oscillators. The unit has provisions for mounting a model TXV-13 crystal controlled transmitter. Connectors are provided for a minimum of eight remotely located pickups. Standard power supplies are available for operation from 6, 12, 28 VDC or 115 VAC 400 cps power sources. Dimensions—14''x 12.4''x 4.75''.

CYLINDRICAL CONFIGURATION





Cylindrical Telemeter Configuration, Model TJW-1

These packages are built up of individual 30° wedge shaped components which plug into a cylindrical mounting assembly, Model TJW-1. As many as 10 subcarrier oscillators or other components can be installed into a 6.5'' circular opening, 5.5'' long. A center opening, approximately 1.5'' in diameter, can be utilized for cables and pressure lines. A two-watt crystal controlled RF transmitter is also available for mounting in this configuration.

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bring the local and remote vertical pulses into coincidence as seen at (B), (C) and (D) of Fig. 6.

The inventor points out that the control of horizontal synchronization is readily accomplished through various comparator and discriminator techniques.

Velocity Measurement

A novel system for "Velocity Measuring by use of High Energy Electrons" has been awarded U. S. patent 2,637,208. The inventor is G. L. Mellen of Framingham Center, Mass. The patent is assigned to National Research Corp. of Middlesex County, Mass.

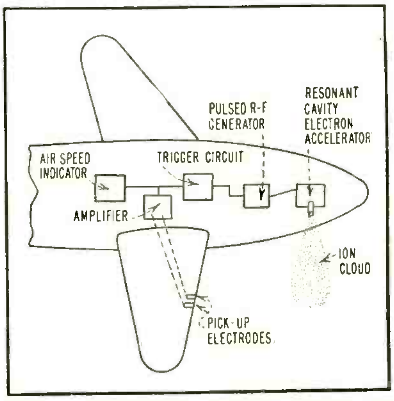

FIG. 7—Supersonic velocity device installed in aircraft

For the measurement of the velocity of objects moving at supersonic speeds specialized apparatus is required. In this invention an ionized gas is projected into the atmosphere from a forward portion of a vehicle or missile. The gas is detected by devices at a rearward portion of the vehicle. The method is clearly shown in Fig. 7 in block diagram form as installed in an aircraft.

The system may also be used to

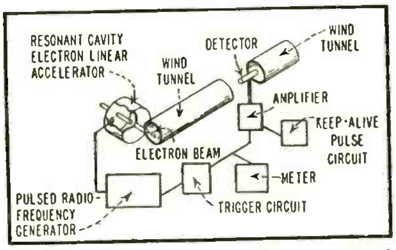

FIG. 8—Wind tunnel application of r-f velocity indicator

determine the equivalent velocity of a stream of air in a wind tunnel as shown in Fig. 8.

The method of operation of the system may be seen from the dia-

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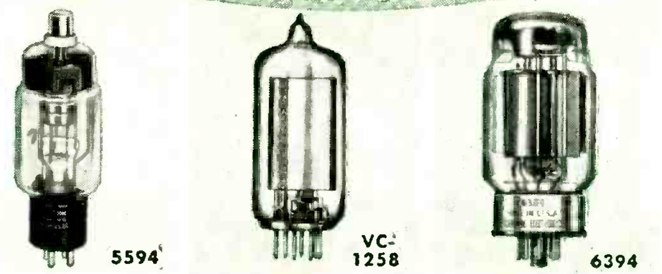

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  Rugged half-wave Xenon filled rectifier. Operates in any position. Ambient temperature range −75° to +90°C. Inverse peak anode voltage 10,000, average current .25 amps. Filament 2.5v., 5 amp.
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  Ruggedly built, half-wave Xenon filled rectifier. Ambient temperature range −75° to +90°C. Inverse peak anode voltage 10,000, average anode current 1.25 amp. Filament 5v., 7.5 amp.
- **VC-1258 MINIATURE HYDROGEN THYRATRON**
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- **6336 TWIN TRIODE**
  for voltage regulation. Features high plate dissipation, hard glass envelope.
- **6394 TWIN TRIODE**
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grams. Referring to Fig. 9, a cloud of ions is created in a chamber through which the gas to be ionized flows. The ionization time of the gas will be considerably less than the transit time of the ion cloud from the point at which the ions are projected into the medium to the point of detection.

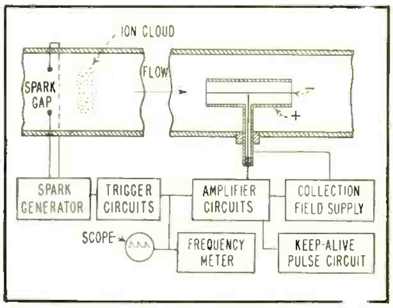

FIG. 9—Ion cloud is created by spark and detected by ionization chamber

The ions are created by an electric spark from a spark-gap discharge. The detection of the ions is accomplished with a form of ionization chamber. The ion current created in the ionization chamber is amplified. The amplified current is triggered in synchronism with the spark generator.

The inventor gives the following formula with which the velocity of a missile may be determined

$$V = 60/88\ FD$$

when V = velocity in miles per hour
D = distance in feet between the point of ion cloud ejection and the point of ion detection
F = frequency in cycles per second of creation of the ion cloud. (Sparking trigger frequency)

The remainder of the circuit elements suggest the operation of the system to be similar to the frequency modulated vhf terrain clearance indicator wherein the Doppler effect is employed and the resulting frequency difference between arrival time of the detected signal and transmitted signal is converted to distance. In the present invention the resultant indication is velocity.

Coin Counter

Patent 2,652,136 has been issued to J. F. Morrison, assignor to Rowe Mfg. Co. of Whippany, N. J. for an "Electronic Coin Totalizer".

The invention describes a means

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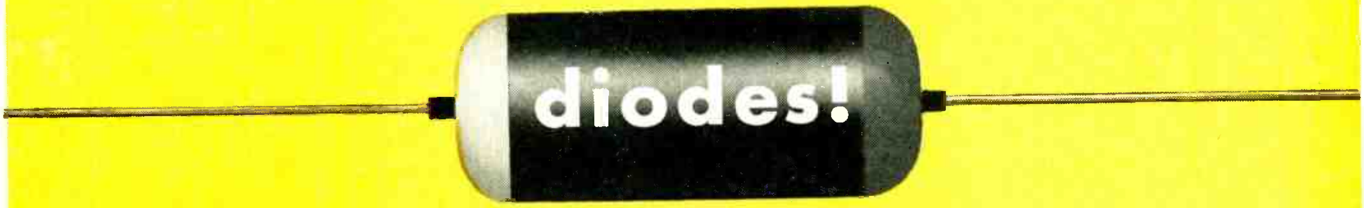

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of determining the required change to be dispensed by a vending machine and controlling the equipment to deliver the correct change along with the vending of the merchandise.

The circuit of this device is shown in Fig. 10. In the coin register, resistors R_2 and R_3 (2,000 ohms each) are arranged to be short-circuited by dimes. Resistors R_4, R_5, R_6, R_7, R_8 (1,000 ohms each) are arranged to be short-circuited by nickels. Resistor R_9 (5,000 ohms) is short circuited by a 25-cent piece.

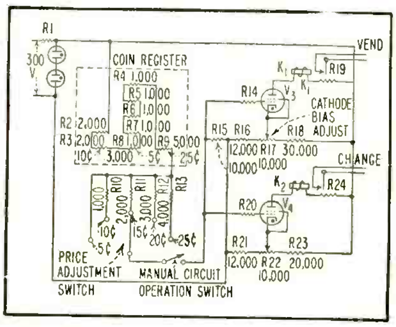

FIG. 10—Coin counter operates by shorting thyratron bias

The resistance values are such that any combination may add up to the resistance equivalent of R_9 thus reducing the total resistance in series by the cumulative values of the resistances short-circuited by the coins in the register up to a value corresponding to 25 cents.

Dropping coins into the register short circuits appropriate resistors to a parallel connection across R_{15} resulting in a bias change on thyratron V_3 to trigger the thyratron and close relay K_1. This operates the vend mechanism when the correct amount, as required by the setting of the price adjustment switch, has been deposited in the coin register.

Thyratron V_4 is set up in parallel with thyratron V_3 to initiate a change-making cycle if the amount deposited in the coin register is greater than the price set by the price adjustment switch. Tube V_4 will not operate if the correct amount is inserted but V_3 will operate. If an insufficient amount is inserted neither V_3 nor V_4 operates. Settings of bias potentiometers R_{17} and R_{22} determine the operating conditions for each of the tubes V_3 and V_4. —N.L.C.

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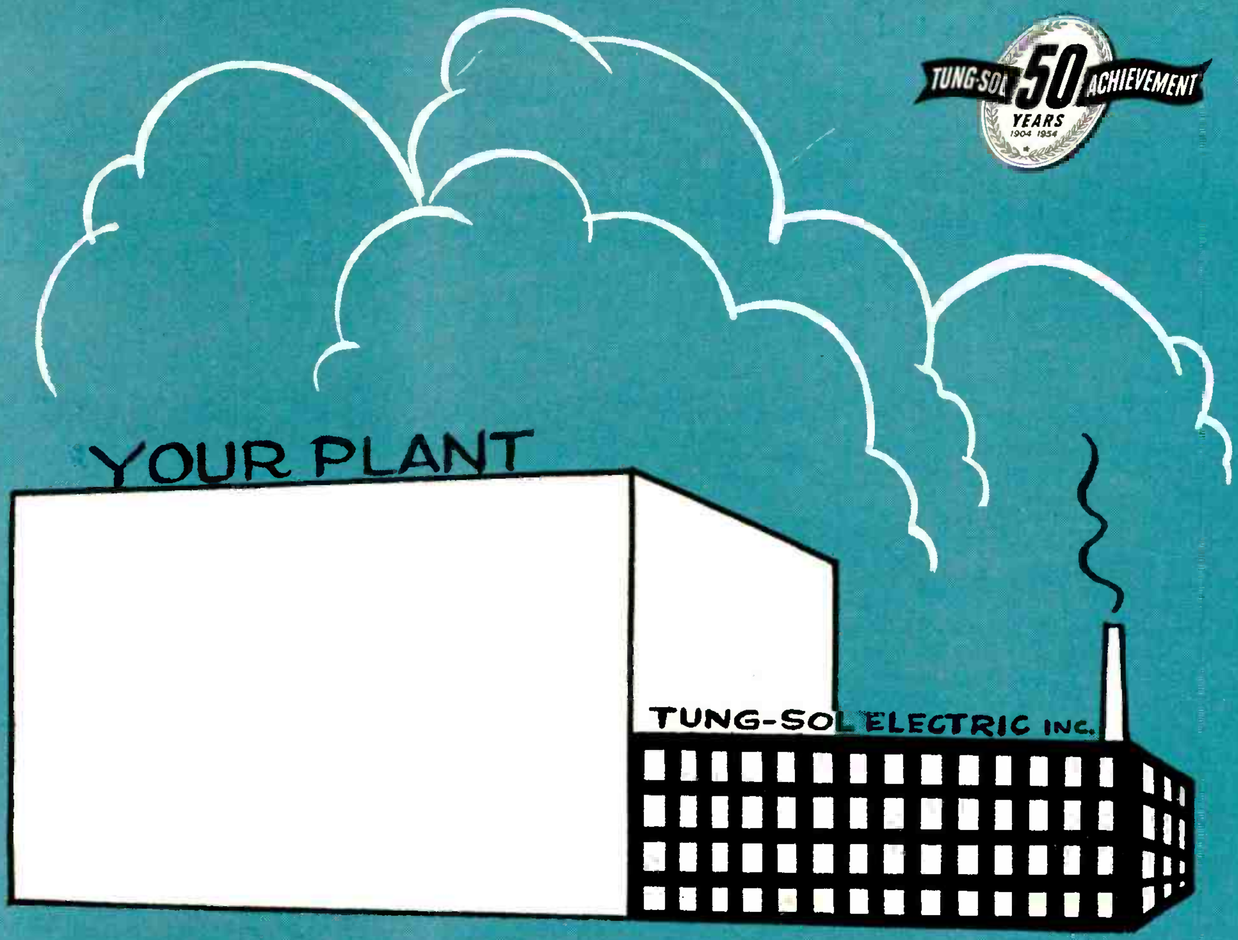

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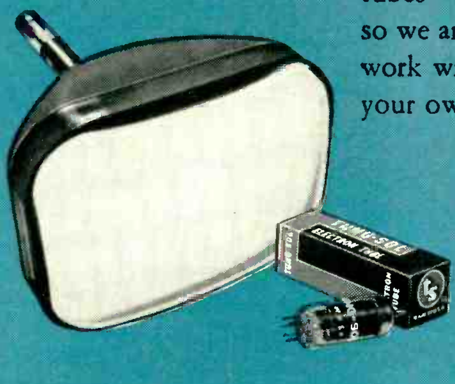

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Production Techniques

Edited by JOHN MARKUS

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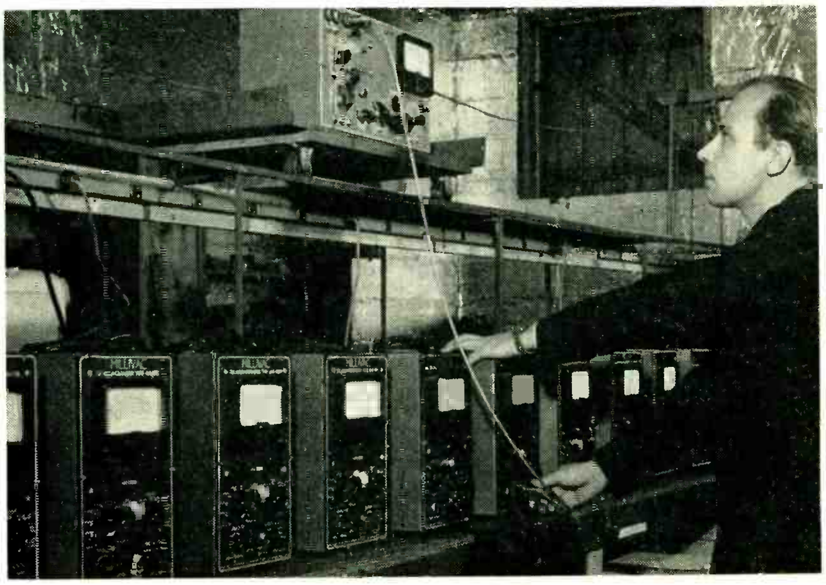
Elevated Instrument Railway Aids Calibration of Multimeters



Method of using master standard on carriage running on overhead rails. Multimeters on bench are calibrated one after another

FINAL METER calibration for a batch of multimeters is expedited by placing the master calibration standard on a trolley cart which runs on overhead rails along the entire length of the production bench. The instruments to be calibrated are placed side by side on the bench and all set to the same range. The technician adjusts the calibration standard to the proper value, feeds the calibration signal into the first meter and adjusts it, then pushes the carriage to each other meter in turn and repeats the procedure.

The calibration standard and the meters are then switched to the next range and the carriage is pushed down the line again step by step for calibration. This technique is used in the Schenectady, N. Y. plant of Millivac Instrument Corp.

Automatic Cycling Machine For Socket and Plug Life Tests

TO HELP evaluate characteristics of multi-pin plugs and sockets used in packaged equipment composed of plug-in units, an automatic cycling machine was devised by production service engineers of Lenkurt Electric Co., San Carlos, Calif. to cycle various plug and socket combinations through thousands of insertions and removals.

Design of telephone carrier equipment with all units made on a plug-in basis is a departure from previous manufacturing methods where all carrier equipment was rack mounted and interconnected with fixed rack wiring and soldered terminal-block connections. Some means was necessary to assure the design and applications engineers that repeated insertion and removal of the plug-in units would not result in system failure through wear or damage to the multi-pin plugs and sockets used in their equipment.

The plug and socket to be tested are mounted on special plates which can be adjusted to provide proper mating (or misadjusted if desired to determine the effects of misalignment). The plug mounting is fixed on the end of a compressed-air-operated piston and moves towards the socket on two guide rods. Length of the piston stroke is determined by two Micro Switches

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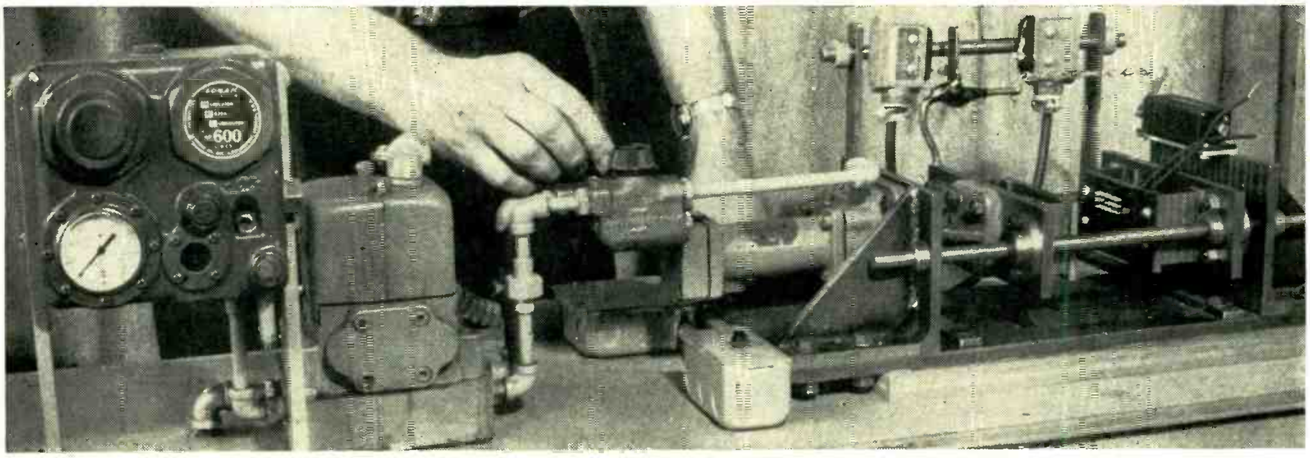


Life-testing multi-pin plug and socket, mounted at right end of cycling machine. Knobs being adjusted by engineer control time of stroke. Extension pipe on moving socket support trips snap-action switches, mounted on overhead rods, to actuate solenoid valves under man's right hand and give reversal of air cylinder operation

which control a valve directing compressed air to either side of the piston. Separate adjustable check valves control the piston speed in each direction so the cycling time can be varied from about 1/20 to 2 cycles per second.

When a plug and socket combination is being tested, a series circuit is connected through plug pins and socket sleeves so a continuous measurement of resistance can be made over any number of cycles. Gradual wear then shows as a gradual change in resistance, while any mechanical damage will normally show as an abrupt resistance change. In addition, wear can be determined by accurate measurement of plug pin diameters before and after testing.

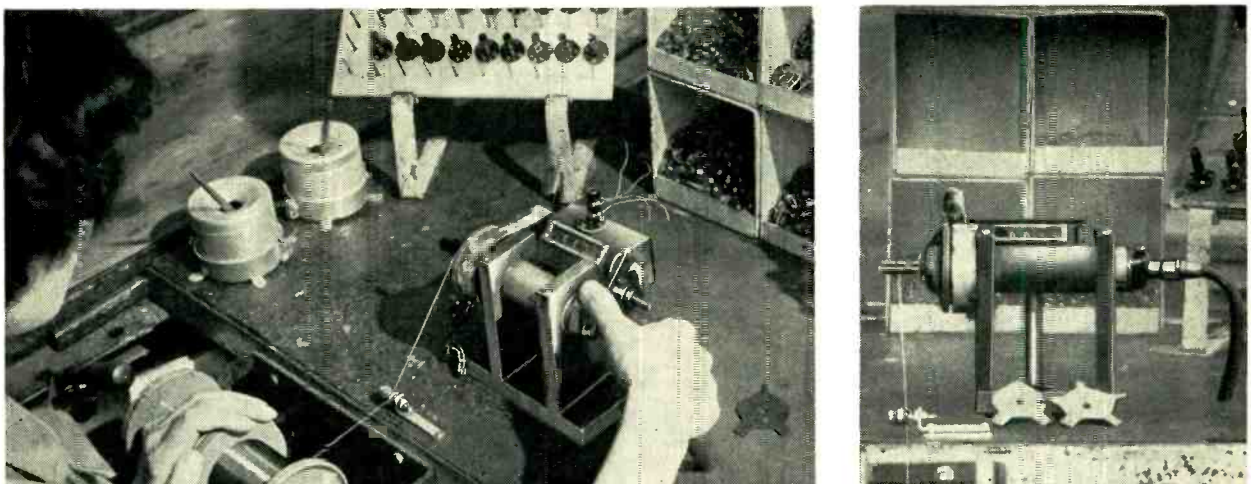
The automatic cycling machine has proved valuable to engineers in making acceptance tests of plugs and sockets. In addition, it is used to analyze rack wiring methods to help prevent socket damage due to sleeve misalignment caused by improper tensions from the rack wiring.

The machine has also been used in testing wiring for tendency to fail after repeated bending either in a cable harness or at the point of attachment to a connection lug. For these tests the accurately determined length of the stroke is used to produce flexure through a controlled angle.

Air-Driven Hand Drill Serves as Winder for Single-Layer Coils

AN ORDINARY air drill mounted horizontally on a simple bench stand provides smooth power for producing layer-wound coils having 30 to 40 turns each. The coil-holding arbor in the chuck of the drill is easily changed for running another type of coil form. A counter just behind the drill indicates the number of turns wound, and is easily reset to zero after each operation by depressing a lever. The technique is used for winding i-f coils of television receivers in the plant of E. K. Cole Ltd., Southend-on-Sea, England.

The air-driven hand drill gun employed is made by Desoutter



Air power winds i-f coils. Punched steel spiderweb gages on bench provide correct spacing between coils on form

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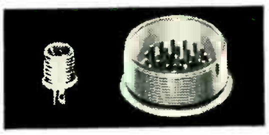
Seals are available in both High Compression and Kovar to hard glass types.



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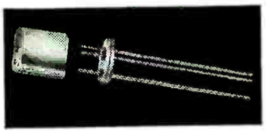

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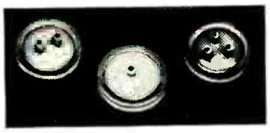

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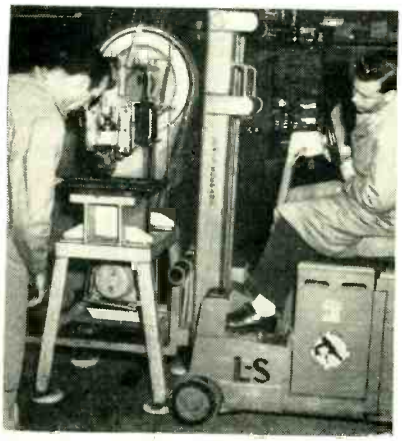
Bros. Ltd. of The Hyde, London NW 9, England. A gear was added to the gun shaft to mesh with an identical gear on the turns counter, giving a 1 to 1 ratio. Starting and stopping is achieved with a push-button on the right-hand side, adjacent to the air supply hose.

A small bracket attached to the bench between the winding arbor and the wire reel holds a sewing-machine type of tensioning device. This is useful for providing winding tension needed for close-wound coils and for preventing the wire from flying when it is snipped off a finished coil.

Quick-Leveling Mounts for Production Machines

PUNCH PRESSES, grinders and other machinery involved in the production of electronic equipment and components can be moved to new locations on any type of plant floor and set up ready for use in a few minutes by using Leveling Barrymounts in place of conventional floor anchor bolts. In one demonstration, an assembly line of eight heavy machines was moved and connected to power and air systems in only 24 minutes.

The new mounts also serve to absorb machine vibration, permitting use of punch presses in areas not having reinforced concrete floors. The mounts rest directly on the floor, and are leveled with a few turns of a wrench. Cost is about $50 per set of four mounts capable of supporting six tons each. Once on a machine, the machine can be



Method of using fork lift truck to move punch press equipped with leveling mounts

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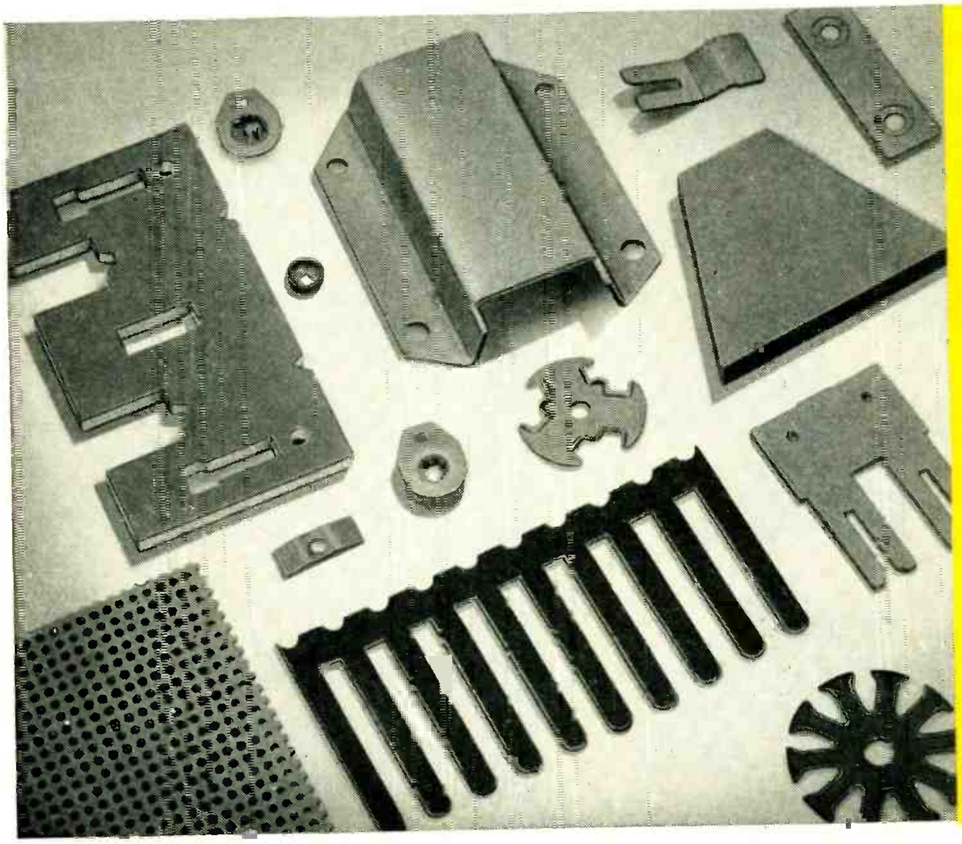

SPECIFICATIONS

Thickness Range:	.005″ to 1″
Finish:	Pressed and calendered
Punching:	To 3/16″ thick
Sheet Size:	56″ x 90″
Roll Width:	56″ for thicknesses of .005″ through .060″. Coils to 3/16″ for thicknesses of .005″ through .090″.

PROPERTIES

Mechanical	
Flexural Strength	
(Lengthwise)	14000 psi min.
(Crosswise)	12000 psi min.
Tensile Strength	
(Lengthwise)	7500 psi min.
(Crosswise)	5500 psi min.
Compressive Strength	
(Flatwise)	20000 psi min.
Izod Impact Strength	
(Lengthwise)	3.5 Ft.-Lbs./inch
(Crosswise)	2.9 Ft.-Lbs./inch
Electrical	
Dielectric Strength	
(1/32″ thick)	250 min.
Short Time Test	
(1/8″ thick)	175 min.
Arc resistance, seconds	100

Make it from turned rods. Diameters from 1/8″ to 1″ with ground or buffed finish.

Make it easy for yourself when you're buying vulcanized fibre. Call your Taylor engineer . . . he will be glad to work with you . . . help select the correct grades to fit your needs —Commercial, Bone, Super White, Abrasive and Built-up. Also ask him for samples of Taylor Laminated Plastics . . . *Phenol, Silicone and Melamine Laminates* . . . suited for a variety of your product requirements.

Taylor Fibre Company, Norristown, Pennsylvania—La Verne, Calif.

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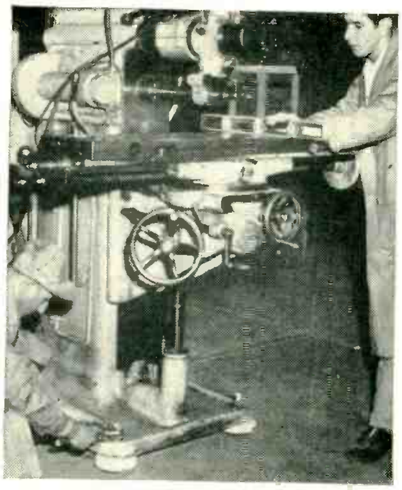


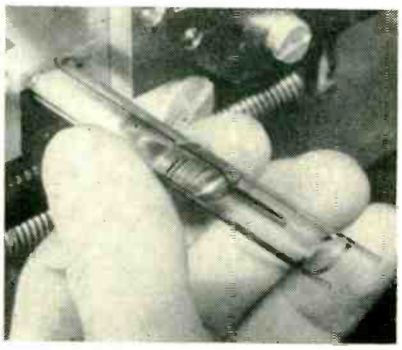
Method of leveling machine by adjusting bolt on mount

moved with a lift truck as often as desired for maintaining efficiency of production despite frequently changing product designs. A disabled machine can be quickly replaced, without a long halt in operation of the line. Repairs can then be made at leisure in a more permanent central tool room.

With all modes of vibration absorbed, walking of machines becomes impossible and there is hence no need for fastening machines to floors. In addition, the plant noise level is reduced, with corresponding increase in worker efficiency. The mounts are manufactured by Barry Corp., Watertown, Mass.

Grid Stretcher

A HAND-OPERATED stretching mandrel has been developed by Amperex Electronic Corp. for precise shaping of wound grids for their type 5894 twin tetrode. The operator pushes a grid over the forward projecting split mandrel and rotates the hand crank half a turn. The



Method of loading grid on mandrel

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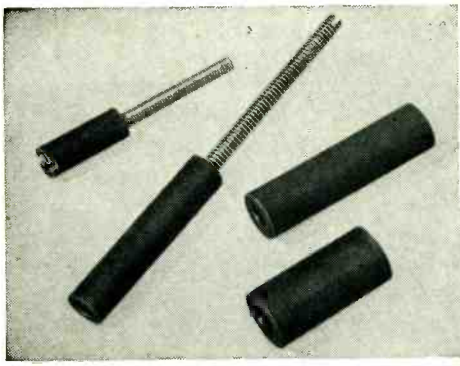
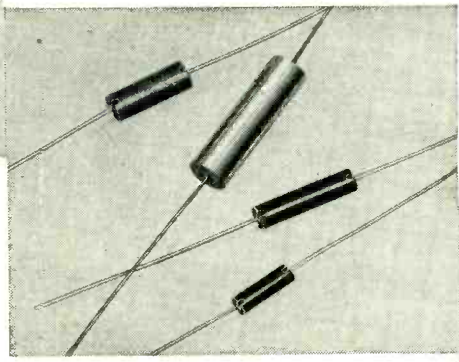
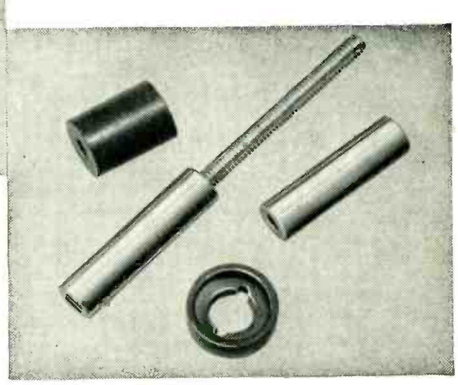


FERRICORES



MOLDED COIL FORMS



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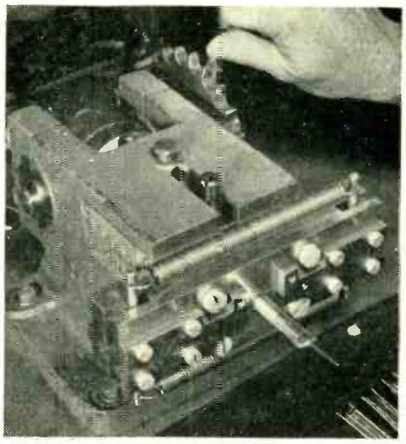


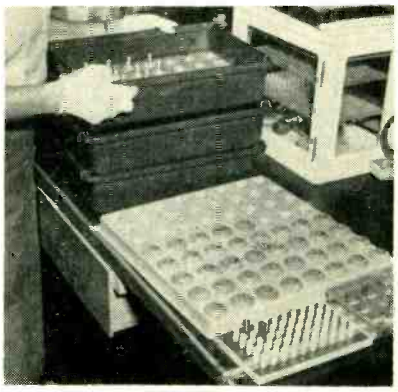
Turning crank to stretch grid

crank actuates an eccentric cam which pushes a tapered pin between the two halves of the mandrel to spread them apart the desired distance. The crank is then moved one-half turn backward to release the pressure so the shaped grid can be easily slid off. Springs bring the mandrel halves together when the pin is retracted.

Self-Stacking Plastic Trays

COMPONENTS for magnetrons and other microwave tubes are protected from damage during handling or storage by using special molded plastic trays having individual recesses for each part. As an added advantage, the number of parts in either filled or unfilled trays can be counted at a glance. Removable inner trays of the plastic trays are interchangeable, so that the same standard pans can be used for many different types of parts. Wires running inside each pan at the top serve as supports when nesting the pans to prevent them from jamming into each other.

Smaller parts are stored in clear



Tube parts in plastic handling trays


BLILEY
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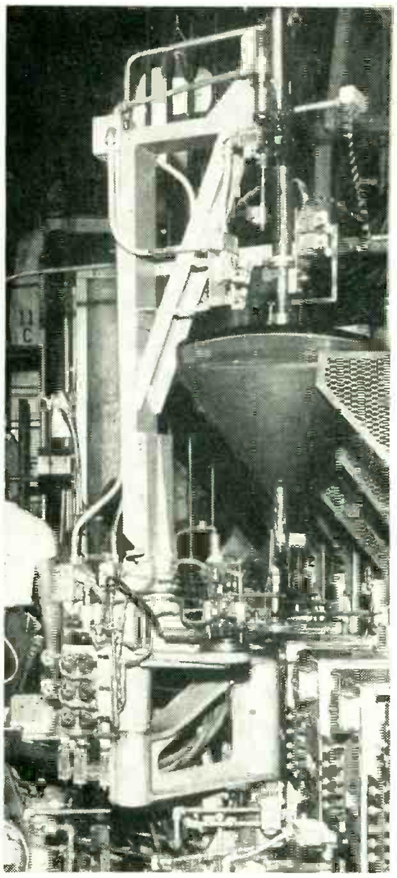
UNION STATION BLDG., ERIE, PENNSYLVANIA

plastic boxes with hinged covers, available in hardware stores with various sizes of inner partitions. Tubular parts are stored on plastic pegs set into a plastic tray or sheet.

These material-handling techniques are used in the Hicksville, N. Y. plant of Amperex Electronic Corp. The large trays are molded economically from a new Boltaron plastic material that can be formed in simple wood molds.

Automatic Tip-Off Machine



Tip-off machine has raised tube after completing seal. As next step, tube is swung forward so operator can remove it for transfer to overhead conveyor

THE DELICATE process of sealing off the glass tubulation of television picture tubes has been mechanized in General Electric's tube plant at Electronics Park, Syracuse, N. Y. After the exhaust machine has completed its index, the automatic tip-off unit swings into position with a live-vacuum suction cup directly above the bulb to be tipped. Pre-set fires adjust themselves to the proper position on the glass tubulation and, as it is heated to the soft-

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SERIES 901-903
TEN-TURN
POTENTIOMETERS

BUSHING MOUNT AT BOTH ENDS

Designed for the utmost versatility and adaptability, Borg Micropots eliminate the need for special design. New standard Borg Micropots are available in single or double shaft models with exceptionally rigid servo-mount or bushing-mount at either or both ends. The housing floats on sturdy mounting flange.

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SERIES 931-935
THREE-TURN
POTENTIOMETERS

SERVO MOUNT AT BOTH ENDS

All potentiometers are available with double end support to assure efficient operation where subjected to excessive vibration. Precision ball bearings and precision rolled lead-screw provide higher accuracies and longer life. New scanning bar-contact reduces noise and lengthens life. Adjustable contact assembly provides higher accuracies at lower cost.

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BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
Janesville, Wisconsin

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ening point, the tube is raised, stretching the tubulation. Application of further heat cuts the tubulation and forms the final vacuum seal.

The tipping equipment then swings away from the exhaust machine, carrying the tube to position for removal by the operator. After manual removal of the tube, the machine is ready for the next cycle. Safety interlocks prevent improper sequential operation of the complex equipment.

Polishing Copper Laminates for Etched Circuits

A ROTARY scrub brush in a modified drill press arrangement is used with extra fine pumice and water to prepare copper-clad plastic sheets

Polishing copper-clad plastic sheet with rotary scrub brush in drill press arrangement that is free to move horizontally as well as vertically

for conversion to etched components. The mounting arrangement permits moving the rotating brush horizontally in all directions so as to cover the entire surface of the sheet. Vertical pressure on the brush is applied conventionally with a drill press lever working against a spring. A belt drive is used for the motor, to achieve speed reduction along with flexibility of movement.

The polishing operation, which takes about 30 seconds per sheet, is used to remove oxides and adhering foreign material, clean the copper

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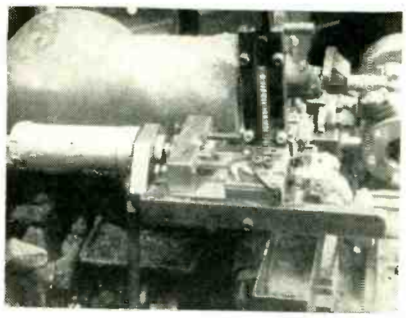
and leave a fine rough surface for coating with a photographic emulsion. High-quality fiber brushes costing approximately $7 each are used to prevent undesired scratching. When the cleaning operation is carried out continuously, a brush lasts about a third of a day.

Cotter Pins Serve as Insulator Terminals

SILVER-PLATED cotter pins inserted in insulating bushings are staked into chassis holes with a punch press for use as mounting terminals and connection points, by means of a technique developed in the television receiver plant of E. K. Cole Ltd., Southend-on-Sea, England. The pin terminals take considerably less chassis space than conventional Bakelite panel terminals with soldering lugs and riveted mounting brackets. The pin terminals also reduce overall labor and material costs, as all terminals on a chassis can be staked in one operation. The reduced size allows a better distribution of component parts, which in turn makes assembly and wiring operations easier.

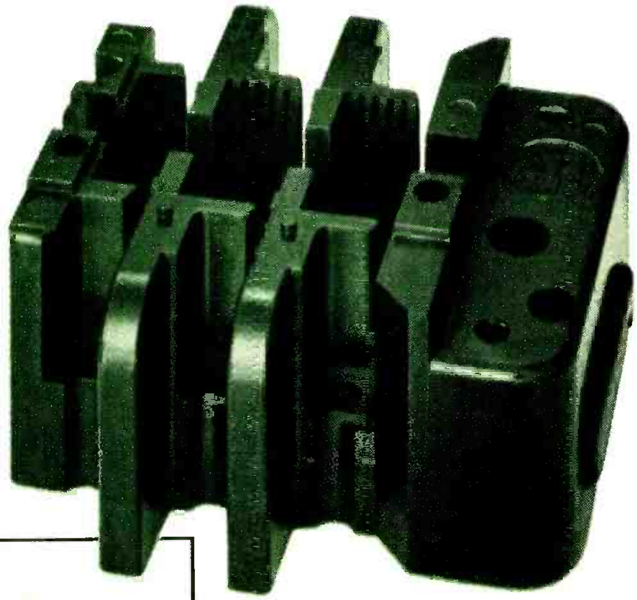
The first step in production is machining the insulating bushing on a Brown & Sharp 00G automatic lathe. The insulating material used is a synthetic resin bonded fabric known as Carp Brand Tufnol, made by Ellison Insulators Ltd., Perry Bar, Birmingham 22B, England, but any other high-quality insulating material will serve the purpose.

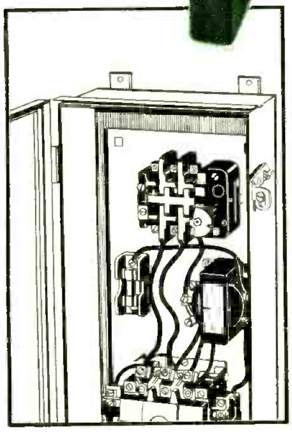
After the bushing is automatically turned and formed, it is picked up by a transfer arm on the machine and moved into line with a small hole through which a cotter



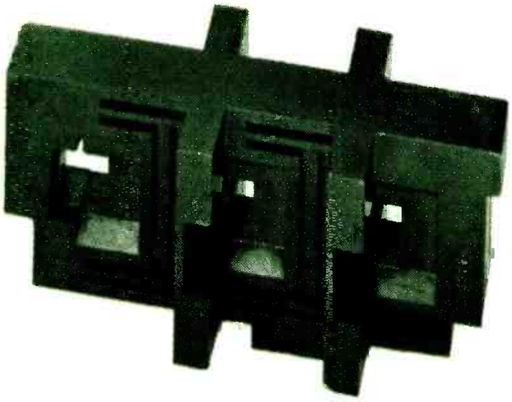
Automatic lathe for machining bushings and inserting cotter pins. Air cylinder at left drives in pins. Magazine feed for pins rises vertically at right

How would you handle this electrical parts problem?





Combination starter, containing parts molded of Monsanto's Resinox 3700 thermosetting material, manufactured by Arrow-Hart & Hegeman Electrical Co.



Arrow-Hart solved it with new RESINOX 3700

Arrow-Hart & Hegeman Electrical Company of Hartford, Conn. needed a strong, stable, electrical-grade material with high arc-resistance for important parts of their combination starter shown here. They specified Monsanto's new thermosetting molding powder, Resinox 3700. Result: Complete satisfaction!

Resinox 3700 is the ideal all-around material for magneto ignition, motor control and electronic circuits, and other electrical applications.

1. **It combines high arc-resistance with outstanding dimensional stability. Eliminates undesirable after-shrinkage.**
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Address ____________________

City, Zone, State ____________________

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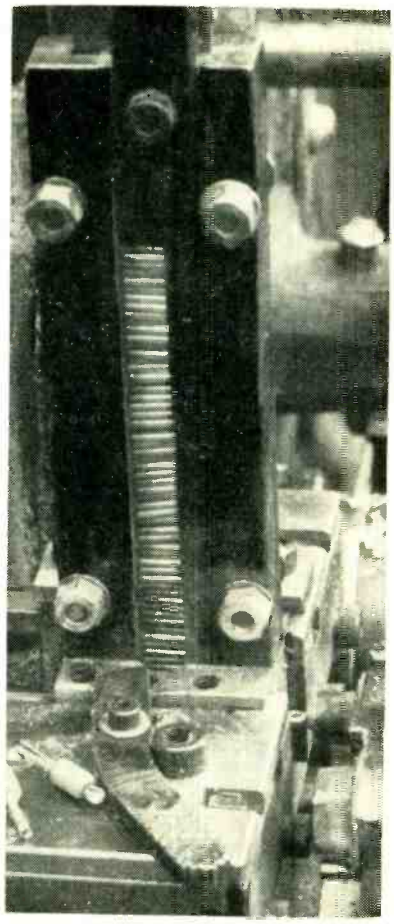

Details of magazine feed for pins

pin is automatically fed by an air-operated pluger. The transfer arm then moves past the ejector blade, releasing the pin and bushing assembly so it drops into the delivery chute.

The cotter pin is driven in with a tight friction fit so it cannot drop out later. The complete cycle time for making one terminal is 4.25 seconds. The air cylinder of the plunger that drives in the pin is operated by a roller valve which is tripped by a special cam on the main cam shaft of the lathe.

As the first step in staking the terminals to a chassis, the operator loads the pin and bushing assemblies into the bottom tool of the staking fixture, points upward. The chassis is next dropped over this fixture and the press is operated. The top tool consists of hollow punches with staking points that close up the chassis metal around the Tufnol bushings. No difficulty is encountered in placing the chassis over the terminals because the punched holes are appreciably larger then the bushings. The swag-

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Inserting terminal pins in bottom tool of staking fixture

Removing chassis after all terminal pins have been locked in position with one staking operation

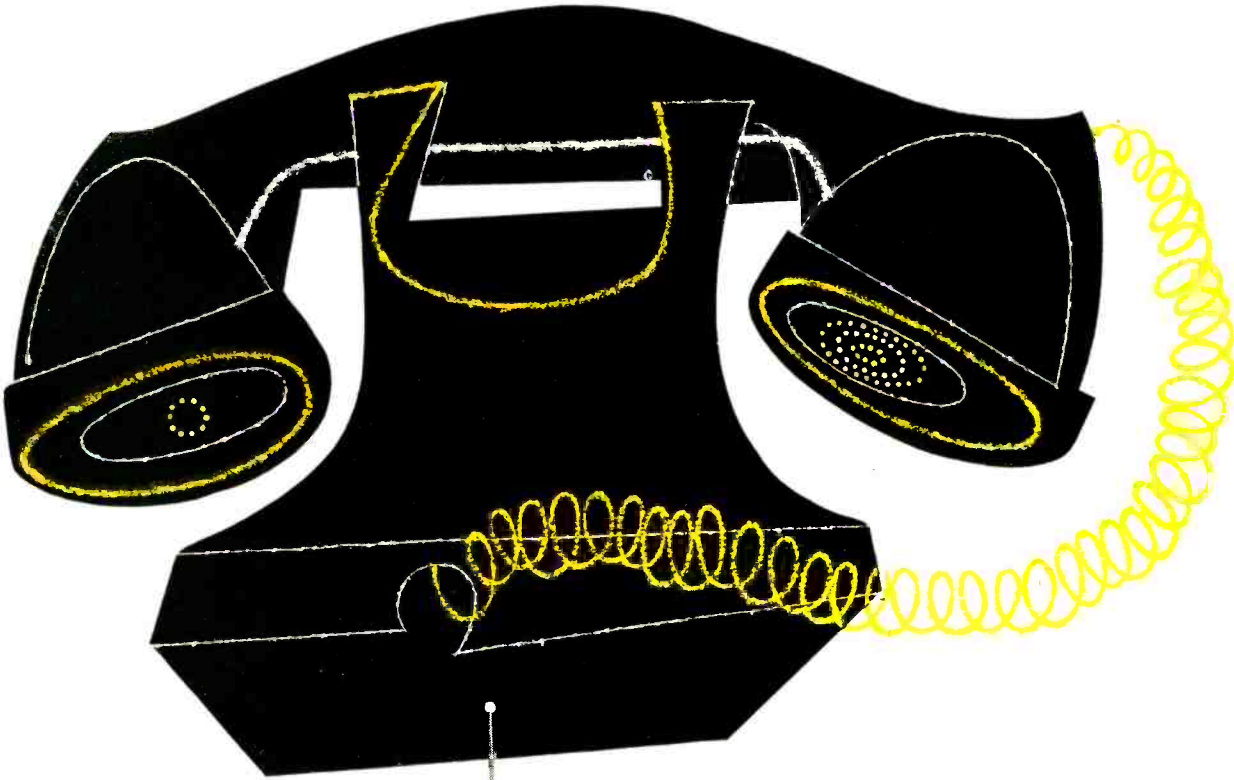
ing operation closes up this space to give a tight and rigid terminal mounting.

This method cuts the cost of terminals approximately in half as compared to the older technique of bolting terminals in position.

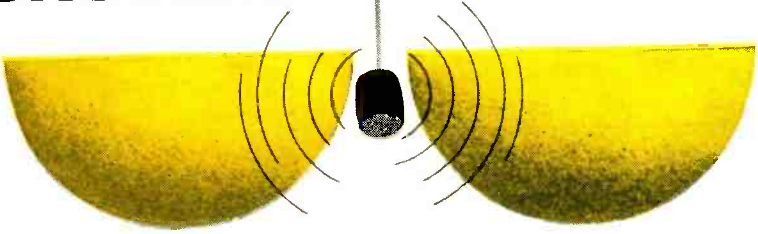
After assembly of the pins on the chassis, the legs are spread open as much as desired. The cotter pins used are long enough so that up to three wires can be soldered on each leg during the wiring of a television receiver. Additional connections can also be made to the head of the pin on the top of the chassis if desired. These pin heads also serve as convenient test terminals for troubleshooting during servicing of the receiver.

Potting-Wax Centrifuge

METAL cans containing capacitors and resistors embedded in potting wax are spun at high speed in a centrifuge at the Hawthorne Works of Western Electric Co. This procedure was introduced to eliminate



CRUCIBLE PERMANENT MAGNETS



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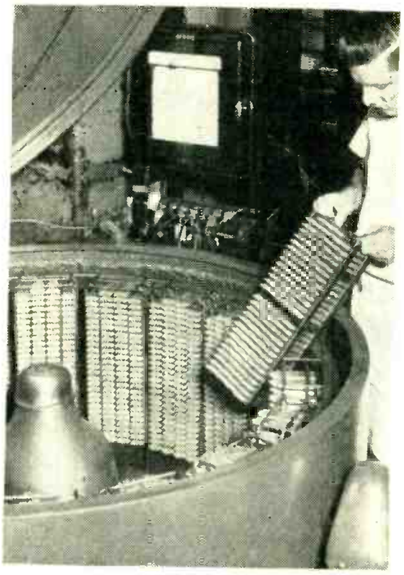


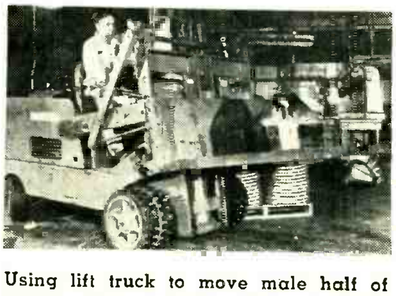
Loading racks of potted components into centrifuge. Cover at upper left is lowered before starting machine

the voids or cavities that formerly developed in the wax during shrinkage after cooling.

Spinning the cans in the centrifuge under a blast of hot air binds the wax together and eliminates cavities, thereby giving more dependable electrical networks. Savings in reprocessing costs and improved reliability of components combine to give an annual saving estimated to approach $100,000.

Moving TV Tube Dies With Fork Lift Truck

MALE and female dies for stamping stainless steel television tube shells, weighing 2,500 and 4,000 pounds respectively, are loaded into and removed from their press in the plant of the United Specialties Co. in Chicago with a Towmotor fork lift truck equipped with a special unloading device. This new material-handling technique is saving 65 percent of the time it formerly



Using lift truck to move male half of picture tube shell die. Finished shells can be seen in background

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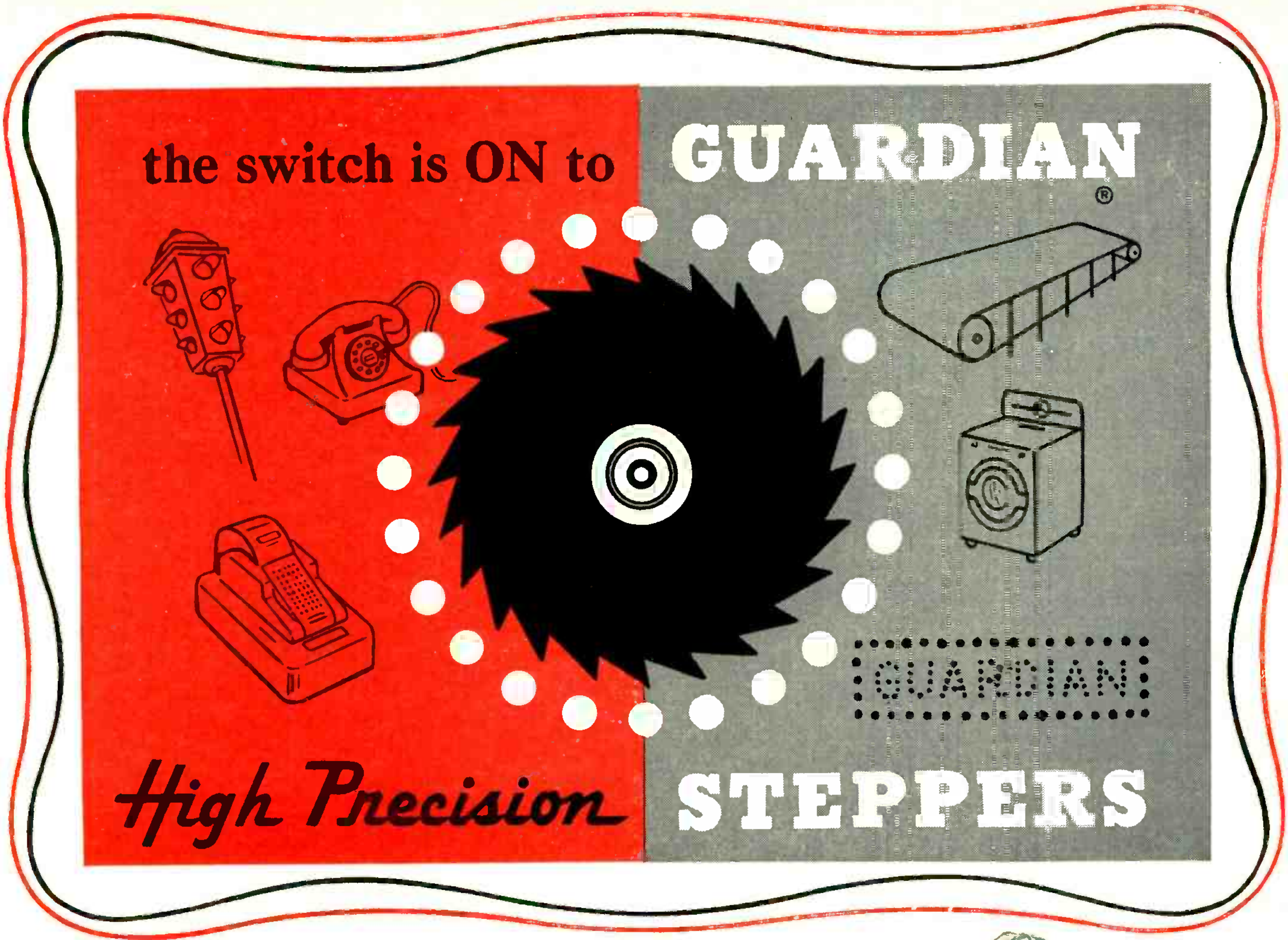
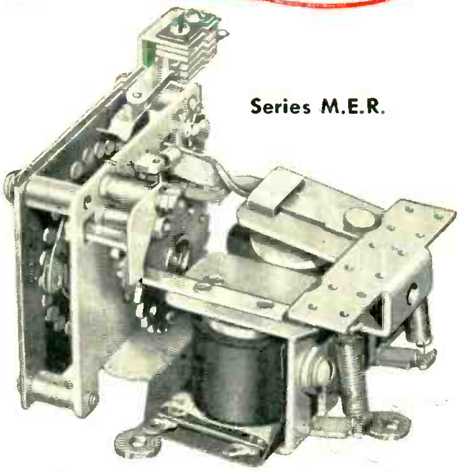
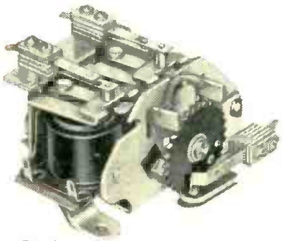


These *high precision* standard Guardian Steppers afford positive selection and control of multiple circuits in Business Machines, Counting Devices, Totalizers, Computers and a vast array of similar products *at low cost*. Applications include: automatic circuit selection; automatic sequence selection of circuits; automatic sequence cross-connection of circuits.


Series M.E.R.

SERIES M. E. R. GUARDIAN MIDGET ELECTRICAL RESET STEPPER

Keeps the reset magnet open, allows the ratchet to reset freely on a pulse of 10 milli-seconds. Stepping magnet releases lock mechanism on first step to ready unit for recycle. Standard unit has one disk with one finger rotating counter-clockwise. Two fingers available. Up to 21 of total 24 points on disk are active. Rated at 10 steps per second. Voltage ranges: 6 v. to 115 v. A.C., 60 cycles, or 6 v. to 110 v. D.C. Auxiliary small combination contact switches can be mounted on ratchet or on either magnet. New 3-point mounting for easy installation.

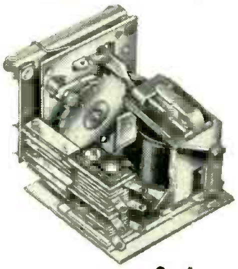

Series M.A.S.

SERIES M. A. S. STEPPER

A compact dependable Add and Subtract unit. Up to 27 active points on total of 30. Rated at 10 steps per second. S.P.D.T. contact switch can be mounted on any ratchet position or on either magnet. Available to operate on 6 v. up to 115 v. A.C., 60 cycles, or from 6 v. 110 v. D.C.

SERIES M-120 STEPPER

Up to 3 position contact combinations are available on the Guardian Series M-120 Stepper. 24 point ratchet employs case hardened steel construction to assure long life precision operation. Contact combinations in 3 standard ratings: 1.5, 10 and 12 amps. at 115v., 60 cycles, non-inductive. Voltage range: 6 v. to 115 v. A.C., 60 cycles; or 6 v. to 110 v. D.C. intermittent duty.


Series M-120

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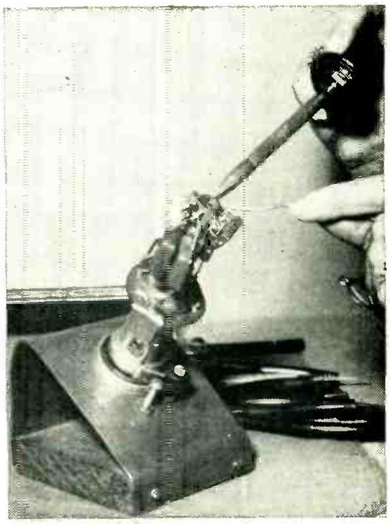
took two men to set up the dies. With the aid of the truck, the two die setup men can have the press ready for use in about 2 hours, as compared to 6 hours formerly required.

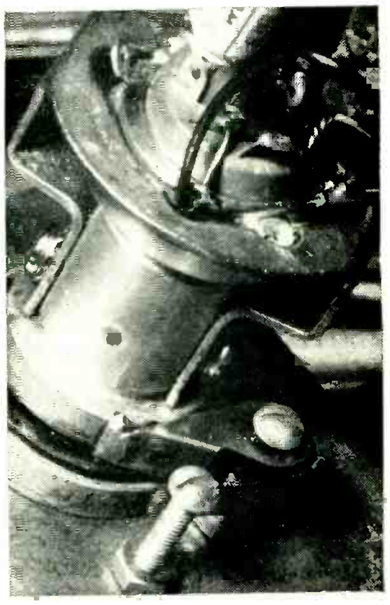
The same technique is used for removing the dies, by simply reversing the direction of the unloader and using two cables to pull the dies onto the forks. Removal now takes about $\frac{3}{4}$ hour, as contrasted with $2\frac{1}{2}$ hours before. The LT-72 Towmotor truck and the unloader are made by Towmotor Corp., Cleveland, Ohio.

Tube Socket Holder

STANDARD octal tube sockets with attached turrets are supported in a specially designed three-position holder during subassembly work at Ampex Electric Corp., Redwood City, Calif. The base of the holder is a piece of sheet metal bent at an angle of 45 degrees and nailed to a block of wood. The socket holder itself is bolted to the slanting face of the base, and has a detent mechanism that permits rotation and



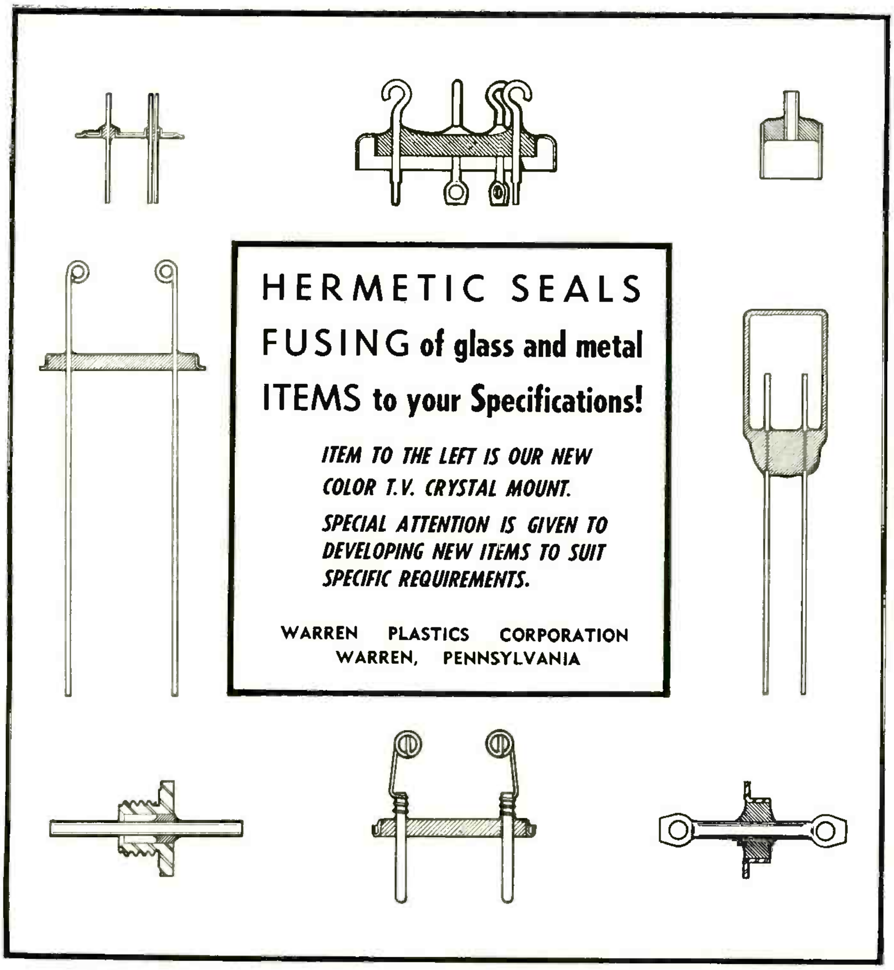
Method of using socket holder



Finished turret in holder, showing how indentations in top plate provide clearance for grounding terminal lugs of socket. The entire holder is mounted on shaft going through slanting base, for rotation past detent spring in foreground

locking of the turret in any of three positions for maximum convenience during assembly work.

A socket assembly is inserted by pushing the socket down through the punched metal top plate after orienting the socket mounting lug with the cutouts in the plate. Pushing downward against the spring-loaded central column permits rotating the entire socket slightly, so that the threaded inserts of the flanges click into smaller indentations to lock the socket in position. Other indentations in the top plate provide clearance for the grounding



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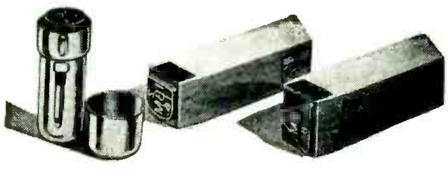

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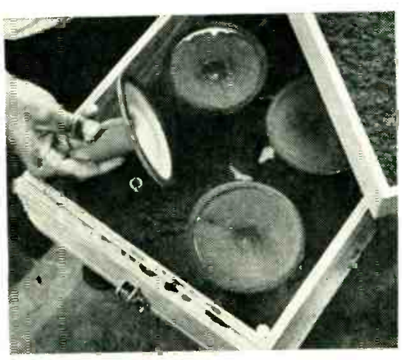
terminal lugs on the socket. Removal of a finished unit is achieved by pushing the assembly down and rotating counterclockwise, just as for removing a bayonet-base lamp.

Flocking Waveguide Stands

FLOCKING of bases for waveguide stands cut job time to one fifth of that previously needed for glueing on felt pads and turned out a neater job, in the Palo Alto, Calif. plant of Hewett-Packard Co.

A silk screen setup was devised to apply the adhesive—not glue, but ordinary kitchen enamel the same deep green color as the flock. The enamel works well in the silk screen and gives a richer color to the felted base. While the paint could

Silk screen permits quick, even application of green kitchen enamel as flocking base on bottom of waveguide stand. Enamel works well in silk screen, gives rich color to the green flock



Four flocked stands come out after 15-20 sec agitation in standard flocking box. Note snap-on holding fixture

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Precision re-positioning devices for application in electronic and industrial equipment requiring accurate multiple channel pre-set control

THE Collins Autotune has long been the basis for both remotely and directly controlling automatic tuning of high quality, military and commercial communication equipment. It is also applicable to the design of many other industrial and electronic equipments. Variable pre-set positions are chosen by the operator — when once set, the Autotune automatically returns to the selected position with an accuracy unmatched by any other means.

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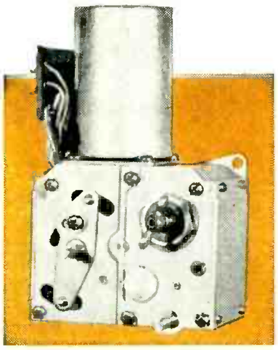
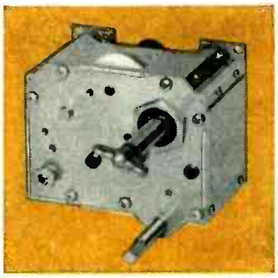
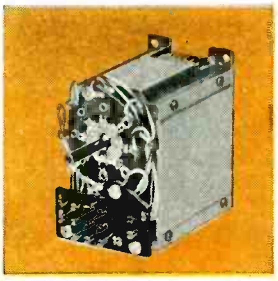


Collins
AUTOTUNE SYSTEM COMPONENTS — for variable pre-set positioning of multiple shafts incorporating several Autotunes driven by one motor.

Singleturn Autotune Head

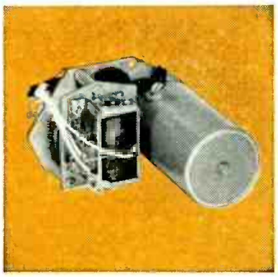


Multiturn Autotune Head



Autotune Control Unit

Collins
AUTOPOSITIONER — for use where up to 20 or more pre-determined fixed positions are needed. Both packaged and individual Autopositioners are available.



For complete information on Collins Autotunes and Autopositioners, contact the nearest Collins office. You will receive prompt attention.

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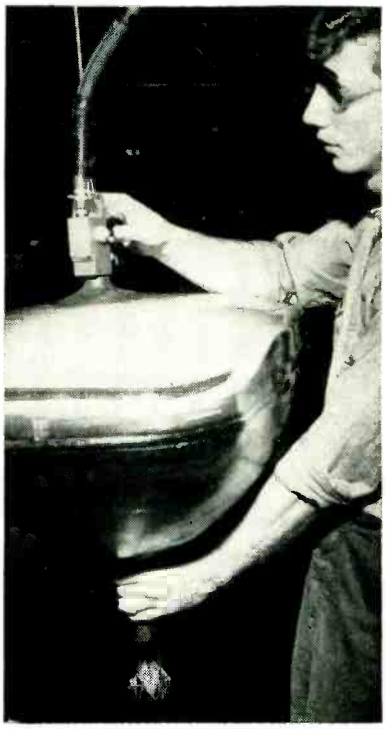
be applied by hand, the silk screen does a faster, evener job.

The stands are slipped on holding fixtures in the standard flocking box, four at a time, for an agitation period of 15 to 20 seconds using the longest fibred flock available ($\frac{1}{16}$ inch).

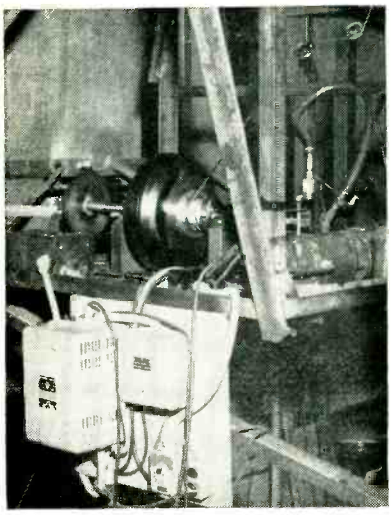
Lifting Aids for Large Picture Tubes

A COUNTERBALANCING lifting aid fitted with a live vacuum suction cup aids operators in handling 27-inch all-glass picture tubes weighing 45 pounds each, in the Syracuse, N. Y. plant of General Electric Co. The equipment relieves the operator of heavy work, allowing him to concentrate on guiding the bulb into and out of the processing equipment.

Counterbalancing is achieved in one setup by running the lifting cable up over pulleys to a power unit consisting essentially of a variable-speed electric motor driving a fluid transmission. This ar-



Lifting aid employing single vacuum-powered suction cup in conjunction with counterbalancing system employing motor-driven fluid transmission. Thumb of operator is on trigger button which is pushed to release vacuum after picture tube has been transferred to a rack or a conveyor cradle rangement automatically applies the required lifting force to counterbalance the load being handled. The power unit is located on a platform suspended from the ceiling. Also on this platform is the vacuum pump for the suction cup. The lifting cable and control wiring feed out to a boom and then down to the desired operated point. The fluid transmission is the conventional automotive type, modified for belt drive from an electric motor on



Under-ceiling platform supporting motor-driven counterbalancing units and vacuum pump. Lifting cable runs from drum on fluid transmission upward over pulleys to a boom (not shown) which swings over operator's working area

one side, with the cable drum on the other side.

A trigger button releases the vacuum to permit removal of the suction cup. An electric cable coming down along with the vacuum hose goes to a switch near the trigger button, used for starting and stopping the lifting button that automatically counterbalances the weight of the picture tube. This vacuum lifting aid was made by the Equipment Development Works, General Electric Co., Schenectady, N. Y.

In another setup for 27-inch tubes, lifting is done with a commercial air motor hoist made by Ingersoll-Rand, available from mill supply houses. Here two suction cups are used, to minimize the swinging of the picture tube as it is raised. A separate three-way control valve held in the operator's right hand is connected to the lift-

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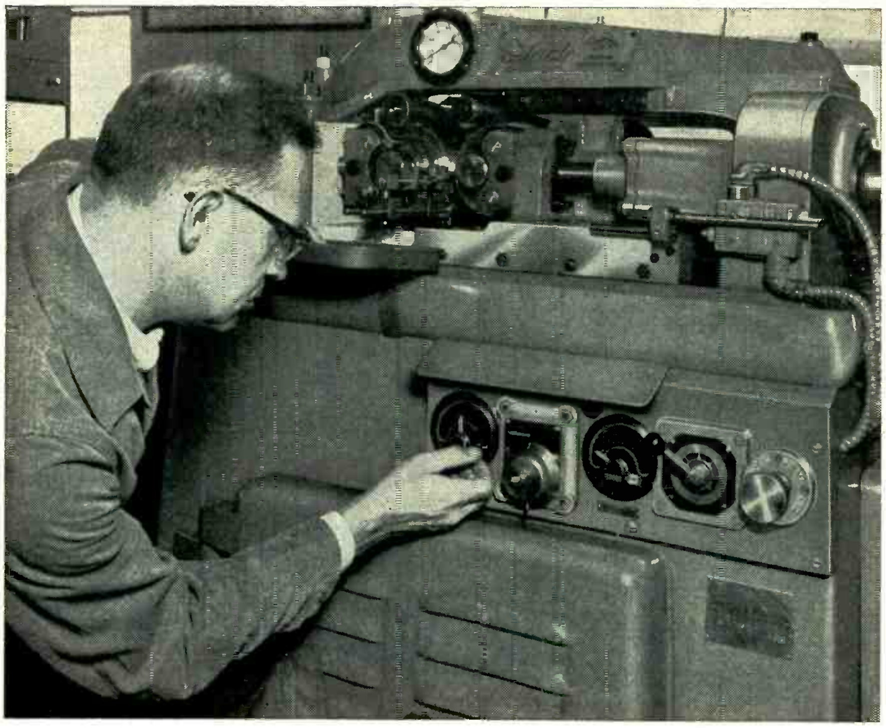


Lifting aid using air motor hoist and two ordinary vacuum cups that do not require a vacuum line. The three hoses control the air-type hoist motor overhead. At right is the vacuum-type spinning chuck

ing unit with three lengths of rubber hose. One hose supplies air to the valve, one is for up and one is for down. Fingertip valves on the control bleed air into the cups to release the picture tube. When attaching the cups, the operator needs to apply only a slight pressure to make them grip the glass; no vacuum line is employed with the cups in this instance. Finger-actuated levers just above the cups operate tiny valves that bleed air into the cups to release the picture tube.

A single vacuum cup serves in conjunction with four rubber-covered positioning rods to hold the picture tube at a downward angle while it is being rotated by an electric motor through a gear reduction box when applying a conductive coating to the inside walls. The vacuum is applied to the suction cup through a rotating fitting. The operator releases the vacuum with a foot pedal while holding the tube with both ends, when transferring the tube from the spinning chuck to the wood fork on which it rests temporarily while he attaches the air motor hoist fitting.

Setscrew Fittings for Pipes Speed Plant Alterations

COMMERCIALLY-AVAILABLE Nu-Rail alloy fittings make it possible for regular plant maintenance crews at General Electric's picture-tube plant at Electronics Park, Syracuse, N. Y., to erect fencing, guard rails and similar units, using regular pipe for the horizontal and vertical members.

The fittings are made in many

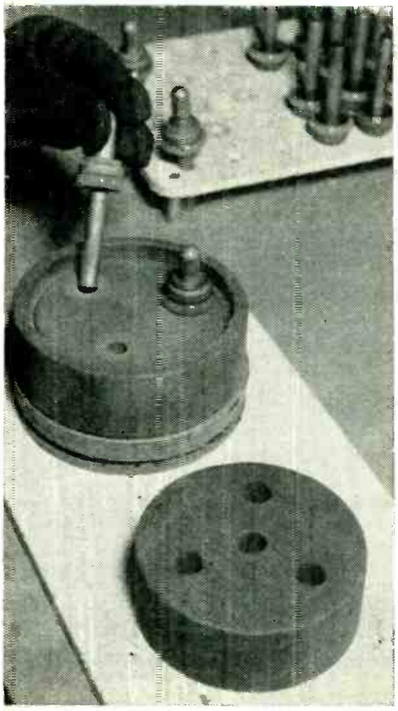
Top fitting for post of pipe fence surrounding picture tube storage area

standard designs by Hollaender Mfg. Co., Cleveland, Ohio, to be used at corners, cross-overs, floor flanges, stair-railing mountings and other installations. Pipe lengths are held in position by set screws which permit rapid changing when necessary.

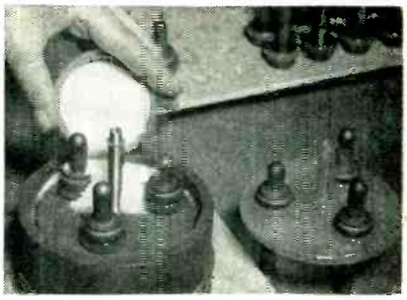
Molding Tube Stems with Powdered Glass

HEAVY STEMS for Amperex type 6333 10-kw triodes are now produced with integral sealed-in copper terminals by means of a powdered glass technique developed in this firm's Hicksville, N. Y. plant.

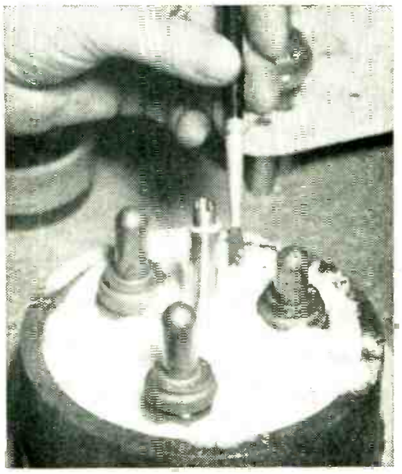
The first step in the molding tech-



Loading terminals in mold



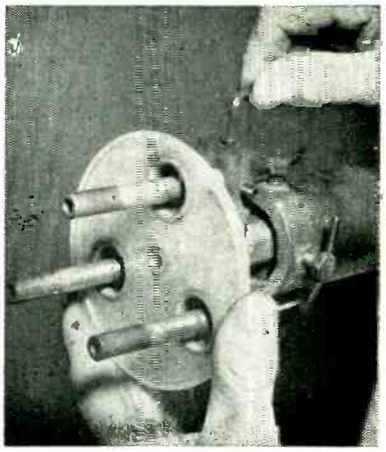
Pouring powdered glass in mold



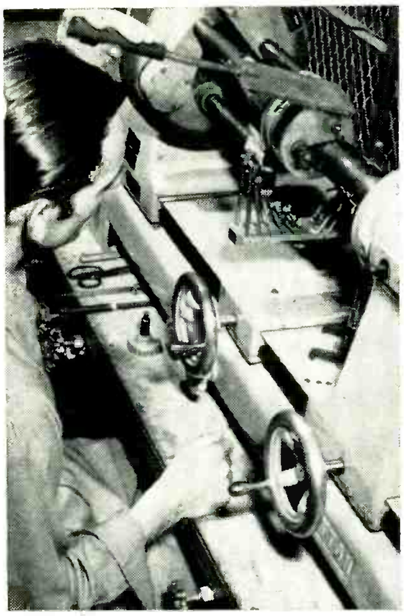
Leveling powdered glass

nique involves loading the heavy solid copper terminals in the combination graphite and ceramic mold for the stem. These terminals have previously been coated with glass in the region where they are to pass through the stem. The glass exhaust tubulation, with a spring inside to prevent it from collapsing, is then inserted in the center hole of the mold.

A measuring cup is now filled exactly level with powdered glass that has previously been prepared by grinding the required grade of



Locking finished stem on tailstock arbor of glass-blowing lathe



Sealing stem to envelope on lathe, with operator using paddle to true up the seal while glass is soft

glass. This powdered glass is carefully poured into the mold and distributed evenly around the terminals with the aid of an artist's brush. The mating top cover of the mold is now placed over the terminals and the mold is placed in an oven for heating sufficiently to fuse the glass.

The completed stem, after cooling, is locked in position on the tailstock of a Litton Industries model HSA standard glass-blowing lathe. The glass envelope is mounted on the headstock arbor and fused to the molded stem in a conventional manner with gas flames.

Switching Production Heads Gives Plant Savings

By Benno Bordiga

Director of Manufacturing
Olympic Radio & Television, Inc.
Long Island City, N. Y.

THE PROBLEM of occasional interdepartmental friction on various levels of production in the Long Island City plant of Olympic Radio & Television, Inc. was largely solved by an experiment called "Operation Switch". This involved switching department heads for two days, to give each a deeper insight into the problems of the others.

At one of the regular monthly staff conferences, the idea was outlined. It was emphasized that this

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was not being done to belittle or show up inefficiencies in any department, but rather to get a fresh approach to dormant problems which might have existed for some time. Conferences would be held between each foreman and his stand-in after the experiment, in order to discuss on a close and friendly basis their various findings.

Initial Planning

After successfully selling the idea to the department heads, top management was skeptical but cooperative. The day before the actual experiment, a conference was called and each department head was instructed to have a two-hour conference with his stand-in in order to acquaint him with the proper functioning of his new department.

On the day of the actual switch an air of excitement prevailed throughout the organization. Each new man tackled his assignment with enthusiasm. During the afternoon, another short conference was held and a general appraisal of the situation was obtained. The success of the experiment can be measured best by the fact that most of the men involved asked for an extension of the experiment in order to study the problem much more closely.

Final Evaluation

Three days after the two-day experiment, a general conference was called to evaluate results. The most apparent result was a complete physical clean-up of the plant, since no department head wanted his section to appear in an unflattering light.

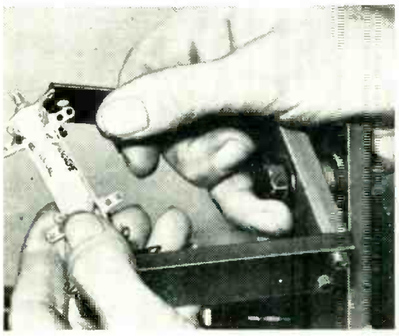
In addition, many problems which had just been pushed aside from week to week were aired. Many eyesores to which department heads had grown accustomed were rediscovered by their stand-ins. The maintenance staff was busily occupied for the next six-week period in an effort to catch up with the many maintenance problems which were thus discovered.

The total expense involved in this experiment, which by the end had received the enthusiastic approval of everyone, was a negligible cost of conference time, which would amount to approximately 8 hours per man involved. Against this is an estimated saving of $50,000 per year occurring from production-line suggestions made by those seeing departments in a new light on a king-for-a-day basis.

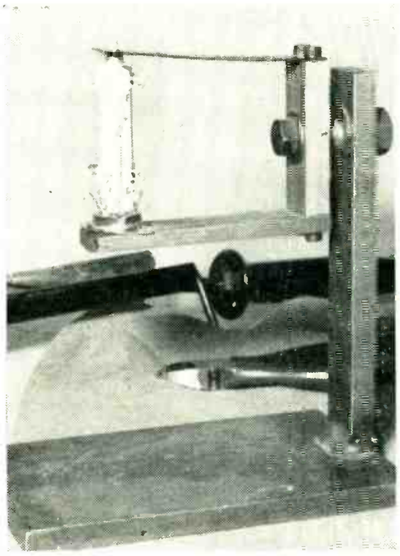
Since the experiment, a new spirit of understanding and co-operation has prevailed amongst department heads, who now view each other's problems with renewed respect. Numerous requests have been made to continue this experiment on a semi-annual basis.

Three-Size Turret Jig

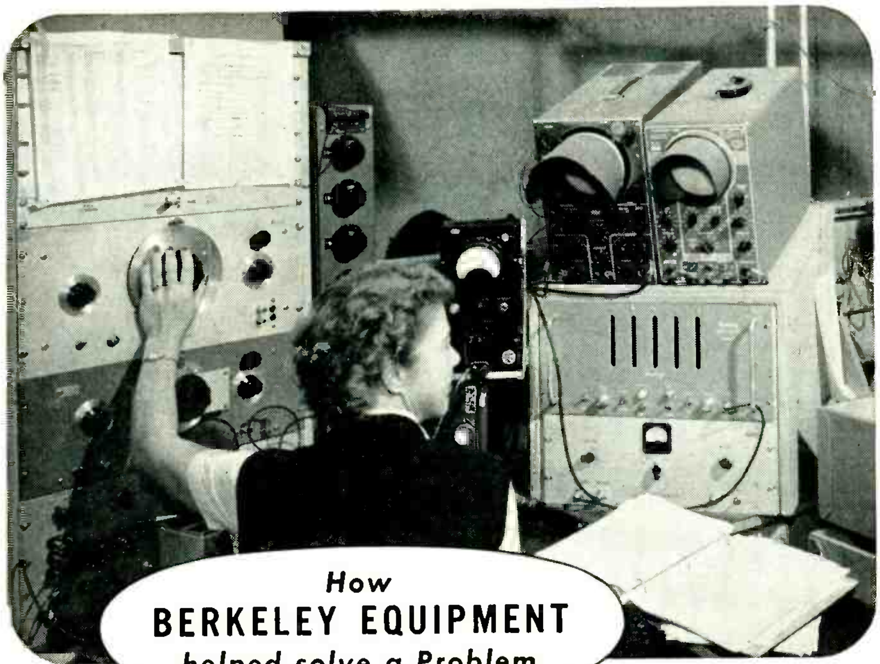
USE of a spring-steel leaf as one holding member on a rotating jig permits use with the three most common sizes of turrets attached to tube sockets. To insert a unit for subassembly work, the operator sets the socket end into a drilled recess in the rigid member of the



Inserting empty turret in jig



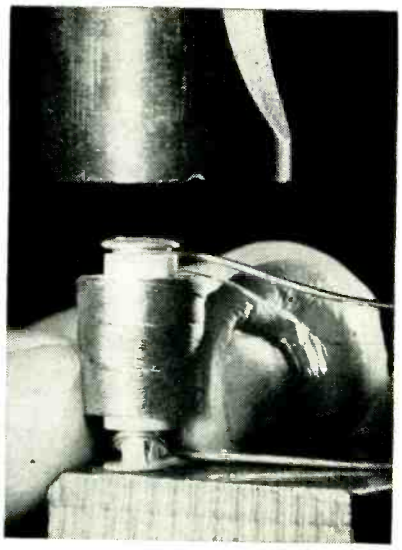
Turret in position on jig



holding jig, then bends up the spring leaf and brings it down over the projecting center bolt of the turret.

The metal upright of the jig is welded to a heavy metal plate serving as a weighted base. A small coil spring is placed on the pivot bolt between the upright and the rotating arm, to provide sufficient friction for holding the assembly in a desired position while permitting easy change of position. This simple jig is used in the Redwood City, Calif. plant of Ampex Electric Corp.

Snap-In Mounts Serve as Resistor Terminals



Pressing snap-in terminal into ceramic sleeve of finished coil on arbor press after first placing eyelet of formed lead over Tri-mount. Terminals are applied one at a time to insure accurate positioning

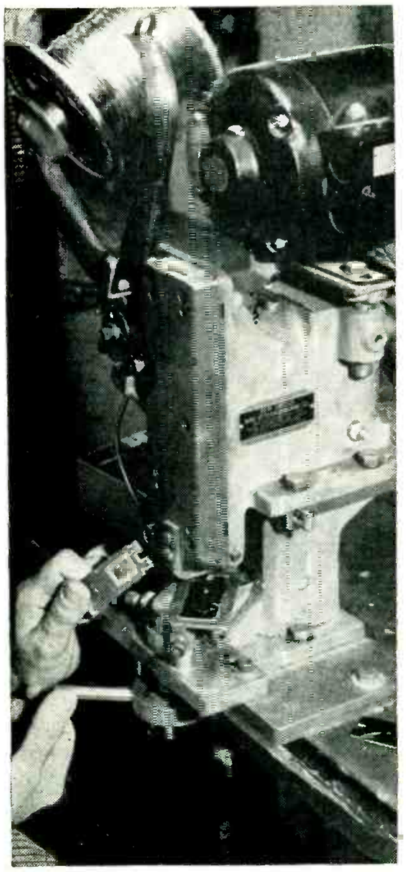
CHANGEOVER to a multiple winder for resistor coils necessitated use of leadless ceramic forms. This created the problem of adding terminals to the forms, as those previously used came fitted with leads.

The problem was solved in the plant of Hewlett-Packard Co., Palo Alto, Calif. by pressing United Carr Tri-mounts through eyelet leads into the ends of the ceramic form after winding, to serve as terminals. The terminals are pressed into the forms with the aid of an ordinary hand-operated arbor press. After winding ends are cleaned and wrapped around the terminals and leads, the joints are made permanent by dip-soldering.

Although changeover from one-at-a-time winding to the four-coil multiple winder increased setup time and involved the extra terminal-mounting operation, the new machine cut over-all time per component in half.

Staples Serve as Conductors for Etched I-F Coils

CONNECTIONS to inner ends of etched coils for 40-mc video i-f components are made at high speed and low production cost with a stapling machine to which has been added a sliding two-position anvil unit. The electric-motor-driven machine, made by New Jersey Wire Stitching Machine Co. of Camden, N. J., draws wire from an overhead reel and converts it into staples that are driven through previously punched



Applying conductors to back of etched i-f coil strip with stapling machine. One staple has already been applied, and operator has swung anvil around to correct position for other staple

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holes in the etched copper-clad plastic sheet.

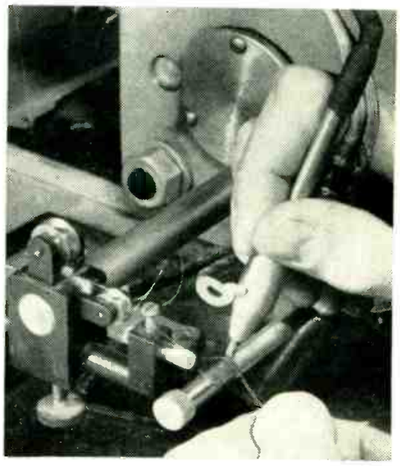
A rotating two-position anvil, manipulated by a lever under the bench, permits precise application of staples in two different positions on strips having two coils. The staples serve to bring the inner lead of each coil out to the edge and connect it there to printed conductors going past the coils to the printed terminals of the unit. The stapling technique eliminates etching of conductors on both sides of the strip.

After stapling, each strip is held face up over a vertically mounted soldering iron, with the back of each staple resting in turn on the iron. Solder is applied to the clinched ends of the staples on the etched side, connecting staples to conductors securely.

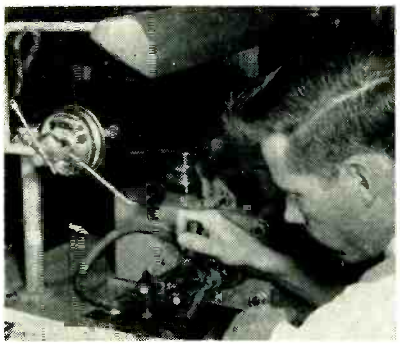
Welding Techniques for Gold-Plated Grid Wire

THE OPERATION of winding grids for type 5894 twin tetrodes in the Hicksville, N. Y. plant of Amperex Electronic Corp. required development of special welding techniques for the 0.00024-inch gold-plated wire used.

The first step involves placing molybdenum grid rods in the grooved corners of the copper mandrel, which is designed to hold the rods in position automatically. The grid wire is now anchored at one end of the mandrel and the winding machine is started. A glass rod with a fine center hole is mounted



Welding nickel band around ends of grid on mandrel of winder



Using roller electrode to weld grid winding to moly rod

on the feedscrew-driven guide to give the required spacing between turns. Pulleys and an intricate automatic tensioning system maintain essentially uniform winding tension to minimize breakage of the delicate wire during winding.

After the winding has been completed and anchored, a nickel strap is welded around each end of the grid to the four rods, using a flow of nitrogen gas at the weld to stop oxidization of the nickel. The copper mandrel serves as the other electrode for welding. Spot welding is used here, with a pressure switch built into the hand-held welding electrode to start the electronic timer automatically each time the

Method of rocking roller electrode over grid for welding wires

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electrode is pressed against the nickel strip. Either two or three cycles of current are used for welding.

Next, a continuous-duty roller welder segment is rocked over each of the four moly rods in turn to weld the gold-plated grid winding to the rods. Here also a stream of nitrogen is directed at the weld from a glass tube taped to the roller electrode. The flexible welding cable for the roller is encased in rubber tubing to prevent contact with the winding machine, since the mandrel is against the other electrode.

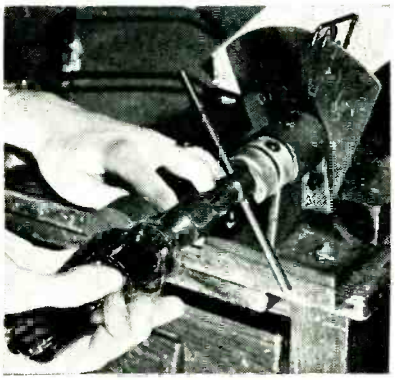
Both types of electrodes are frequently dipped into a pan of alcohol during use, to keep them cool and clean.

Cement Adhesion Tester For Receiving Tubes

By W. P. Koechel
Director of Quality Control
Tung-Sol Electric Inc.
Bloomfield, New Jersey

A large percentage of radio receiving tubes utilize cement to fasten the glass to the base. The quality department must have complete assurance that any day's batch of cement is acceptable. For this reason, random samples of the tubes are subjected to an 18-hour im-

Setup for torque-testing tube bases to determine adhesive qualities of cement. Brass block on tester has hole arrangements for six different types of bases



Setup for testing top-cap cement. Torque is applied by weight on rod just back of tube

mersion test in water at 50 C. After immersion in the water the tubes are subjected to a torque test to determine the adhesive qualities of the cement. The device used to torque-test tube bases consists of a pivoted socket on which is attached a fulcrum with a weight at the end. The tube base is inserted into the pivoted socket, and the operator (wearing a leather glove) then twists the glass envelope of the tube until the fulcrum is horizontal. At this point the

Top-cap torque-tester used on production line. Cap is rotated counterclockwise while inserting in hole, then rotated clockwise. This causes an off-center roller inside, spring-pushed in a clockwise direction, to wedge between the cap and the hub for gripping the cap

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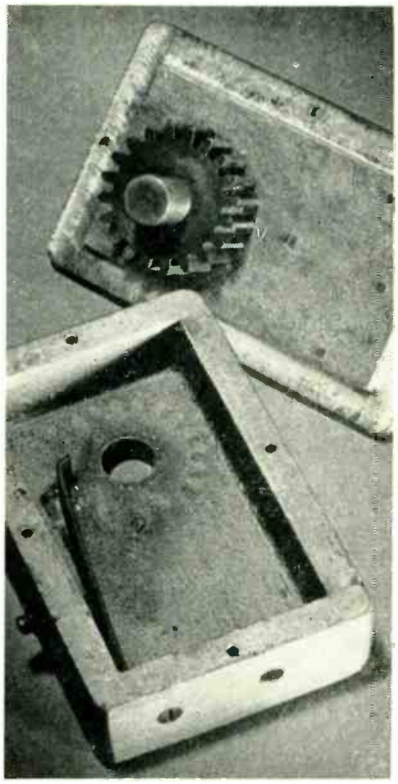


Inside of top-cap torque gage, showing how stiff flat spring bearing against gear provides friction equivalent to desired torque. Screw threaded through housing of gage bears against spring and can be adjusted to change torque

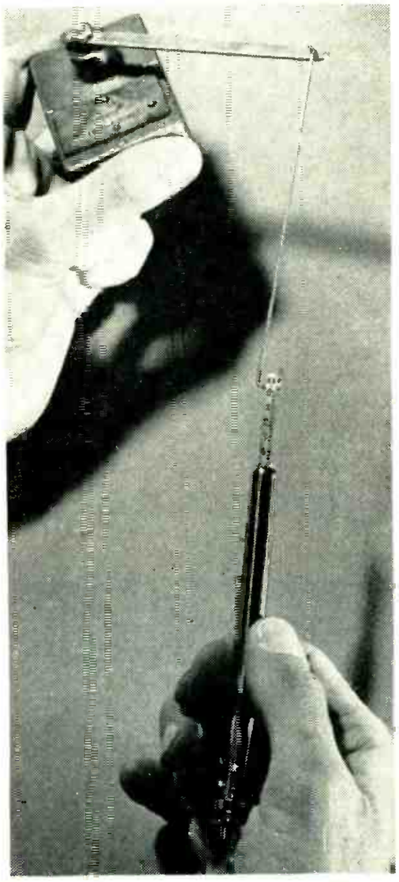
base is being subjected to a torque of 30 in.-lb. If the base should come loose at any intervening point, the fulcrum immediately drops back, but an idler indicator remains stationary, indicating on the scale at which point the base came loose.

A similar device is used to torque-test the top-cap cement of a tube. The scale here is calibrated up to 6 in.-lb.

As a quick test on the production line a different torque test device is used. The operator merely inserts the tube cap into the opening and gives the tube a few turns. In so doing, the top cap is subjected to exactly 2 in.-lb of torque.

Inside this device is a gear which is fastened to the same shaft that holds the chuck, along with an adjustable spring which engages with the gear and creates friction. Depending on the spring adjustment, a wide range of torque values may be obtained.

To calibrate this torque device, a small stud (the same diameter as the tube cap) has attached to it a fulcrum exactly 4 inches long. At



Method of using spring scale to calibrate top-cap torque gage. Flat lever arm has stud shaped like tube top cap, fitting into hole in gage

the 4-inch point there is a small hole which permits engagement of a calibrated spring tension tester. The scale of the spring tension tester is read during calibration at the particular moment when the fulcrum arm slips. Thus, to get 2 in.-lb of torque the spring on the side must be adjusted so that the fulcrum slips at the precise moment that the scale reads 8 ounces.

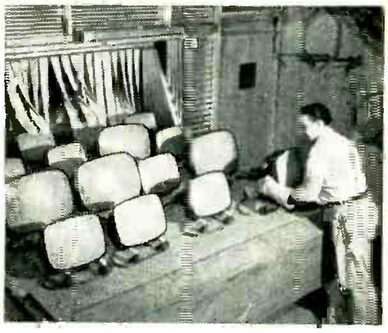
Screen-Bake Oven for Picture Tubes

A WOVEN-WIRE conveyor belt moves television picture tubes through a 103-foot oven used in DuMont's Clifton, N. J. cathode-ray tube plant. Temperatures inside the oven can be as high as 600F for baking the screens inside the tubes.

At the loading end of the oven, tubes with freshly coated screens are placed on supports made from iron rods, to which are attached small blocks that serve as rests. The blocks are covered with an insulating and protective coating to minimize scratching of the tubes.

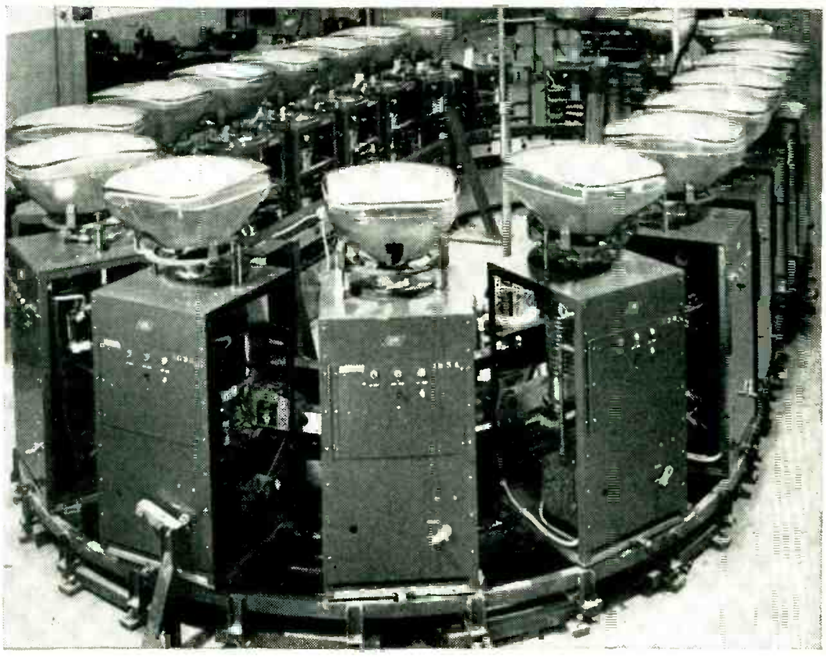
Strips of asbestos hang from the doors of the oven to form a curtain that serves to hold the oven temperature practically constant even though tubes are continually moving in and out.

Tubes are unloaded from the conveyor manually by an operator wearing asbestos gloves and are placed on an overhead conveyor for further cooling during transit to the next operation in the plant.



Unloading picture tubes after passage through Lehr screen-bake oven developed and built under the direction of Kenneth A. Hoagland

Inline System for Aluminizing Picture Tubes



Complete 20-tube aluminizing system. In left foreground is the floor-mounted dog which trips the kick switch on each cart to change from rough pumping to the final fine pumping with the diffusing pump

AN ELECTRIC locomotive pulls 20 aluminizer carts around an oval track in the new inline system developed by Consolidated Vacuum Corp., Rochester, N. Y. for aluminizing tv tube screens. The carts will accommodate 21-inch, 24-inch or 27-inch tubes. Production rate for a 20-cart machine is approximately 100 27-inch tubes per hour, with still higher rates for smaller tubes.

The carts are coupled together in much the same way as the cars of a railroad train, except that the last car is coupled to the head of the locomotive to form an endless train. Heavy coil springs combined with a few links of large roller-type chain provide shock-absorbent couplings that minimize jolts during startup.

Each cart is an aluminum casting mounted on rollers, supporting a complete vacuum pumping and aluminizing system. This means that a cart can be removed at any time for repair without interfering with production.

The locomotive cart has an electric motor that works through a reducing gear box to drive a pinion which engages the oval-shaped rack located at the bottom outer edge of the machine. Normal operating

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C.44	4.1	252	1.03"
C.4	4.6	229	1.03"
C.33	4.8	220	0.64"
C.3	5.4	197	0.64"
C.22	5.5	184	0.44"
C.2	6.3	171	0.44"
C.11	6.3	173	0.36"
C.1	7.3	150	0.36"

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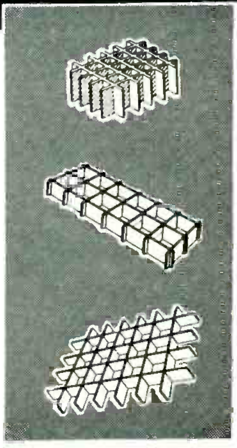

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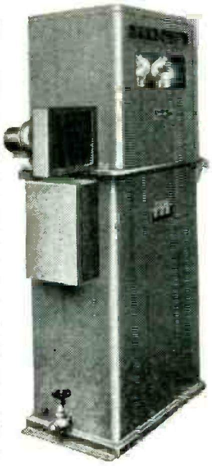

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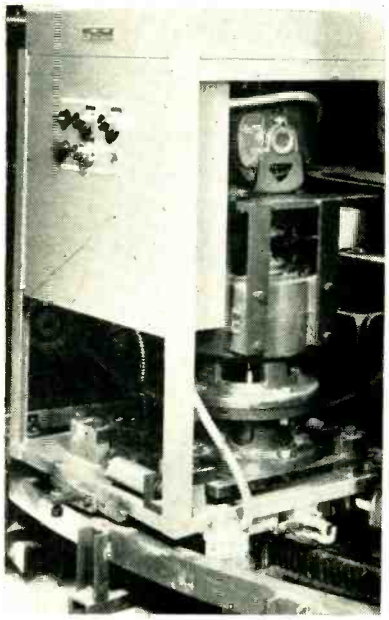
MAGNATRAN ®



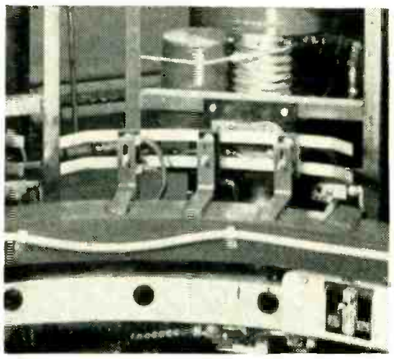
Locomotive cart, with drive motor on top of gear box. Pinion at bottom meshes with teeth of large oval rack to give positive motion without slippage

speed is approximately 4½ feet per minute, but this can be varied to provide the proper cycling time for any particular size of tube.

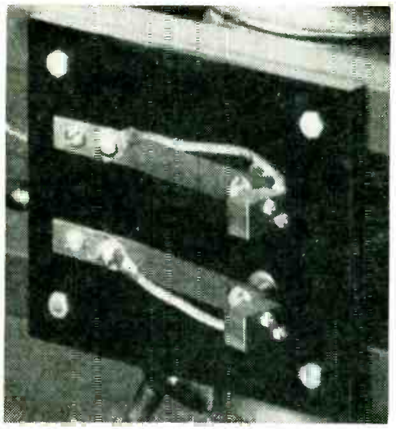
Electric power for the motors that drive the vacuum pumps on the carts is picked up by a trolley on each cart running in a Bulldog power duct. This duct is arranged in an oval just inside the path taken by the carts.

Power for the filaments that vaporize the aluminum is applied after pumpdown by means of a bus bar arrangement that is mounted on an oval steel frame directly over the power duct. Each cart has two contact brushes that slide over the bus bars as the cart moves through the vaporizing portion of the cycle.

The cycle starts with rough



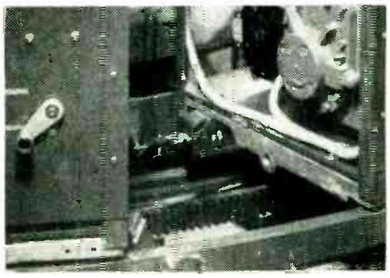
Method of mounting power bus bars on frame over power duct, for energizing the aluminum vaporizing filament on each cart in turn as they move past



Brush mounting arrangement used on each cart for taking power from aluminum-vaporizing bus bars

pumping for 5 to 6 minutes on the mechanical pump alone. By the end of this period, the cart has moved to a point where a stationary dog on the machine actuates a lever that valves in the diffusion pump for about 5 minutes of fine pumping. Finally there is breaking of the vacuum, requiring about 1½ minutes. The remaining time in the cycle is used by the operator to unload each tube, replace the filament and load in a new tube on the cart. One man can handle the entire machine.

Each cart has one compound Kinney mechanical pump having a capacity of about 5 cfm, one Consolidated Vacuum booster type diffusion pump with a capacity of approximately 100 liters per second at 5 microns, a water pump and the necessary switches and valves. The vacuum pumps are secured directly to the body of a mechanically-operated bellows-sealed valve which closes off the diffusion pump during the rough pumping. This valve body also provides the recep-



Details of coupling arrangement used between carts. At left is roughing-holding switch that is actuated by a stationary dog to turn on the diffusion pump at the correct time in the cycle

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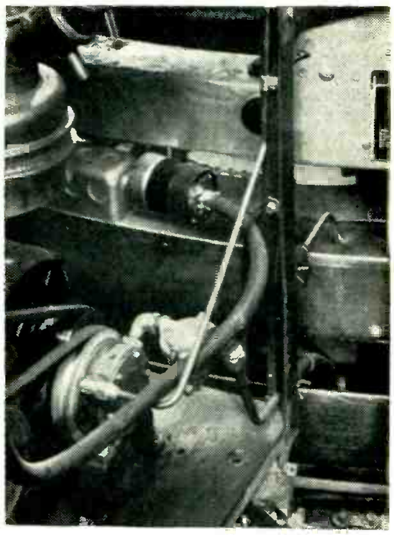
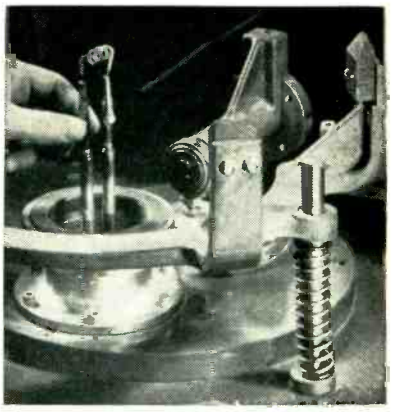


Cooling water from diffusion pump is drawn from gutter at bottom and is discharged into the upper gutter. Water pump is alongside electric motor at left. Above the gutters is the power duct from which the carts obtain line voltage a-c through chain-towed trolleys

tacle for the neck of the cathode-ray tube.

Cooling water for the diffusion pumps is supplied by a vane-type pump on each cart, driven by the vacuum pump motor through speed-reducing belts and pulleys. The pump draws water from one gutter that surrounds the machine and discharges it to another gutter directly below it. The gutters are located below the power duct, just inside the route of the cart.

Changing of filaments is made easy by mounting an alligator-type clip at the top of each filament post for holding the replaceable tungsten filament from which the aluminum is vaporized.



Method of installing replaceable filament from which the aluminum is vaporized. At right of filament is circular cam which operates valve over diffusion pump when it moves over a dog on the frame of the system

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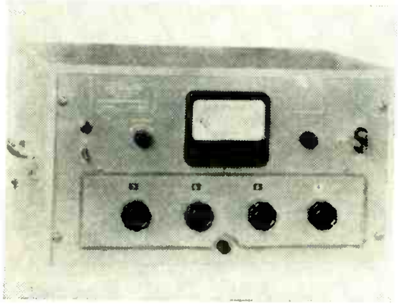
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Fifty-Seven Products and Fifty-One Bulletins Reviewed

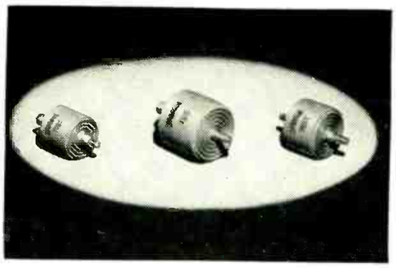
OTHER DEPARTMENTS featured in this issue:

SIGNAL GENERATOR
provides decade selection



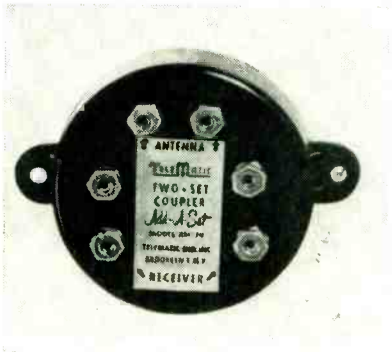
DECADE INSTRUMENT CO., Box 153, Caldwell, N. J., The Decalator 100-1 signal generator provides decade selection of 9,000 predetermined crystal-controlled frequencies, in 100-cps steps over the range from 100 kc to 1 mc. Its functional electrical and mechanical design permits instant selection of any desired frequency in its range. Frequency selection is accomplished by a series of easy-to-read window-type dials that display the unit's output frequency directly in kc. Two banks of crystals control the output of the device, having short-term stability of 5 cps and overall accuracy within 0.025 percent. Output voltage is 3 v maximum, into 600 ohms, with a total harmonic content of less than 3 percent at any frequency. Signal generator output measurement characteristics are obtained through the use of an output meter followed by a step-by-step attenuator calibrated in fractions of full-scale meter readings. An agc circuit maintains the output level within 1 db. A heavy-duty electronically regulated power supply maintains overall stability under adverse power-line conditions.

FILTER CAPACITORS
are molded ceramic units



SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. The new molded ceramic h-v filter capacitors will find broad usage in the filter circuits of modern tv receivers and c-r instruments. These capacitors, molded in moisture-resistant, non-inflammable thermosetting plastic, are available with 15 different terminal combinations to meet practically every mounting requirement. Standard rated capacitance is 500 $\mu\mu$f. Maximum operating temperature is 85 C. Type 702 C capacitors, rated at 25,000 v d-c, withstand a dielectric test potential of 35,000 v; type 701C, rated at 30,000 v d-c, a test potential of 40,000 v. Minimum insulation resistance under standard test procedures at 25 C is 10,000 megohms.

TV COUPLER
utilizes a transformer with h-f core



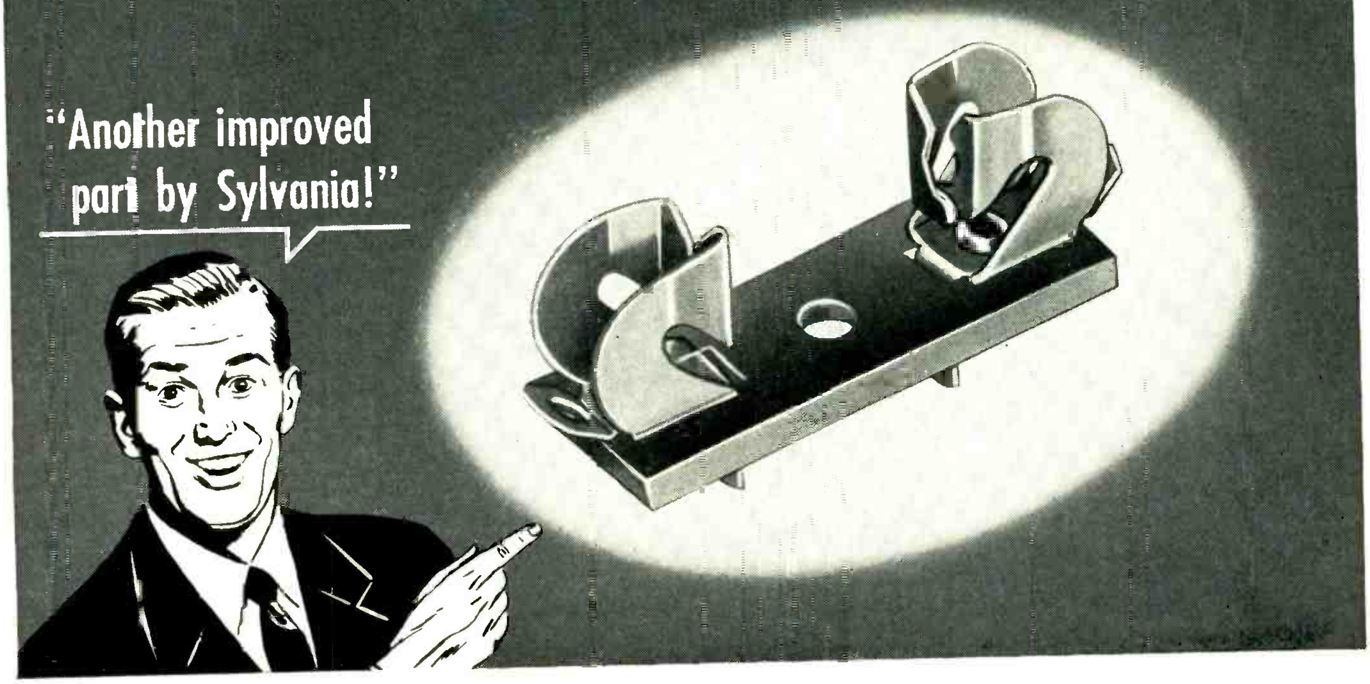
TELE-MATIC INDUSTRIES, INC., 1 Joralemon St., Brooklyn, N. Y. Model AM-74 coupler operates two tv sets from one antenna on all vhf channels on either 72 or 300-ohm line. It is an inductive coupler incorporating an efficient transformer with a special high-frequency core. This maintains a constant impedance over the entire band and a minimum of loss as compared to a resistance network coupler. The Add-A-Set coupler isolates the antenna and receivers by the use of individual windings of the transformer and, therefore, inter-receiver action is minimized.

TV CAMERA SYSTEM
features unitized design

KALBFELL LABORATORIES INC., 1090 Morena Blvd., San Diego 10, Calif. A new tv camera system featuring unitized design consists of camera,

A new, efficient crystal diode holder

Sturdy Sylvania Holder Contacts Provide High Retention for Diodes



Here's a brand new, extremely efficient Crystal Diode Holder designed for you by Sylvania.

The contacts retain diodes with terminal leads ranging from .078 to .125 diameter, with ease of insertion and withdrawal. The center-line of retention is specially located at sufficient distance from the surface of the mounting plate to allow installation of large diameter Crystal Diodes. Mounting plate is made of laminated phenolic and the contacts can be furnished in either phosphor bronze or brass with silver plating. Eyelets are made of nickel-plated brass.

For detailed specification sheets concerning this improved diode holder or any other Sylvania part write to Sylvania today!

SYLVANIA

Sylvania Electric Products Inc., Dept. 4A-1602, 1740 Broadway, New York 19, N. Y.

In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St., Montreal, P. Q.

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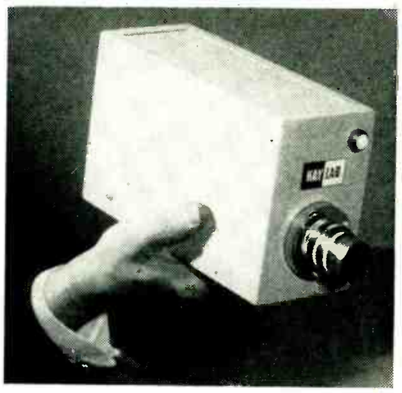
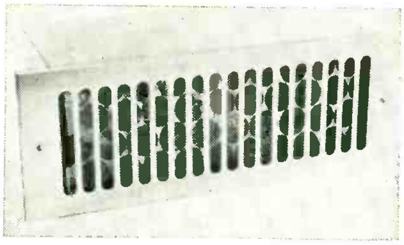
camera control and synchronizer-monitor. The camera is constructed so that all operating adjustments can be performed remotely. It is ideally suited for installations in inaccessible locations. Its light weight and compact size make it useful for field and remote pickup operation in commercial broadcasting. Plug-in construction of camera control components provides ease of maintenance. Camera and camera control can be used separately to pro-



duce a noninterlaced picture. Broadcasters may supply horizontal and vertical driving pulses and standard blanking pulses to these two units through back-chassis connectors. Interlaced pictures are produced when the camera and camera control are used with the synchronizer-monitor. The monitor tube is large enough so that no additional receivers are required for practical operation. All controls are readily at hand for front-panel adjustment.

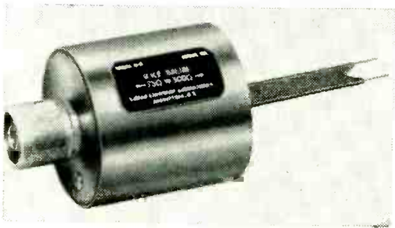
RACK-MOUNTED FAN
cools electronic cabinets



McLean Engineering Laboratories, P. O. Box 531, Princeton, N. J. A rack-mounted, self-contained unit is offered for cooling electronic cabinets. The assembly is a single unit with the filter located inside the case. Two fans, mounted side by side, provide maximum air with minimum panel height. The cooling fits the standard 19-in. electronic rack and pressurizes the cabinet with filtered air, preventing dust from entering through cracks and joints of the cabinet. The fan assembly is rack mounted the same as any chassis and the filter is replaced from the front by merely removing the stainless steel grille.

IMPEDANCE MATCHER
covers 400 to 900 mc

Linear Equipment Laboratories, Brightwater Place, Massapequa, L. I., N. Y. A new impedance matching device for the purpose of transforming the output impedance of an unbalanced source of voltage, such as a signal generator, noise generator or sweeper, to a balanced 300-ohm output is provided in the U-1, U-2 transformer-balun combination. Covering the 400 to 900-



mc portion of the spectrum, the units are specifically designed to facilitate measurements in the uhf-tv band. Model U-1 transformer transforms a 50-ohm unbalanced source to 75 ohms unbalanced over the 300 to 900-mc range with an swr of less than 1.15. The U-2 balun transforms a 75-ohm unbalanced source to a 300-ohm balanced impedance over the 400 to 900-mc range with an swr of less than 1.2. Overall swr of the combination from 400 to 900 mc is less than 1.2. Terminations are available for calibrating the transformer or transformer-balun combination.

MAGNETIC AMPLIFIER
is a low-level d-c device

Polytechnic Research & Development Co., Inc., 55 Johnson St., Brooklyn, N. Y. Type 806 low-level magnetic amplifier features high sensitivity. It will operate from input signals as low as 200 $\mu\mu$w and will provide an output of 0.05 w of reversible polarity to a 50-ohm load. A power gain of approximately 300,000 can be obtained. The unit is completely self contained and requires no additional rectifiers or power supply. It operates from 115 v, 60 cycles, single phase. Two feedback windings are provided and may be connected externally.

PULSED RECTIFIER
for color tv receivers

Radio Corp. of America, Harrison, N. J. The 3A3 is a half-wave vacuum rectifier tube of the glass octal type designed for use as a rectifier of high-voltage pulses produced in the scanning systems of

LAVOIE

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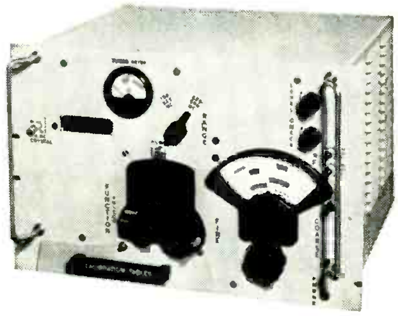
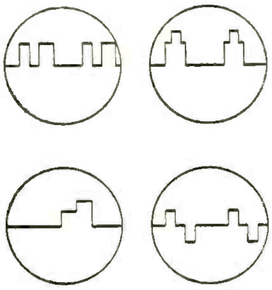


FREQUENCY METERS

Three frequency meters accurate to 0.001% cover ranges from 10 to 2000 MC. Model LA-5 covers the 10 to 100 MC range, LA-6, 100 to 500 MC and LA-61 500 to 2000 MC.



PULSE GENERATOR—MODEL LA-592D

A double-pulse generator with wide range control, excellent pulse shape. Eliminates necessity for many instruments usually required in an electronics laboratory.

OSCILLOSCOPE—MODEL LA-239C

The new and improved Lavoie oscilloscope offers wider frequency range, greater sensitivity and faster rise time. The Lavoie Camera Adapter may be added quickly and without modification.

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Low Cost Marine Radar by Lavoie
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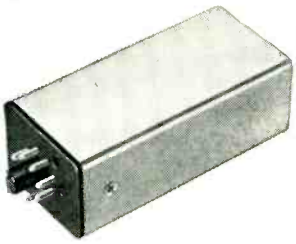
Production Road, Opposite Components and Electronics Aves.



PRECISION CRYSTAL OVEN 75° or 85° C

Maintains crystal temperature to within 0.025° C at normal room temperature—to within .15° C over outside range from -40° F to 150° F. Available for HC 6 or HC 13 crystal units.

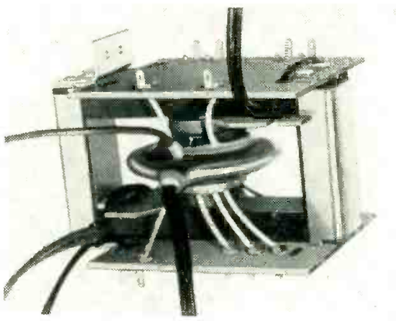
Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

complete line of coaxial attenuators from 0.1 db to 60 db, with a frequency range from d-c to 3,000 mc. The attenuators may be obtained singly or in a turret selector containing any six values of attenuation, featuring a pull-turn-push selection sequence. Small overall size of turret selector is $2\frac{1}{16}$ in $\times$ $2\frac{1}{16}$ in. $\times$ $5\frac{1}{2}$ in. A 4-page pamphlet is available covering the complete line of coaxial attenuators from 0.1 db to 60 db, power ratings, specifications, illustrations and other features. The back cover of the pamphlet gives a block diagram of lab setup for measurements of attenuation using the company's equipment.

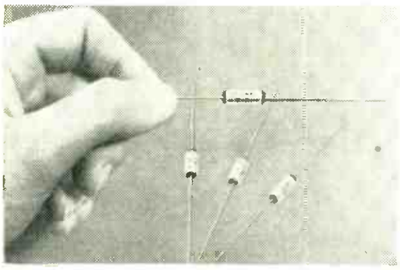
AIRCRAFT SWITCHES are environment-proof

MICRO SWITCH, division of Minneapolis-Honeywell Regulator Co., Freeport, Ill., announces a new series of environment-proof switches designed for use in exposed locations in aircraft. They feature a hermetically sealed, split-contact switching unit enclosed in an aluminum housing. Their performance remains constant regardless of changes in atmospheric conditions. Six mounting holes in the housing are arranged to permit mounting the switch from either side. Drain holes allow drainage of any moisture that might collect within the housing. The bottom plate of the housing is easily removed for wiring or replacement of the basic switching unit. Typical dimensions are $6\frac{3}{4}$ in. $\times$ $3\frac{5}{8}$ in. $\times$ 1 in. Operating force is 9 lb and the total plunger travel is ⅜ in. Four different conduit connectors are available.



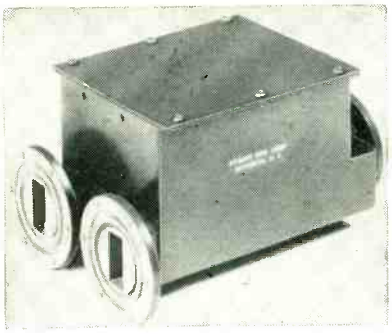
TRANSFORMER
for color synchronization

ELECTROMETRIC, INC., Woodstock, Ill. A new color tv horizontal output transformer designed for use with a single 6DC6 driver and to work into an 11.8-mh yoke is now available. Type CTV515 reproduces all pulses required for color synchronization, including keyed agc, afc and peaking for horizontal driver circuit. High voltage is produced for focusing, beam acceleration and beam deflection. It delivers 20 kv regulated out of 3-tube voltage doubler with 750 μa maximum load.



TINY CAPACITORS
in thirty-five varieties

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has developed a line of compact subminiature Tantalum electrolytic capacitors. Size is kept to $\frac{9}{16}$ in. long and $\frac{3}{16}$ in. in diameter. The units are well suited for application in transistor circuits. They cover an operating temperature range from —55 C to +85 C and have considerably lower leakage current than other electrolytic types. The wound foil construction results in excellent frequency characteristics. Thirty-five varieties are available ranging in capacitance from 0.01 μf to 8.0 μf, and from 3 to 150 v d-c, in both polarized and nonpolarized types.

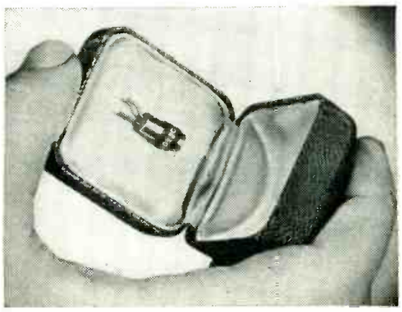


WAVEGUIDE SWITCH
features simple design

BOGART MFG. CO., 315 Siegel St., Brooklyn 6, N. Y. Especially designed for switching of commercial microwave relay transmitters and receivers, model 4426 waveguide switch is an electrically operated spdt section of RG-50/U waveguide. A unique design employs insertion of an attenuator card into the disconnected member automatically, providing a termination for the switched member as well as increasing the isolation between arms to better than 60 db; vswr is less than 1.10 over a 17-percent bandwidth and the entire unit is operated by a momentary pulse of 115 v, 60 cycle power. Insertion loss through the connected member is less than 0.1 db. The simplicity of design makes the unit ideal for scaling to larger and smaller waveguide sizes.

R-F AMPLIFIER
of the broad-band type

WESTLABS INC., P. O. Box 1111, Palo Alto, Calif. Model 24 broadband amplifier utilizes a traveling-wave tube to provide high gain over the 2,000 to 4,000-mc frequency range. The small-signal gain averages 35 db, and the saturation output power, 30 mw. Maximum noise figure is 20 db or less. The unit is completely self-contained, including regulated power supplies and traveling-wave tube focusing structure. The amplifier is housed in a case of JAN aircraft equipment dimensions ($4\frac{7}{8}$ in. wide × $7\frac{5}{8}$ in. high × $19\frac{9}{16}$ in. deep), and is directly usable as either a laboratory tool or a system component. Primary supply requirements are 108 to 122 v at 1 ampere, 50 to 800 cycles.



TRANSISTORS
are point-contact type

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y., has available two new point-contact transistors. One is the type OC50 designed for amplifying purposes, and the other is the type OC51 designed primarily for switching operations. Both are useful in computers, and telephone and communications systems. They feature complete uniformity of characteristics and reliable performance by maintaining extremely tight manufacturing tolerances, both physically and electrically. A 30-page booklet discribing the transistors and containing information on the theory and circuitry of the devices is available.

TRIODE-PENTODE
for use in color tv

RADIO CORP. OF AMERICA, Harrison, N. J. The 6AN8 is a general-purpose, multiunit tube of the 9-pin miniature type containing a medium-mu triode and a sharp cut-off pentode in one envelope. It is in-

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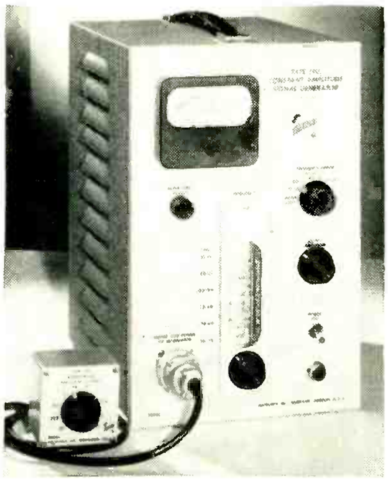
tended for diversified applications in color tv receivers. The triode unit with its relatively high zero-bias plate current is useful in low-frequency oscillator, sync-separator, sync-clipper and phase-splitter circuits. The pentode unit with its high transconductance may be used as an i-f amplifier, video amplifier, agc amplifier and reactance tube. The basing arrangement and internal construction are designed so that coupling between the triode unit and the pentode unit is virtually eliminated.



SIGNAL GENERATOR is constant-amplitude type

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 190 constant-amplitude signal generator generates sine waves in the frequency range of 350 kc to 50 mc. Output amplitude varies less than 2 percent from 350 kc to 30 mc; less than 4 percent from 30 mc to 50 mc. Frequency is continuously variable in 6 ranges, with frequency indication accurate within 2 percent. Output amplitude is continuously variable from 4 mv to 10 v peak-to-peak in 10 ranges, with amplitude indication accurate within 10 percent. Output impedance is 52 ohms. The unit is convenient for checking the high-frequency response of video amplifiers.

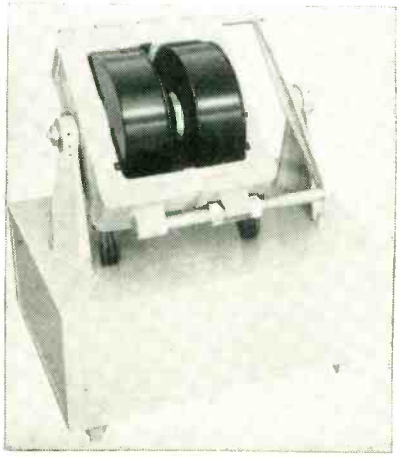
ANALOG COMPUTER
is a self-contained unit

MID-CENTURY INSTRUMATIC CORP., 611 Broadway, New York 12, N. Y. The MC-400 is a portable, highly accurate (0.1 percent) analog computer designed to meet the requirements of a laboratory test instrument or of a mathematical machine for the solution of differential equations. It consists of 12 chopper-stablized amplifiers and 16 ten-turn potentiometers for handling linear operations, and 4 vacuum-tube diodes, 2 relay amplifiers, and 1 servo for simulating nonlinear performance. Dimensions are 52 in. × 24 in. × 27 in. The unit is completely self-contained. It has been applied to a wide variety of problems, the results of which are available on request.

METER CASE
with built-in stand

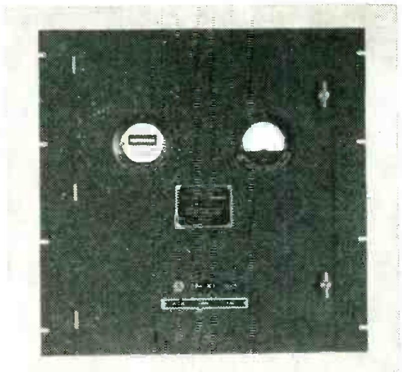
TRIPLETT ELECTRICAL INSTRUMENT Co., Bluffton, Ohio, has available a Neolite case to house its three models of volt-ohm-milliammeters, numbers 630, 630-A and 630T. The

case is constructed with a built-in stand that rests the unit at a convenient 45-deg angle when in use. It also has a back compartment that contains sufficient room to store an instruction book, leads, the stand and small tools. For carrying, the case has a firm handle.



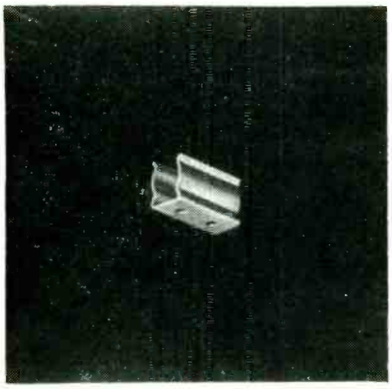
LAB ELECTROMAGNET
is multipurpose unit

VARIAN ASSOCIATES, Palo Alto, Calif. A remarkable range of field values and configurations is featured in the 6-in. model V-4007 multipurpose laboratory electromagnet. It features changeable pole caps for uniform or high field work, an adjustable gap that provides a gap range from ¼ in. to 6 in. and a dolly mount that gives complete mobility without loss of rigidity in operating positions. The magnet yoke angle can be easily changed to provide a variety of positions for working access. Precise machining and accurate alignment assure a high degree of field uniformity. Also announced is a matching model V-2200 regulated magnet power supply that provides highly stable d-c for operation of the V-4007 electromagnet.



POWER SUPPLY
is frequency stabilized

MARYLAND ELECTRONIC MFG. CORP., College Park, Md., has solved the problem of operating electrical devices requiring a very accurate source of 60-cycle power. The unit illustrated is the type M-2027 50-w frequency stabilized power supply. Electrical characteristics are: input frequency range, 50 to 70 cycles; power input, 655 v-a; output impedance, 1,000 ohms; output voltage, 115 or 230 v.



COMPONENT HOLDER
made of spring steel

ATLAS E-E CORP., Bedford Airport, Bedford, Mass., has developed a new component holder for holding tubular capacitors, one and two-watt resistors, miniature and subminiature tubes. It is designed to provide superior rigid mounting for conditions of heavy shock and vibration where space is limited as in airborne electronic apparatus and guided missiles. Made of cadmium-plated spring steel, the component holder provides a 180-deg contact surface—against a normal

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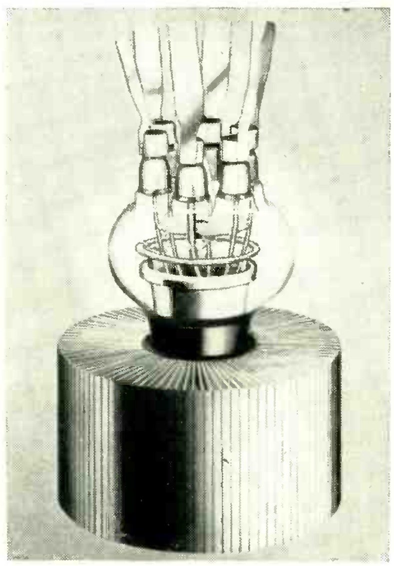
120 deg in most clips—the full length of the component. It comes in the following component diameter sizes: 0.175 in., 0.195 in., 0.235 in., 0.261 in., 0.312 in., 0.375 in., 0.390 in., 0.400 in., 0.562 in., 0.670 in., 0.750 in., 1.00 in. and 1.125 in. with lengths to 2 in.

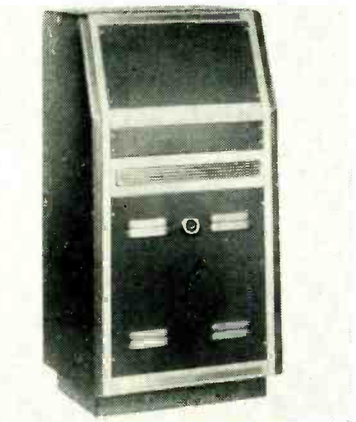
MOUNTING BRACKETS
for E-Z release connectors

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. Black anodized die cast aluminum precision mounting brackets are now available for Continental's series EZ16 easy release connectors. These brackets provide a simple, economical means for mounting the connectors while insuring the free floating action that is necessary to take advantage of the connector's self-aligning feature.



POWER TRIODES
with 3 and 6-kw output

FEDERAL TELEPHONE AND RADIO CO., 100 Kingsland Road, Clifton, N. J., has introduced two new 3 and 6-kw output power triodes for use in new equipment designed for the electronic heating, broadcasting and communications fields. The F-6366 is a three-electrode industrial oscillator with 3-kw output and filament characteristics of 11 v, 29 amperes. The F-6367 is a three-electrode 6-kw tube designed for use as a modulator, amplifier and oscillator and having a filament voltage of 13 v and filament current of 36 amperes. Both tubes feature thoriated tungsten helical-type filaments and kovar grid and filament seals, contributing to ruggedness and more dependable operation. Maximum d-c plate voltage ratings of 5,500 v for the F-6366 and 6,200 v for the F-6367 apply up to 30 mc.

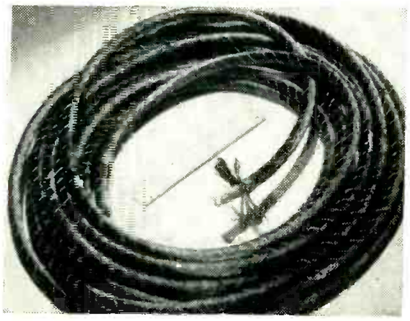


EMCOR SYSTEM
of electronic enclosures

THE ELGIN METALFORMERS CORP., Elgin, Ill., has introduced a new standard line of flexible enclosures designed to meet custom requirements at up to one-fifth the cost of custom construction. The new line, known as the EMCOR system, is designed to meet specific requirements wherever medical, computing, research, integration, transmission, supervisory data, remote facsimile, radio and tv control equipment requires an enclosure, group of enclosures or complete control system. Construction is of heavy-gage steel. The system consists of a basic console assembly frame—21 in. wide × 48 in. high × 21 in. deep—with standard RETMA and WE mounting holes on entire front, top and back. Over 80 lineal inches of insert panel space is available over frame. Provision is made for ease of wire installation via standard knockouts distributed over top shelf, base and side of unit. Provision is also made for a key, jack and auxiliary control panel.

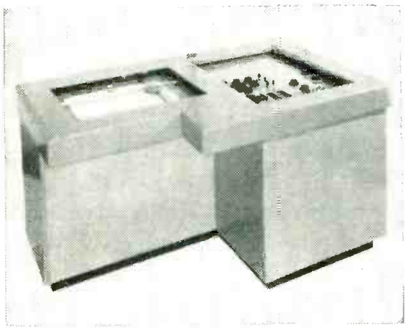
METER
for small-value readings

Tektronix, Inc., P.O. Box 831, Portland 7, Oregon. Type 130 LC meter is a direct-reading unit for small values of inductance and capacitance in components and circuits. It has 5 ranges: 0 to 3, 0 to 10, 0 to 30, 0 to 100, and 0 to 300 μh or μμf, accurate within 5 percent of full scale. It features coarse and fine zero-adjust controls and an illuminated 4-in. meter. The type 130 is also convenient for component testing, sorting and color code checking on a production basis. Weight is 9 lb.



H-V L-F LITZ CABLE
for 20 to 400-kc region

U. S. Plastic Rope Co., 2581 Spring St., Redwood City 10, Calif. Specialized Litz cables for applications of high voltage in the 20 to 400-kc region are being wound on dielectric cores of rope-like construction, formed from a variety of plastic films. Diameter limitations of the production equipment are ⅛ in. core diameter minimum, 2 in. maximum. Typical cables produced have included copper conductors of 33 and 38 gage laid on the core with a spiral of 3 turns per ft. A maximum of 125 multiconductor strands can be applied. Conductors of Nylon-enamel insulated wire can be made individually continuous to very rigid specification requirements.



ELECTROPLOTTER
is ±0.1 percent accurate

BENSON-LEHNER CORP., 2340 E. Sawtelle Blvd., West Los Angeles 64, Calif., has available the new Electroplotter that plots on any type paper up to 11 in. × 17 in. from a variety of input data such as analog or digital computers, punched card machines or manual keyboard. In the latter case, a high speed 10-key keyboard with numerical verifier provides for plotting rates at about 35 points per minute. Pen traversing speed is 18 inches per second. Accuracy is ±0.1 percent. The plotter has several special features among which are automatic symbol printing, independent zero and scale controls for each axis, selectable incremental advance when required and vacuum table for holding paper.

A-C GENERATOR
is wind turbine driven

HOLTZER-CABOT TELEPHONE EQUIPMENT DIVISION of National Pneumatic Co., Inc., 125 Amory St., Boston 19, Mass. A new wind turbine-driven generator serves as

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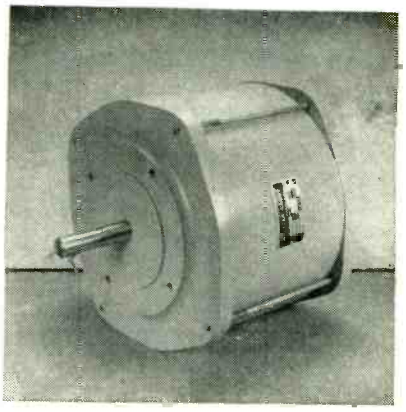
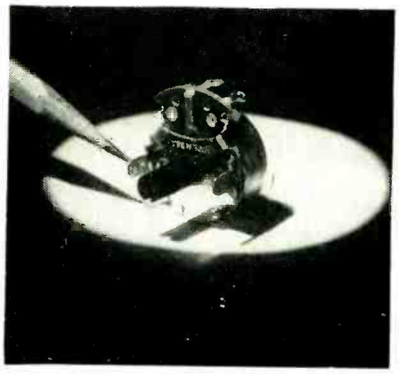
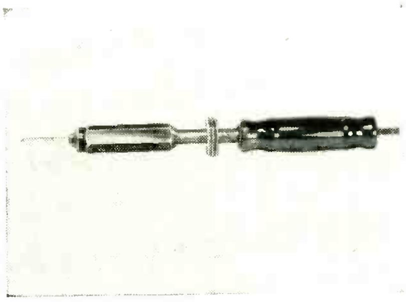


a source of power for use with transistors in unattended microwave relay stations. It meets power output requirements—based on operation of the generator in a wind velocity of 5 mph—of 1 w, 50 cycles, at 100 rpm. Equipped with heavy-duty sealed ball bearings, the generator is built in a 9 in. diameter frame to permit the mounting of a wind turbine on the generator and bell. Although of permanent-magnet construction, the advanced design eliminates cogging, and starting torque is held to within 4 oz-in.



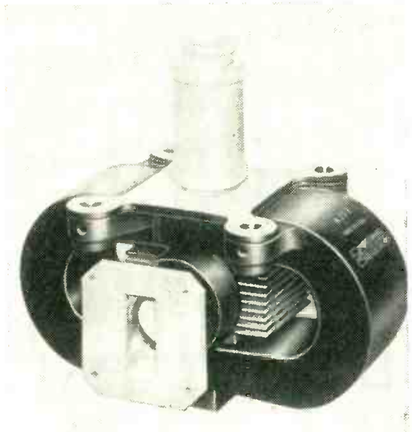
TWISTED TAB CONTROL features economy in cost

CLAROSTAT MFG. CO., INC., Dover, N. H., has announced the series 47 twisted tab control that eliminates the usual bushing, lockwasher and nut, thus effecting marked economy in the cost of the control. The unit is mounted by inserting the tabs through slots in panel or chassis, and twisting them to secure the control in place. The control is available with or without switch, in resistance values from 500 ohms to 5 megohms; 0.5-w rating; choice of tapers and taps; and all types of metal or plastic shafts, including, if desired, a rear protruding slotted shaft.



SOLDERING IRON
for fast production lines

Hexacon Electronic Co., 130 W. Clay Ave., Roselle Park, N. J., has added to its line an electric soldering iron for use on fast production lines where greater soldering speed is required from an iron with a small-tip diameter, and where lower tip replacement cost is a factor. The new iron is plug-tip type, rated at 100-w, but with $\frac{1}{4}$-in. tip instead of the conventional $\frac{3}{8}$-in. diameter tip. It reaches and maintains a temperature considerably beyond the 100-w $\frac{3}{8}$-in. tip iron and its large reservoir of heat speeds the soldering operation. Because less copper is used there is a saving of more than 50 percent in the tip replacement cost.



MAGNETRON
uses new techniques

Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass. The 4J52 magnetron used in airborne radar equipment has been redesigned to incorporate several

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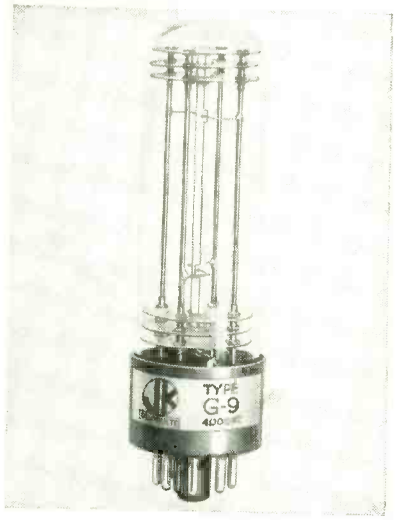
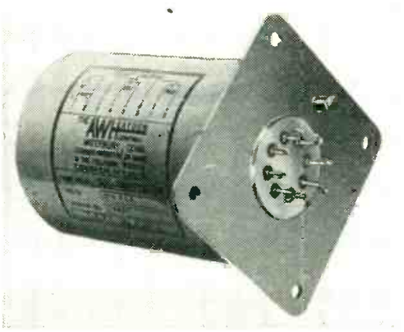
new improvements while retaining physical and electrical interchangeability. For improved stability and life under all conditions, particularly with long pulses, the oxide-coated cathode has been replaced by the new Philips dispenser-type cathode. This cathode is fabricated from tungsten impregnated with barium aluminate and is practically indestructible operating over a wider temperature range than the oxide type. A bifilar winding heater is used reducing tube noise. All of the glass in the tube being replaced by ceramic allows the tube to be baked out at considerably higher temperatures, insuring gas-free operation throughout life in addition to increasing its mechanical strength. The anode is of strap-vane type, known to be very reliable under steep pulse conditions. The waveguide output transformer of the tube has been designed for the center of anticipated load conditions.



CRYSTAL
is hermetically sealed

JAMES KNIGHTS CO., Sandwich, Ill., has introduced a new crystal in its G-9 series, available with flexure mode crystals from 4 to 80 kc. The new crystal provides rugged, precise frequency control at temperatures in the -40 to $+70$ C range. The crystals have a high ratio of capacities (C_o/C) resulting in a high degree of isolation from associated circuitry. This unit provides a practical means of close frequency control in a range not covered by any other single type of crystal. The crystals are hermetically sealed in an evacuated glass holder for maximum protection and freedom from contamination to assure that their precise frequency accuracy will be maintained.



TIME DELAY RELAY
is hermetically sealed

THE A. W. HAYDON CO., 232 N. Elm St., Waterbury, Conn., has in production a new line of hermetically sealed time-delay relays. Designed to take up less space than previously required, they can be supplied with 50, 60 or 400 cycle a-c or governed or standard d-c motors. Close accuracy and low power consumption are featured. The unit is enclosed in a lightweight aluminum hermetic housing, $2\frac{1}{2}$ in. in diameter. Basic length for a single switch unit is $2\frac{15}{16}$ in. Governed or filtered motors, special or extra switches increase this dimension slightly. Three-stud or flange mounting is available. Electrical connection can be made with a glass seal header or AN connector. Weight of the unit is about 1 lb.

ULTRASONIC UNIT
measures metal thickness

SPERRY PRODUCTS, INC., Danbury, Conn. A portable, ultrasonic in-

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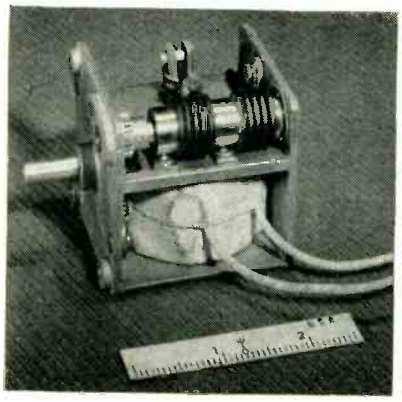
strument for measuring the thickness of steel sheet where only one surface is available, for checking the continuity of bonds, and for testing raw stock for laminar defects, has been announced. Known as the Reflectogage and using high accelerating voltages and slow sweep speed, it gives visual indications of steel thickness from 0.014 to 0.400 on a flat-face, no-parallax crt with directly adjacent calibration tape. The tape is made proportional to screen size so as to give maximum reading space and is cranked into position for any one of the six available testing ranges. Tolerance markers appear as a downward square step on the screen baseline and are adjustable in both width and position. Accuracy of readings is protected by a built-in voltage regulator.

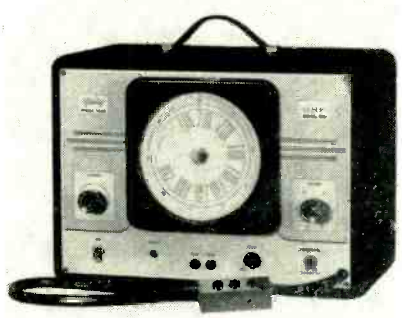


ELECTRIC MOTOR has high starting torque

THE VIKING TOOL & MACHINE CORP., Two Main St., Belleville 9, N. J., has developed a small electric motor that will be extremely useful wherever low speed, high starting torque is required, such as aircraft actuators, remote controlled rheostats and power switches, and indexing devices of all types. Present models operate on 115 v a-c, but the motor can be provided with different coils for other operating voltages. It will operate efficiently over a wide range of frequencies as well as pulsating d-c. The unit combines the feature of having its starting torque equal to its running torque, with instantaneous stopping when power is turned off. Units are now available delivering over 6 inch-pounds of torque at 30 rpm and operating satisfactorily over a temperature range of —60 to +500 F.

TINY RELAY
exceeds military specs

ELECTRO-MECHANICAL SPECIALTY CO., INC., 6819 Melrose Ave., Los Angeles 38, Calif., has introduced the miniature 10-ampere, dpdt relay. It is designed for quality, dependability and vibration immunity that exceeds military specifications. It is made for adaptability with coil resistance up to 80,000 ohms. The unit will operate over a sensitive range as low as 50 mw to 2 w. Mounting plate is drawn and formed of $\frac{1}{16}$ in. steel. The relay measures 1.625 in. diameter, 2.187 in. height and 1.856 in. mounting dimension between 2 holes.



MARKER GENERATOR
and signal generator

THE TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio. Model 3436 is a new uhf marker generator and signal generator with the following features: uhf all fundamentals on channels 14 to 83 (470 to 900 mc); no harmonics for confusion; a large dial with uniform frequency graduations; and 13 in. of long easily readable scale. The r-f output average is 0.3 v. Output impedance is 150 and 300 ohms. It has a piston-type attenuator. The unit especially needed in fringe areas provides a reliable signal source to compare gain of uhf receivers and converters.

POWER SWITCH
has variety of applications

CLAROSTAT MFG. CO., INC., Dover, N. H., is making available the series AE power switch to electronic equipment manufacturers to be used as an integral part, such as push-pull or rotary switches in record changers, and many other applications where a switch of this type is adaptable. The series AE switch is UL approved and rated 1 ampere at 250 v, 3 amperes at 125 v a-c or d-c. It is available in spst, spdt or dpst. It measures $\frac{13}{16}$ in. in diameter.

MICROPHONE STAND
has safety air cushion

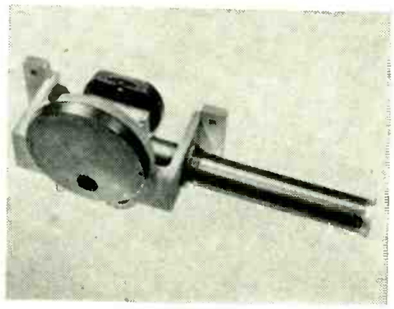
ATLAS SOUND CORP., 1451 39th St., Brooklyn 18, N. Y. Prevention of accidental or sudden slippage of the microphone stand's telescoping section is assured with the MS-25 microphone stand that features a safety air-lock cushion. The telescoping section is always cushioned on air so that the escape of air permits only a slow quiet collapse of the stand if the clutch holding adjustment is insufficiently tightened or accidentally released. Thus the stand cannot suddenly crash down and cause a blast of sound to be fed to the amplifier. The MS-25 has a height adjustment of 37 in. to 66 in., and a base diameter of 17 in. The tube terminates in a $\frac{5}{8}$ in.-27 carefully machined thread. Weight is 24 lb.

CRT SHIELDS
are magnetic type

MULTI-METAL WIRE CLOTH CO., INC., 1350 Garrison Ave., New York 59, N. Y., is producing standard magnetic cathode-ray-tube shields for the 2-in., 3-in. and 5-in. tube sizes. Early delivery is assured on these low-cost Mu-metal and Nicoloi stock shields which formerly required three and four months for delivery. These shields can be furnished with light hoods, retainers and plexiglass windows. Write for literature and quotations.

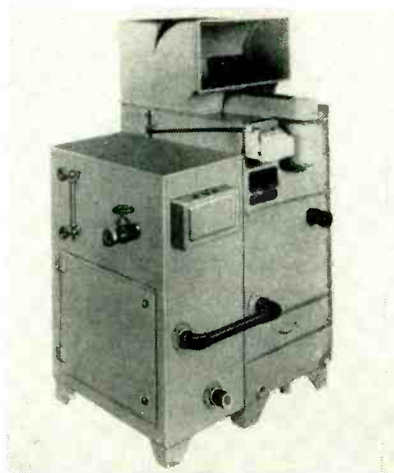
SIGNAL EQUALIZER
does not upset impedance

TELE-MATIC INDUSTRIES, INC., 1 Joralemon St., Brooklyn, N. Y., has introduced the automatic signal equalizer designed for locations where the signals from the l-f channels cause overloading and the h-f channels are not strong enough to tolerate any attenuation. Model AT-25 equalizer provides maximum attenuation on the l-f channel, and minimum attenuation on the h-f channel, without upsetting the impedance of the tv receiver. Once installed, the unit does not require switching or manipulation of the controls.



PHOTOMETER
for star measurement

L. C. EICHNER INSTRUMENTS, 19 Sebago St., Clifton, N. J., has produced a new type of photoelectric photometer which is mounted on astronomical telescopes for direct measurement of star magnitudes. The instrument measures the brightness and color of stars to an accuracy of one part in a thousand. Measurements are made by sensitive electrical equipment after starlight is converted to an electric current by a photoelectric cell. The photometer is mounted directly on the telescope's plate holder and employs the same adjustments as those used for photographic plates.



HEAT EXTRACTOR
is new package type

MAYER REFRIGERATING ENGINEERS, INC., Lincoln Park, N. J. A new package-type heat extractor, while primarily designed to provide recirculated cooling water for transmitter tubes, will find other industrial uses for supplying cooling water to machine jackets, oils and coolants. This equipment employs the evaporation cooling principle and will supply cooling water as low as 86 F with a 75-deg wet bulb condition. The range of capacities is from 36,000 Btu per hr to 465,000 Btu per hr with entering water temperatures from 90 F to 160 F. Volume of cooling water is from 20 to 150 gpm. Full automatic temperature controls are included to deliver constant temperature cooling water, regardless of atmospheric temperatures or conditions. The whole unit is completely assembled, wired and piped in a compact form. Field installation consists only of running electric power to a prewired panel, external cooling and plumbing, piping and air-duct connections. Overall dimensions of the unit are 44 in. wide by 31 in. deep by 61 in. high.

RECORD CHANGER handles three sizes

BIRMINGHAM SOUND REPRODUCERS LTD. of Old Hill, Staffs, England, has introduced the 1954 Monarch automatic record changer. It retains the regular features without any basic alterations. It includes the "Magidisk" selecting 7-in., 10-in., and 12-in. records intermixed in any order, as well as high-fidelity dual stylus cartridge ultra-rapid record change and other features. One of these is a simple centralized control. The sapphire styli in the turnover cartridge are easily replaceable and the cartridge is designed to cut record wear down to a negligible degree. With all working parts well protected against humidity and dirt, the unit is suitable for all climates. The Monarch auto-changer has a 4-pole motor that features smooth power and still uses the turntable rubber mat. The unit is available for operation on 100 to 125 v and 200 to 250 v; frequency, 50 or 60 cycles as required.

SERVOBOARD
on component parts basis

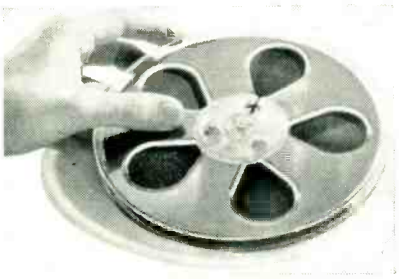
SERVO CORP. OF AMERICA, 20-20 Jericho Turnipke, New Hyde Park, N. Y. The Servoboard is a set of standard precision mechanical parts, including gears, shafts, bearings, hangers and mounting plates, which, when coupled to the necessary motors, tachometers, synchros, potentiometers and amplifiers, rapidly builds a flexible experimental mechanical assembly of a servo system, computer or regulator. It was developed as an aid to the design of servomechanisms by providing means for quickly synthesizing the electromechanical parts of the control system.

SCALING UNIT
used for particle counting

BERKELEY SCIENTIFIC, division of Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif. Model 2200 automatic scaling unit is a high speed instrument for automatic counting of electrical pulses obtained from nuclear particle detection equipment. It consists of an input pulse height discriminator, an electronic scaling channel with 1-μsec paired pulse resolution, mechanical register, time clock and automatic control circuitry. High voltage is not supplied in this instrument. The scaling channel consists of 4 plug-in decimal counting units including one model 706A and three model 705A's. Count indication is entirely direct reading. Maximum counting speed is 100,000 per second. A four-digit mechanical register is used and provision is made for driving an external relay in parallel with the register.

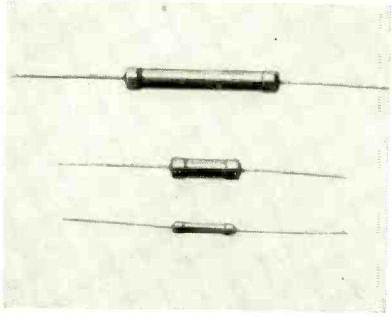
H-V INSULATION
for internal wiring

INDUSTRIAL DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO., Wayne & Roberts Ave., Philadelphia 44, Pa., is manufacturing a moisture-proof h-v insulation for internal wiring of the company's electronic instruments. This thermoplastic material is impervious to moisture and thus is recommended for use where high humidity conditions prevail. Insulation comes in 10 base colors. Where tracers are required the insulation is white with two identically colored helical stripes to identify the base color and a third stripe to show the tracer color. Input circuit wiring will be solid white covered by color-coded rayon braid.



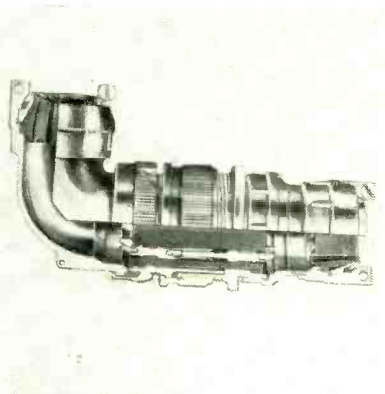
PLASTIC REEL
for magnetic tape

AUDIO DEVICES, INC., 444 Madison Ave., New York 22, N. Y., has announced a new and improved 7-in. plastic reel for magnetic sound recording tape. The reel has a 2¼-in. hub that provides essentially the same accuracy of timing and freedom from tension stresses as the previous 2¾-in. hub, but its additional tape storage space eliminates the danger of the outer turns slipping off the reel. It holds the full 1,200 ft. of tape with ample capacity for adding long leaders at both ends and between selections on the reel. The reel flanges have larger solid web areas, providing more space for labeling and giving greater protection to the rolled tape. Raised edges around the rim and flange openings give increased strength and rigidity with minimum weight, and also serve to keep the large clear plastic flange surfaces from becoming scratched or marred in normal handling.



STABLE RESISTORS
in deposited carbon type

DALE PRODUCTS, INC., Columbus, Neb., has introduced its new commercial grade deposited carbon stable resistors in tolerances of 1, 2, 5 and 10 percent. Standard resistance ranges in the ½-w size are from 1 ohm through 5 megohms; in the 1-w size, from 1 ohm through 10 megohms; in the 2-w size, 5 ohms through 100 megohms. A new tough silicone coating has been developed which seals the stable precision element and protects it from physical abrasion without the addition of protective sleeve.



CONNECTOR
is environment resisting

SCINTILLA MAGNETO DIVISION, Bendix Aviation Corp., Sidney, N. Y. Type E environment-resisting electrical connector illustrated was developed to meet the high-altitude performance requirements of today's airplanes. It was designed to protect sensitive electronic circuits from thermal shock, surface condensation and extreme vibration. Convenience of assembly is an important feature of this E connector. The space between insert and grommet provides an ample working area for all assembly and welding operations. The connector is completely serviceable since individual wires can be removed or repaired with the connector in place.

COLOR TV COILS KIT contains 32 items

ELECTROMETRIC, INC., Woodstock, Ill., has announced a new color tv coils kit containing 32 items for use with shadow mask tubes. Included are a new distributed constant delay line, a new horizontal output transformer, horizontal dynamic-converging and dynamic-focusing transformer, horizontal dynamic-convergence phase control, width control, linearity control and a complete set of i-f, video and color information circuit coils.

ADAPTER for tube testers

SUPEREX ELECTRONICS CORP., 23 Atherton St., Yonkers, N. Y., is marketing an adapter that can be used with any make tube tester and all picture tubes. Simplicity of operation is the keynote. One end plugs into the present tube tester (of any make or model), and the other end hooks into the picture tube, without removing the latter from the tv cabinet. Any tube, new or old, from 10 in. to 30 in., can thus be checked for electrostatic or magnetic shorts. Overall length is 49½ in.

CONTROLLERS provide automatic testing

TINIUS OLSON TESTING MACHINE Co., 1022 Easton Rd., Willow Grove, Pa., has announced a line of automatic testing controls. The controllers are designed for production testing, proof testing, yield strength by the extension under load method, stress cycling (load), strain (unit deformation) cycling and crosshead cycling.

H-V PROBE LEAD extends d-c voltage ranges

RADIO CITY PRODUCTS CO., INC., 152 W. 25th St., New York City, N. Y., has brought out a new high-voltage multiplier probe lead for extending the d-c voltage ranges of model 655 peak-to-peak v-t voltmeter. It comes complete with multiplier resistor and terminations and is of the heavy-duty type with safety barrier. It multiplies the scale used by 100.

Literature

High-Gain Audio Input Tube. Kingdom Products, Ltd., 23 Park Place, New York 7, N. Y., has published a single-sheet bulletin presenting the Emitron 2729, a voltage amplifying pentode that is expressly designed for the first stages of high gain audio amplifiers. Included are a typical circuit, operating data and characteristics chart. An illustration, dimensional diagram, ratings and operating conditions are also given for the KT66 power amplifier tube.

Thyrite. General Electric Co., Schenectady, N. Y. Bulletin GEA-4138C deals with Thyrite, a nonlinear resistance material in which the current varies as a power of the applied voltage. The material described has found important applications in the electric-power, communications, and electronic industries. Included are photographs, tabular data, characteristics charts and circuits. A supplement to the bulletin contains a page of information to be filled in for special applications.

Precision Stainless Steel Wire. Fort Wayne Metals, Inc., 3211 MacArthur Drive, Fort Wayne, Ind. As an aid to present and potential wire users, the company has announced a new specification form that gives product design, engineering and purchasing departments a definitive means to specify wire requirements. The new form covers all known stainless steel wire subjects, and is designed both to suggest uses and to simplify buyer procurement problems. The rapidly lengthening list of uses which makes such a form extremely valuable includes electronic shielding, industrial brushes, minesweeper cable, nonmagnetic stainless steel wire, spiral-four cabling, magnetic recording wire, suture wire, filters and spiral thread inserts. Standard or custom specifications can be listed on the new forms.

Photoelectric Controls. The Autotron Co., Box 722-H, Danville, Ill. A recent catalog describes general-purpose, fail-safe, high speed and ultrasenitive photoelectric controls with electronic timers and safety relays. The controls described have light sources with straight beams, wide selection of pin-point beams, and adjustable focus beams. They are also available with beam intensity adjustment, dual filament lamps and safety relays.

Wattmeters. Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y. Volume 20, No. 4 of "Electrical Measurements" covers the selection and use of wattmeters. It deals with questions which a purchaser must ultimately answer, such as: What is the supply voltage?; do I need a low power factor wattmeter or can I use a standard 50-percent P-F model?; how much current does the load take?; and what ranges of voltage, current and power do I need? The 8-page illustrated booklet gives technical specifications.

Mechanical Measurements With Electronic Counters. Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif. Proven techniques for making common mechanical measurements quickly and accurately with electronic counters are described in Vol. 5 No. 1–2 of the H-P Journal. The issue discusses techniques for measuring operating time of high speed clutches, rpm on very high speed shafts, stability of rotation, electrical relay operating times and

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phase delay in l-f devises such as servomechanisms. It also indicates how electronic counters may be applied to measurement of pulse interval or pulse duration, linear velocity, flow, distance expressed in time, viscosity and the timing of photographic and other high-speed mechanical equipment. Schematic and circuit diagrams illustrate appropriate mechanical and electronic setups for performing the measurements. Waveform drawings and oscillograms show how phenomena measured by a counter appear when studied visually.

Electromagnetic Controls. Automatic Switch Co., Orange, N. J., offers a pamphlet outlining their services and products for use on the power side of electronics systems. The pamphlet, titled "When Normal Power Fails," discusses items designed and constructed to RETMA standards and covers such controls as automatic transfer switches, engine-generator starting units, differential relays, time delay relays and complete control panels. Information is given on such related subjects as: current surge tests, adequate lighting, relay protection and auxiliary equipment for engine generator controls. Write for publication No. 528.

Corner Console Enclosure. James B. Lansing Sound, Inc., 2439 Fletcher Drive, Los Angeles 26, Calif., has issued booklet No. 34, a 4-page instructional folder on its rear-loaded folded horn corner console enclosure. Well illustrated with photographs and schematic drawings, it depicts eight separate and distinct constructional steps from raw material to the finished product: from the component assembly to the installation of the grille cloth.

Wire and Cable Catalog. Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago 47, Ill., has available a most elaborate catalog providing description and complete specifications on the company's entire line of hookup and lead wires and cables for the electronics field. All Lenz wire and cables are fully illustrated, so that the catalog will prove very useful to electronic engineers and purchasing agents.

TV Replacement Guide. Thordarson-Meissner, Mt. Carmel, Ill. Flybacks, peaking coils, horizontal syncs, focus coils, deflection yokes, width controls, vertical outputs and ringing coils are among the components listed in the recently published tv replacement guide. The 32-page booklet features schematics, diagrams, catalog material and replacement listings for approximately 6,000 tv models.

Magnetic Recording Folder. Logistics Research, Inc., 141 So. Pacific. Redondo Beach, Calif. A 4-page illustrated pamphlet on Airfloating, a new principle in magnetic recording of information, is now available. The pamphlet describes experimentation known as Project Halo, which is said to have eliminated the biggest barrier to widespread application of modern automatic computing equipment in business, manufacturing and science.

Cyclo-Monitors. Counter & Control Corp., 5213 W. Electric Ave., Milwaukee 14, Wisconsin. A new 34-page engineering data catalog describes the augmented line of Cyclo-Monitors—electric control devices that incorporate a spdt switch and a predetermining counter The 3 basic models illustrated in the catalog pick up the count from a rotating machine member, a reciprocating member or an electric impulse from a sensitive switch or photoelectric cell. A number of new specialized types of Cyclo-Monitors are described for the first time. The catalog includes typical cycle diagrams, dimension drawings, photographs, performance ratings and other detailed information on these controls.

Transistor Literature. The Glenn L. Martin Co., Baltimore 3, Md., has published a 54-page booklet entitled "Guide to Transistor Literature." The transistor papers cited in this compilation number well over four hundred. A subject index is included. The entries highly versatile new 150 series system.

Shock and Vibration Isolators. The Barry Corp., 807 Pleasant St., Watertown 72, Mass. Product bulletin 538 presents detailed technical and application information on the series 670 and series 297. The units described are designed to reduce shock and noise caused by impact-type machines, and vibration and noise caused by heavy rotating and reciprocating machines. Isolators discussed are available in seven load ratings, covering the range from 500 to 4,400 lb per unit isolator. Included are data on dimensions and loads, installation procedures, variation of natural frequency with load, percent isolation of vibration for various frequencies and applied loads, and performance under shock.

Short Slot Hybrid Junctions. Microwave Development Laboratories, Inc., 220 Grove St., Waltham 54, Mass. Bulletin HJ-1 describes special features, gives electrical and physical characteristics of a line of short slot hybrid junctions that have found wide application in high-frequency radar and communications. Some applications are illustrated and described.

Microwave Bolometers. NARDA-Nassau Research & Development Associates, Inc., 66 Main St., Mineola, N. Y. A two-page color bulletin provides technical data on the N-821B bolometer, including resistance and sensitivity characteristics. Data are also included on the X-band frequency meter (Model 810) including a photograph of the unit.

Measurement Techniques and Instrument Operation. Sierra Electronic Corp., 1050 Brittan Ave., San Carlos 2, Calif. Five technical bulletins recently offered contain description, operation, application and measurement techniques for new instruments. Bulletin 101 covers directional couplers in the 10-kc to 3-mc range; bulletin 102—a line fault analyzer for locating telephone, telegraph and power line faults

½ to 200 miles distant; bulletin 103—model 121 wave analyzer for study of complex waveforms between 15 and 500 kc; bulletin 104—wideband directional couplers and crystal detector for power, vswr and match measurements from 30 to 1,500 mc; and bulletin 105—the model 141 wattmeter for r-f power measurement between 2 and 30 mc.

Power Rectifiers. McColpin-Christie Corp., 3410 W. 67th St., Los Angeles 43, Calif., has issued bulletins AC-54 and AC-54-1 on two lines of power rectifiers for aircraft use. The Stavolt rectifiers discussed are automatic voltage regulated types, and are engineered for applications requiring closely regulated d-c voltage. The Rectodyne manually controlled rectifiers covered are for applications requiring moderately stabilized d-c voltage, for 28½-v aircraft systems. Among features in both are the small, compact size and light weight. A new greatly simplified circuit is another important development.

Stamping Manufacturers. Pressed Metal Institute, 2860 E. 130th St., Cleveland 20, Ohio, has published a booklet containing an alphabetical listing of the facilities and services of all member companies. End products manufactured and sold by members of the institute are listed and numbered for reference to the page on which they can be found. The directory also contains suggested terms and conditions of sale for the pressed metal industry.

Flexible Coaxial Cable. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 70-A illustrates and describes the type HX-O Heliax, a new ⅞ in. diameter r-f coaxial cable combining flexibility approaching that of solid dielectric cables with the high transmission efficiency of air dielectric cables. Complete technical characteristics are given.

Microminiature Tanalytic Capacitors. General Electric Co., Schenectady, N. Y. Bulletin GEA-6065 deals with microminiature Tanalytic capacitors for low-voltage d-c applications. Included are an illustration and a diagram showing dimensions and tolerances. Ratings, specifications, application and prices are given.

Electrostatic Voltmeter. Sensitive Research Instrument Corp., 9 Elm Ave., Mount Vernon, N. Y. Volume 20, No. 9 of *Electrical Measurements* illustrates and describes the company's electrostatic voltmeter and its associated peak voltage adapter. Listed are full scale values, lowest readings, code words and prices.

High-Vacuum Rectifier. CBS-Hytron, Danvers, Mass., has prepared a series of design rating charts and curves defining the performance of its 5AW4 high-vacuum rectifier under a wide variety of operating conditions. The tube described is rated for continuous tv service. It has an A-frame construction for greater ruggedness, a heavy-duty 20-w filament for greater emission, and other engineering features that give it durability. It provides greater maximum average and peak currents, and it is also conservatively rated to provide large safety margins.

Heavy-Duty Transformer Winders. Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill., has released a catalog page describing its new model 147-AM heavy-duty transformer coil winder. Technical data are given on the types of coils wound, coil sizes and wire sizes handled, winding speed, motor equipment, set-up time, the instant reset automatic counter, the positive stopping magnetic brake, mounting and other features. The machine is also pictured.

Precision Potentiometers. Helipot Corp., 916 Meridian Ave., So. Pasadena, Calif. An eight-page illustrated technical paper, "Computing with Servo-Driven Potentiometers" examines linearity and loading effects in analog systems and shows how errors may be eliminated. Practical circuit techniques are discussed, including restriction of potentiometer range, preloading, and unloading with feedback amplifiers.

High-Vacuum Rectifier. Lewis and Kaufman, Ltd., 50 El Rancho Ave., Los Gatos, Calif. A new data sheet describes the Los Gatos brand 3B24W high-vacuum rectifier. The sheet illustrates the tube, provides outline dimensions and general characteristics. Average plate characteristics for this ruggedized half-wave rectifier are shown graphically for full-filament and half-filament operation.

Connector Bulletin. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. The single-page technical sales bulletin No. 4 covers the series C-20 one-piece molded inserts hexagonal vibration-proof connectors. The connectors discussed insure constant reliability and performance under all conditions. Illustrations, description and specifications are given.

Hermetic Seal Bushings and Terminals. Heldor Mfg. Corp., 238 Lewis St., Paterson, N. J. A complete line of MIL-T-27 and special transformer cases as well as compression-type bushing assemblies for hermetic sealing are illustrated and fully described in a new combined catalog. Complete with full engineering data, specifications and dimensional drawings, the illustrated bulletin covers the company's standard and nonstandard MIL-T-27 cases, hermetic seal bushing assemblies and assembly service.

Curie Temperature Alloys. International Nickel Co., Inc., 67 Wall St., New York 5, N. Y., has available bulletin A-167, featuring 6 pages, with 17 charts and illustrations. It contains data on the Curie temperature (the temperature at which a magnetic alloy becomes nonmagnetic) of many alloys and shows how this phenomenon is of importance. Four basic applications where the Curie temperature must be known are in devices that require: (1) strong magnetic properties over a wide temperature range; (2) a nonmagnetic alloy having strength and other desirable properties as provided by nickel and iron; (3) special expansion alloys used for glass-to-metal seals, bimetals or in precision instruments; and (4) magnetic properties of the alloy to change with temperature, used for instrument compensation and the like. Some specific applications are given.

Power Supplies. Allied Engineering Div., Allied International Inc., Connecticut & Richards Aves., South Norwalk, Conn., offers its newest bulletin on power supplies for voltage regulation. The 8-page, 3-color catalog presents 5 standard models, including a miniature unit measuring 8 in. × 5 in. ×5½ in. overall. Clear illustrations and factual engineering specifications are given for each type of supply. The specifications provide information on input voltage requirements, voltage and current outputs, percent regulation, ripple, ambient temperature operating range, standard meters supplied and complete mechanical specifications. Included in the literature is a detachable specification sheet for those wishing price quotations on custom-built power supplies.

Measuring Phase Shift. Technology Instrument Corp., 531 Main St., Acton, Mass. Laboratory Report No. 8 featuring "A Method of Measuring Phase Shift through a Computing Magnetic Amplifier Using the Type 7000-A Primary Phase Standard" is available upon request. An additional feature deals with the measurement of small angles in the vicinity of zero degrees with the type 320-AB phase meter.

Vibration Isolator. The Barry Corp., 807 Pleasant St., Watertown 72, Mass. Product bulletin 537 presents detailed technical and application information on the series 262 and 633 Barrymounts for light industrial applications. Included are data on dimensions and load ratings, installation procedure, variation of natural frequency with load, and percent efficiency of isolation. Both series are designed to isolate vibration and noise caused by motors or motor-driven equipment applying static loads of 30 to 260 lb to each unit isolator. Isolation of 60 percent to 85 percent of structure-borne vibration is obtained at 20 cps (1,200 rpm), and 95 percent or better at 1,800 rpm.

Oscillograph Tubes. National Union Radio Corp., Jacksonville Road and Summit Ave., Hatboro, Pa. A recent data sheet announces the new 8CP type 8½-in. oscillograph tubes. The six types described are electrostatic focus and electrostatic deflection tubes, differing only in the characteristics of the fluorescent screen. Other features are a zero first anode current electron gun and high voltage post accelerator electrode. The data sheet gives complete electrical and mechanical characteristics.

Differential Pressure Potentiometer. Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif. A 2-page data sheet No. 508 gives complete technical information on a new diaphragm bellows-type differential pressure potentiometer in standard ranges from 0-to-1 to 0-to-30 psi. Included are photographs, an outline drawing, a temperature-vs-deviation graph and complete detailed specifications covering such information as linearity, hysteresis, resolution and the effects of vibration and acceleration.

Picture Tube Selector. Allen B. DuMont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J., has made available the picture tube selector, a pocket-size, slide-rule device that solves most picture tube replacement problems. It gives complete electrical values, basing, and important physical features for 36 major replacement picture tube types. Over 100 other tube type listings are indexed according to interchangeablity with the basic types.

Communications Receiver. Hammarlund Mfg. Co., 460 W. 34th St., New York 1, N. Y., has announced a 2-color-, 4-page bulletin describing in detail the designs, specifications and operating procedure of its newest communications receiver, the HQ-140-X. The folder pictures in detail, also, the layout, construction and physical design of the receiver, which is built for both amateur and professional use. The HQ-140-X covers the frequencies from 540 kc through 31 mc in six bands. Bandspread dial calibrations are for the 80, 40, 20, 15 and 10-meter bands.

Leveling Mounts. Barry Corp., 1100 Pleasant St., Watertown, Mass., has available a brochure dealing with its new leveling Barrymounts. The brochure outlines such advantages of the new LM-3 and LM-5 series as the installation and leveling of heavy machines without bolting or shims, increased plant mobility, reduced maintenance costs and lessening of the noise level.

Relay Data File. Price Electric Corp., Frederick, Md., has compiled a handy relay data file containing specifications and photographs of 42 relay types. The file serves as a convenient reference for both commercial and military relays and is no larger than an ordinary file folder. There are no loose sheets or attachments; all information being printed on the body of the folder itself. Information provided includes contact arrangements and rating, coil data, dimensions and weight. Requests for copies of the folder should be made on company letterhead.

High Impedance Input Instrument. Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa. Data sheet 10.0-14 describes the Electronik high impedance input instrument that can be used with source impedances varying from 0 to 50,000 ohms, without serious impairment of sensitivity, speed of response or damping. No d-c preamplifier is required. The instruments described are available for spans of 2 mv or greater, or 10 mv or greater.

Liquid Level Indicator Systems. Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson, N. J., has available an 8-page booklet describing the operations of liquid level indicator systems using ultrasonic pulses. The bulletin, No. S-68, describes the systems, which use no moving parts but nevertheless accurately indicate liquid levels in petroleum, chemical and pharmaceutical processing and storage tanks within ±0.01 ft. Included in the booklet is information on the application engineering and diagrams describing typical installations in different types of storage tank.

Mercury Switches. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill., has published a 12-page, 2-color catalog No. 90 covering standard designs of mercury switches for use in a-c or d-c industrial and commercial switching applications that provide low force and tilt motion. It covers five families of switches, classified as protected, heavy duty, general use, small and sensitive mercury switches. In all, 29 catalog listings are included. The catalog gives complete information on each switch, including dimensions, description, electrical rating, differential angle, lead wires and the type of application that each switch is suited for. A complete section on technical data and application aids is included. Another section pictures and describes typical applications.

Pulse Networks. Corson Electric Mfg. Corp., 540 39th St., Union City, N. J. Pulse capacitor and pulse network design and production facilities are described in a 2-color bulletin. The single $8\frac{1}{2} \times 11$-in. sheet also illustrates typical company units, shows a typical installation (in a 10-megawatt test modulator), reproduces on oscillograph of a typical Corson waveform and discusses deliveries and ordering information.

Amplifier System. Heiland Research Corp., 130 E. Fifth Ave., Denver, Colo., has available the 5-page illustrated bulletin 107 with complete information and specifications on the model 119 amplifier system. It presents detailed descriptions of the various features, operation and applications of the 5,000-cps carrier-type amplifier system for static and dynamic recording.

 Want more information? Use post card on last page.

PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

Industry associations name new officers . . . Manufacturers announce further plant expansions . . . Engineers and executives are promoted . . .

OTHER DEPARTMENTS
featured in this issue:

Western Electronic Show Board Meets

THE 1954 WESCON board of directors held its first official meeting in Los Angeles. The Western Electronic Show and Convention, sponsored jointly by WCEMA (West Coast Electronic Manufacturers' Association) and the Los Angeles and San Francisco sections of IRE, will take place in Los Angeles August 25-27. Seated around the table are, left to right: R. A. Huggins of Huggins Labs; W. E. Noller of Lynch Carrier; T. P. Walker of Triad Transformer, vice-chairman; Jeanne W. Jarrett, recording secretary; W. D. Hershberger of the University of California at Los Angeles, chairman; C. F. Wolcott of Gilfillan, vice-chairman; L. B. Ungar of Ungar Electric Tools, secretary-treasurer; Mal Mobley, Jr., business manager; N. E. Porter of Hewlett-Packard and J. H. Landells, Westinghouse.

RETMA Conference Plans New Industry Actions

CULMINATING a three-day industry conference in New York City, RETMA took steps to facilitate the elimination of tv set radiation, to urge Congress to exempt color tv from excise tax and to support a research program in educational tv.

R. C. Sprague, RETMA board chairman, was authorized to appoint a committee to establish procedures and facilities, after consultation with FCC, so that set makers can eliminate sources of tv interference.

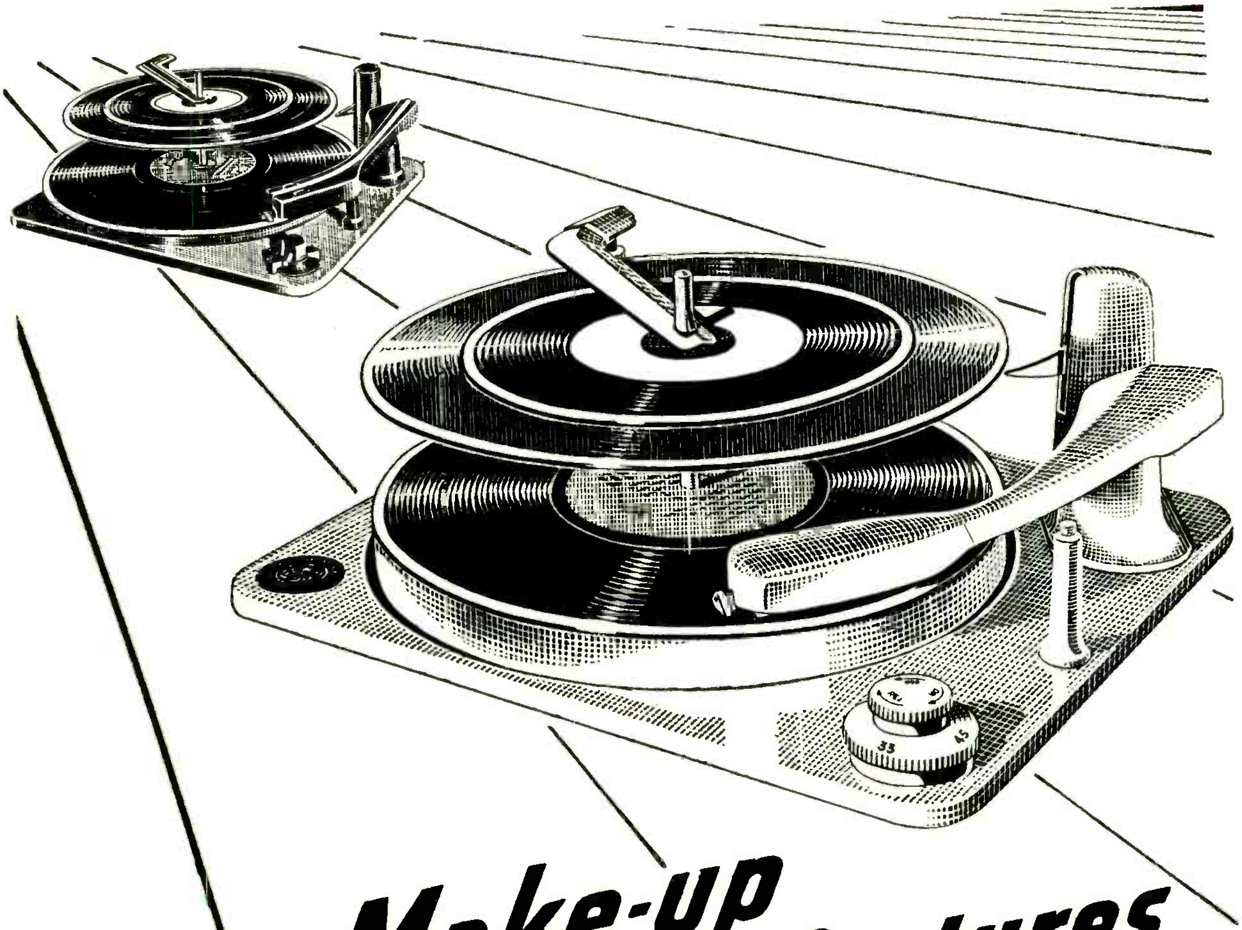
President Glen C. McDaniel and the tax committee were authorized to renew their efforts to eliminate or reduce the wartime excise tax on tv sets and to make a special plea for temporary exemption of color tv sets in line with the customary waiver on new products and industries.

The radio-tv industry committee, under Max F. Balcom, tactily approved a proposal that tv manufacturers provide equipment for an educational research project at New Jersey State Teachers College at Montclair. The project, which has the support of the Ford Foundation, is designed to develop proper techniques for effective use of tv in school classrooms.

Reports on the outlook for military requirements for electronic equipment were made at the meeting. Present indications are that government spending for electronic military products in the fiscal year 1955-56 will be higher than expenditures in this field during the current fiscal year.

The problems retarding the growth of uhf broadcasting were discussed. It was the consensus of set division executive committee members that the growth of uhf is not being hampered by the shortage of either receiving or transmitting equipment.

The RETMA board adopted a resolution complimenting the FCC on its speedy handling of new tv station applications, including uhf, and its adoption of the NTSC color tv proposal. Earlier, the dissolution of NTSC was announced by its chairman W. R. G. Baker of GE. Referring to the work of the NTSC, Dr. Baker said: "For the second time engineers and scientists of the tv industry and allied fields have given freely and unselfishly of their time and efforts to create successfully a new service for the American public. The first NTSC created



New Make-up for famous features

Everyone knows the Monarch couldn't be better, but the universally acclaimed features have been given a new-look. It's fresher—smoother looking—superfinely finished. In fact it's a new conception that still stars—

★The 'Magidisk'—that exclusive feature of the Monarch that selects any record, any size, in any order.

★The quickest changeover that gives uninterrupted pleasure.

★The hidden music discovered by the BSR dual stylus cartridge.

★The control—so simple—so handy.

That is why it is agreed that the Monarch is the World's Finest and most wanted Auto-changer.

BSR

WORLD'S FINEST AND MOST WANTED AUTOCHANGER

BIRMINGHAM SOUND REPRODUCERS LTD. OLD HILL, STAFFS. ENGLAND

the standards for black-and-white tv. The present NTSC, after 3 years intensive work, has made possible the introduction of color tv."

In a letter to all of the members and alternates Dr. Baker said: "I would like to thank each member of the organization for the great effort they put behind this work. Especially do I appreciate your cooperation and understanding which to no small extent has made possible the outstanding results of the second NTSC."

In another action, RETMA filed a statement with the Senate Committee on Labor and Public Welfare supporting the President's recommendation for a secret strike ballot after a strike or work stoppage has started. According to the statement, RETMA supports a strike vote amendment to the Labor-Management Relations Act because it would give recognition to the rights of individuals. The post strike vote is advocated in the statement because "in most instances no clear cut issue on which to vote could be presented to the employees prior to a strike". Also "employees could hardly be expected to hamstring their representatives and weaken their bargaining position by announcing through a vote that the possibility of a strike was cut."

Du Mont Aligns Communication Division

MANAGERS of the recently formed communication products division of DuMont Laboratories have been appointed. Executives of the mobile communications department, shown discussing sales and merchandising plans, are, left to right: Fred M. Link, director of operations for the department and formerly president of Link Radio; C. J. Harrison, department sales manager and previously marketing manager for the transmitter division; Herbert E. Taylor, Jr., manager of the communication products division and formerly manager of the transmitter division; and Robert E. Kessler, assistant division manager.

In the division's new tv transmitter department, James B. Tharpe, formerly sales manager of the tv transmitter division, was named national sales manager. He joined the firm in 1947 as an engineering consultant to the transmitter sales department and in 1949 was appointed sales manager.

Named to aid Tharpe in the new setup is Kenneth F. Petersen, who was appointed marketing manager of the department. He joined WABD as maintenance engineer and later became supervisor of technical facilities for WPIX.

Others appointed to the new transmitter department are Charles E. Spicer, sales operations manager; Lewis C. Radford, eastern district manager; Herbert Bloomberg, central district manager; R. J. Myers, western district manager and T. B. Moseley, southern district manager.

According to the company, sales of station and studio broadcast equipment have more than tripled from 1952 to 1953. Shipments to broadcasters in the past year were 167 percent greater than in 1952.

New Committee Names Officers

A CONFERENCE COORDINATING COMMITTEE, which was established by six trade associations within the electronics industry to coordinate regional conferences run by sales representatives, has designated Russ Diethert, national president of The Representatives, as its chairman and S. L. Baraf of United Transformer as its co-chairman.

The six associations which participated in the committee are the National Electronic Distributors Association, West Coast Electronic Manufacturers Association, Radio Electronics Television Manufacturers Association, Eastern Group of the Sales Managers Club, Association of Electronic Parts and Equipment Manufacturers and The Representatives of Electronic Products Manufacturers.

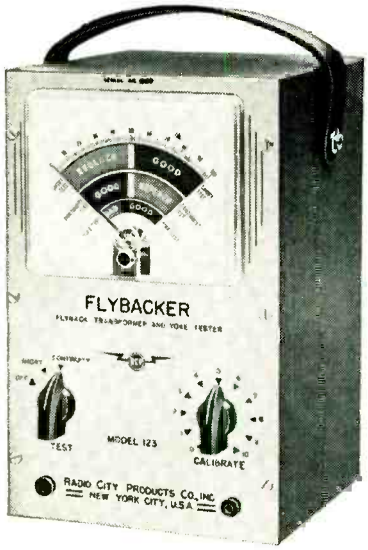
Hi Fi Institute Is Organized

THE HIGH FIDELITY INSTITUTE of the Electronic Industries, a nonprofit association to promote the interests of the high-fidelity indus-

Advanced Flybacker Cuts Down Test Time

RCP Model 123 Provides Fast, Reliable Check of Flyback Transformers and Yokes

Designed for speedy testing of the horizontal output circuits in all TV receivers, the Flybacker is the latest design to come from the laboratories of the Radio City Products Co., 152 W. 25th St. New York 1, N. Y.



The RCP Flybacker is reasonably priced at only $39.75

Extremely sensitive, the Model 123 Flybacker immediately shows up a shorted turn in a flyback transformer or yoke.

All tests can be carried out with the components in place in the TV receiver. Flyback transformers and yokes in stock can be checked for opens, shorts, etc. Flybacker tests are also applicable to inductive windings on any transformer, choke speaker, solenoid, relays, etc., where the impedance is not relatively low. In fact, the instrument may be used as a proportional AC ohmeter.

Easy to Operate

Minimum of connections necessary. All you do is remove flyback plate caps—set switches—apply leads and then read meter. The slightest change in inductance due to a shorted turn or the effect of intermittents shows up on the meter immediately as "BAD".

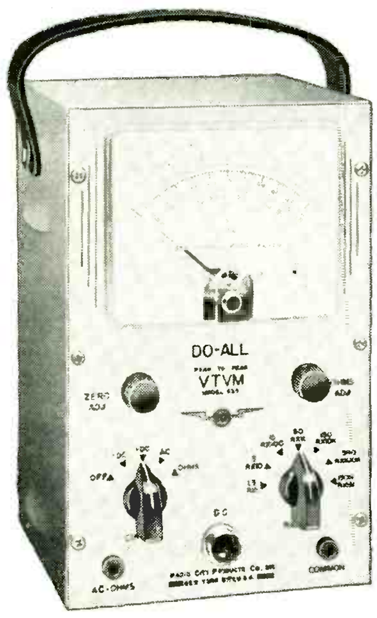
Extra features provide added efficiency:—

- Three "GOOD BAD" Scales.
- One Scale For Yokes.
- Tests Low and High Impedance Yokes.
- Direct Reading Numbered Scale.
- Tests while components are in TV receiver.
- Tests high impedance sections of all transformers.

First introduced in December of last year, the instrument was an immediate success. Users everywhere have heaped praise upon its efficiency and advanced design.

Perfected Peak-to-Peak Measurement Achieved With VTVM "DO-ALL"

New circuit developments inherent in the RCP Model 655 provide for the efficient and accurate measurement of complex waveshapes. It gives a true reading measurement of complex and sinusoidal voltages with necessary peak-to-peak or RMS value read directly for analysis of waveforms in video, sync and deflection circuits.



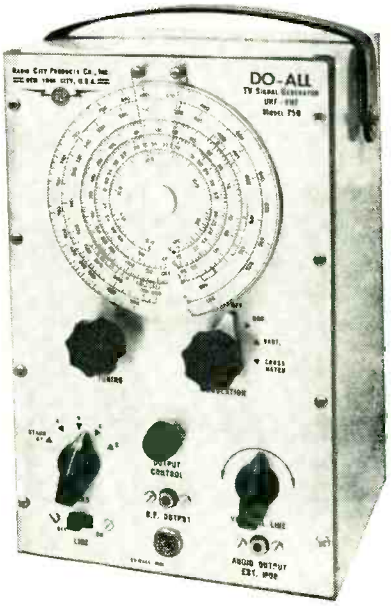
RCP Model 655 provides for the accurate measurement of complex waveshapes.

Versatility of measurement, built into each Model 655, serves a variety of industrial applications in the service of vibrator power supplies, AC generators and all equipment utilizing any type of waveform or DC.

The range and the coverage available with the RCP Model 655 provides a multitude of advantages. For example, peak-to-peak AC measurements of from .2V to 4200V on 7 ranges; AC RMS measurements of .1V to 1500V on 7 ranges; DC measurements of from .02V to 1500V on 7 ranges; RESISTANCE measurements of from .2 ohms to 1,000 megohms on 7 ranges.

Considering the many advantages available, the price—only $59.50—beats any competitive product on the Market. Of high impedance design, the Model 655 makes use of an electronic balanced push-pull circuit and peak-to-peak rectification. The result is an absence of circuit loading, waveform error or frequency distortion.

Signal, Marker, and Pattern Generator Combined in TV "Do-All"



The RCP Model 750 is priced at only $79.50

In the "DO-All" TV Signal Generator Model 750, the Radio City Products Co. has combined, in one instrument, the facilities of a signal generator, marker generator, and pattern generator for both UHF and VHF.

Versatile in concept, the RCP Model 750 can check, test and align front ends, IF's, sound and pix traps, linearity, syncs, sweeps, positioning, focus and deflection. Designed for portable or bench use, the Model 750 reflects the finest in construction and appearance. It is handsomely finished in an attractive brushed aluminum panel with a steel carrying case.

The superior design of the RCP Model 750 provides for the following advantages:

- Inductuner insures accuracy of within ½ of 1% over the entire range of 9Mc to 900 Mc.
- All VHF frequencies are on fundamentals.
- RF's and IF's are clearly calibrated on a large etched aluminum dial.
- Steady horizontal bars, vertical bars and crosshatch individually produced on all channels.

For further information write Dept. E-4, Radio City Products Company 152 West 25th Street, New York 1, N. Y.

try, was organized in Los Angeles. Its purpose is to work for uniformity of technical standards for the high-fidelity industry, new and increased markets, the establishment of equitable trade practices, effective promotional methods and generally to promote welfare of this industry.

Jerome J. Kahn of Chicago was named temporary commissioner of the group to launch the program outlined by it and to serve in a liaison capacity in the industry. Pending permanent organization of the group, he will serve without pay. Temporary headquarters of the institute will be in Chicago.

The six-man provisional board of governors includes: C. A. Hansen of Jensen, L. Carduner of British Industries, E. Berlant of Berlant Associates, G. Yarbrough of American Microphone, J. H. Cashman of Radio Craftsmen and W. O. Stanton of Pickering.

TV Academy Presents Award To NTSC

L. HOFFMAN, president of Hoffman Radio, left, accepted the TV Academy's "Emmy" award to the National Television System Committee for the compatible color tv system. Ed Sullivan, master of ceremonies, lauded the tv industry for "contributing more than a million man-hours to bring color tv to the American people."

The Representatives Membership Climbs

THE Representatives of Electronic Manufacturers recently added seven new members from Canada, one from Honolulu and 21 from

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various regional chapters, bringing membership to 439 seniors, 200 associates and 1 honorary for a grand total of 640 members.

The New York chapter is the largest single unit of the organization. It recently topped the 100 mark in total membership.

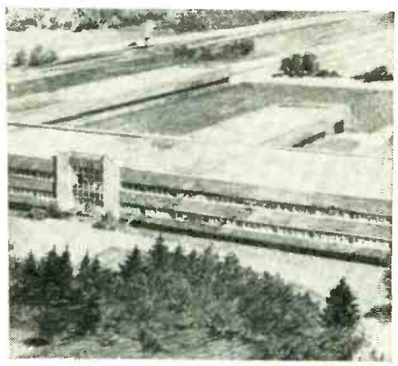
Chicago has the second largest chapter with 96 members.

Philco Appoints Two Chief Engineers

WILSON P. BOOTHROYD was appointed chief engineer of the advance development laboratory for Philco's tv and radio division. Harris O. Wood was named chief engineer of the tv division of the company.

Boothroyd has been in charge of Philco's engineering and development laboratory for the past four years. He is known for special research on microwave communication and television involving synchronizing circuits and color tv.

Wood has been in charge of the company's tv receiver design since 1951. During World War II he achieved an outstanding record at Philco in the design of radar and electronic equipment for the government, the company said. He was recently appointed chairman of the tv receiver committee of RETMA.



Raytheon Plans Electronics Laboratory

TENTATIVE plans for the construction of a large electronics engineering and research laboratory in Wayland, Mass., 20 miles from Boston, were announced by C. F. Adams, Jr., president of Raytheon.

The plans are conditioned upon the completion of satisfactory arrangements with the officials of the town of Wayland and suitable fi-

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nancing. Company officials have been meeting representatives of the town to explore the possibility of re-zoning land for use as a site for the proposed laboratory. Options have been obtained on about 73 acres. It is expected that the plant will be occupied under lease.

Plans call for an initial building to be erected in two stages, to provide about 110,000 sq feet of floor space, with a possibility of additional sections in the future to total up to 300,000 sq ft of floor space. About 400 engineers and related personnel will occupy the first section, 400 in the second and eventually possibly 1,500, if and when the whole building is completed. Actual construction on the site, if approved, will begin shortly after the financial arrangements are completed and options are taken.

"This project," Adams said, "was initiated to provide increased space for our expanding engineering program which includes both commercial and governmental projects." He said that a gradual consolidation of the firm's research and engineering into a single location, instead of conducting them in many scattered areas, has been considered for some time.

In Chicago, Harold W. Beveridge has been named manager of Raytheon's equipment division operations. Beveridge has been with the firm for 9 years. He has had engineering experience with Laurentian Forest Protective Association, National Research Council of Canada, Naval Research Laboratory, and in other fields. He holds patents on mercury delay lines, beacon systems, high-speed digital computer memory systems and radar equipment.

Beveridge will be responsible for all development and production work carried out in Raytheon's equipment division plant in Chicago. This building formerly housed the special products department of the tv and radio division.

Motorola Makes New Personnel Appointments

HENRY MAGNUSKI has been named associate director of research in Motorola's communications and electronics division and will be tech-

Henry Magnuski

nical consultant on all products manufactured by the division.

Magnuski is credited with developing the firm's "Walkie-Talkie," AN/CPN-6 radar beacon and the first 1,000-mile private microwave system in the U. S. He developed the basic circuits of the company's Sensicon receiver for two-way radio communication systems as well as a vhf cavity resonator.

Before his promotion, Magnuski had been chief engineer of the microwave research department and later chief engineer of the communications and electronics division's research department. He was educated in Poland and was chief engineer in charge of military communications equipment for the Polish State Radio & Telephone plant before coming to this country in 1939. He joined Motorola in 1940.

Also in the communications and electronics division, Lloyd P. Morris has been appointed chief engi-

Lloyd P. Morris

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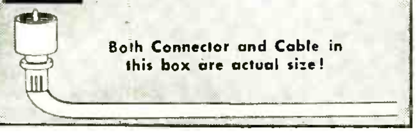

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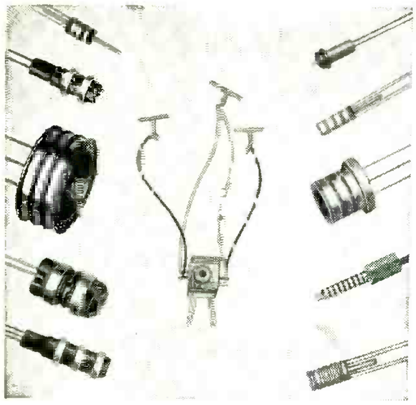

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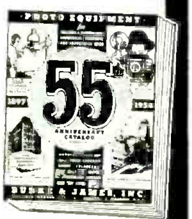

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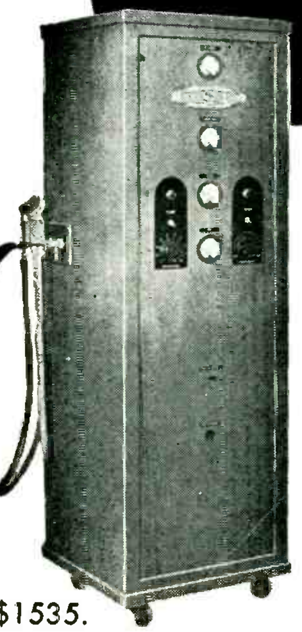

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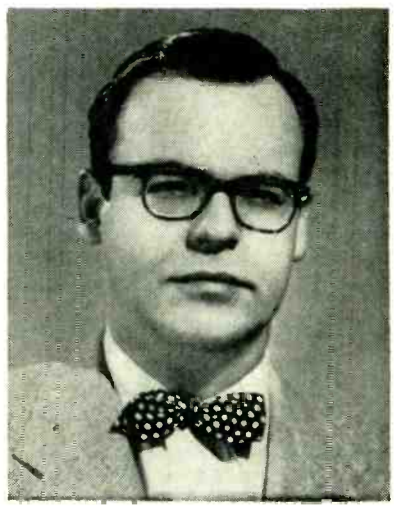
neer of a new service, the national radio systems consulting service. His primary duties will be advising on engineering design of complex, co-ordinated vhf point-to-point and 2-way radio systems for customers. He joined the firm in 1940 and has served as chief systems engineer since 1947.

Leonard G. Walker was promoted to power utility product engineer and acting product manager

Leonard G. Walker

in the communications and electronics division. As product manager, he has engineering, marketing and production responsibility extending from engineering concept of equipment to successful installation of the system. Walker's group handles power line carrier, audio frequency carrier, supervisory control, power line coupling networks and related devices. Prior to his new assignment, he was chief



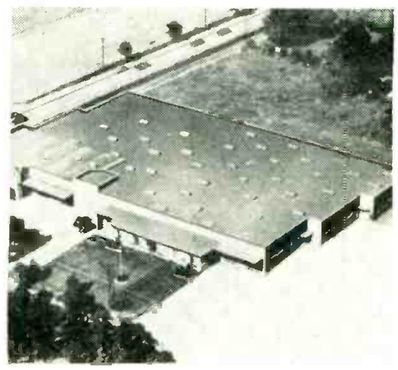
Harold A. Jones

Want more information? Use post card on last page.

systems engineer for power utility products. Before joining the firm in 1951, he was electrical engineer for the Idaho Power Co. in Boise.

Harold A. Jones was named executive assistant to the national sales manager of Motorola Communications & Electronics, Inc., a wholly owned subsidiary of the parent company. He will assist the national sales manager in sales and promotion management of all communications products distributed through the subsidiary. Direct factory distribution is made through ten regional sales offices.

Jones has been with Motorola since 1946, and since 1949 has headed its technical information center, a post he will continue to hold.



Ketay Readies New Manufacturing Plant

INSTALLATION of equipment is underway at Ketay Manufacturing's new 43,000 sq ft plant in Commack, Long Island, N. Y.

Production equipment includes stamping facilities for 3 million pounds of lamination materials per year. Special facilities for corrosion-proofing materials will be provided. The plant will produce electronic and electromechanical devices, airborne electronic devices and flight instruments.

CBS Names Christensen And Mintz

THE APPOINTMENT of John W. Christensen as vice-president and chief engineer of CBS Laboratories was announced by Peter C. Goldmark, recently named president of the Labs. Seymour Mintz was

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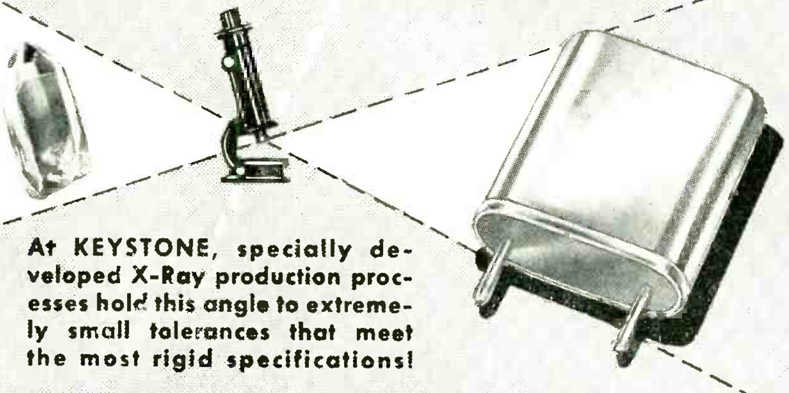

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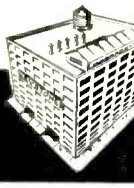

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John W. Christensen

named president of CBS-Columbia.

Christensen joined the firm in 1946 and participated in the development of color tv projects, including the field sequential system and the CBS Chromacoder.

During the war, he was associated with Radio Research Laboratories of Harvard University in the development of vhf and uhf antennas, receivers and direction-finding systems for aircraft and guided missiles. For his contributions in these fields he received citations from the War Department and the Navy. In 1941 and 1942 he was a member of the engineering staff of KSL in Salt Lake City. Mintz was formerly vice-president and advertising director of Admiral. He was associated with the company for ten years. Previously he was with Montgomery Ward.

CBS-Columbia also announced that Carmine Masucci has been appointed to the engineering staff as a senior project engineer assigned to the advanced development department. He was formerly a member of the engineering department

Seymour Mintz

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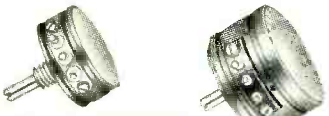

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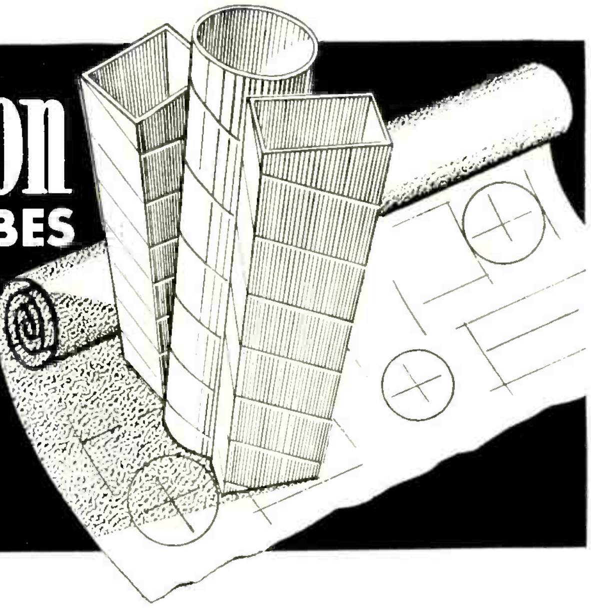

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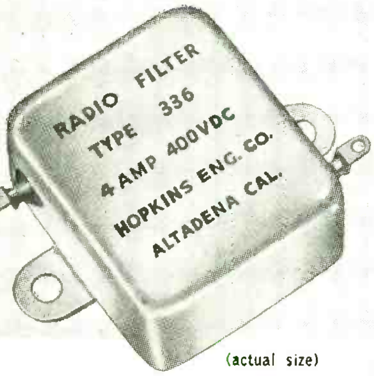

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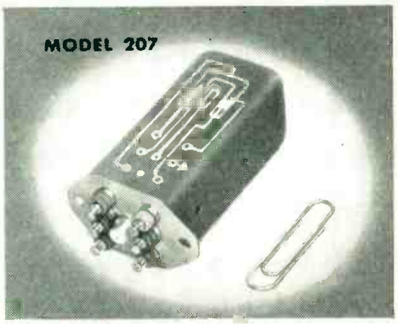

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of Sylvania, and holds a number of electronic patents.

The firm also announced that it inaugurated the first of a series of 35-hour color tv training seminars for selected distributor personnel. They will cover basic color principles, the Colortron tube, signal transmission, basic circuitry, components and installation-maintenance procedures.

Gertsch Named President of WCEMA

E. P. GERTSCH, owner and president of Gertsch Products of Los Angeles, was selected president of the West Coast Electronic Manufacturers' Association for 1954.

Gertsch was one of the founders of WCEMA and has been an active leader in the association since its birth 11 years ago. He has served on the board of directors as vice-chairman of the Los Angeles Council in 1952 and as chairman of the first WCEMA scholarship committee. He was recently elected chairman of the 1954 executive committee for the Los Angeles Council.

Prior to organizing his own company, Gertsch held management positions with Hoffman Radio, Air Associates and RCA.

Cornell Builds New Engineering Center

CONSTRUCTION has begun on Cornell University's new $1.6 million electrical engineering center. It will house the school of electrical engineering and will provide advanced facilities for instruction and research in communications, illumination, servo-mechanisms, elec-

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trical machinery and other phases of electronics and power.

The building will be named for Ellis L. Phillips of Plandome, Long Island, N. Y., a Cornell engineering graduate of the class of 1895, former president of the Long Island Lighting Co. and founder of the Phillips Foundation of New York which granted the funds.

The center features a large sound-proof, echo-free chamber for work in acoustics and audio research, along with specialized labs for work in electronics, vacuum tubes, transistors, tv and radar. A computing section will house the McIlroy pipeline network analyzer developed at Cornell and a Westinghouse network analyzer for studying power systems. The roof will be used for research with antennas and other equipment.

Completion of Phillips Hall, which is expected in one year, will enable the school to consolidate activities now being carried on in five buildings. The high-voltage, ionosphere and radio astronomy laboratories will continue at their present sites.

Air Associates Elects Sereno Vice-President

CHARLES A. SERENO has been elected vice-president and general sales manager of Air Associates, electronic and mechanical products divisions.

The new officer held executive engineering posts for five of his seven years with the company. During this time, he directed the reestablishment of the electronic equipment division at Orange,

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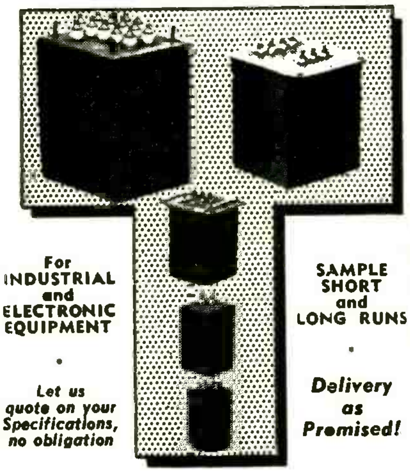

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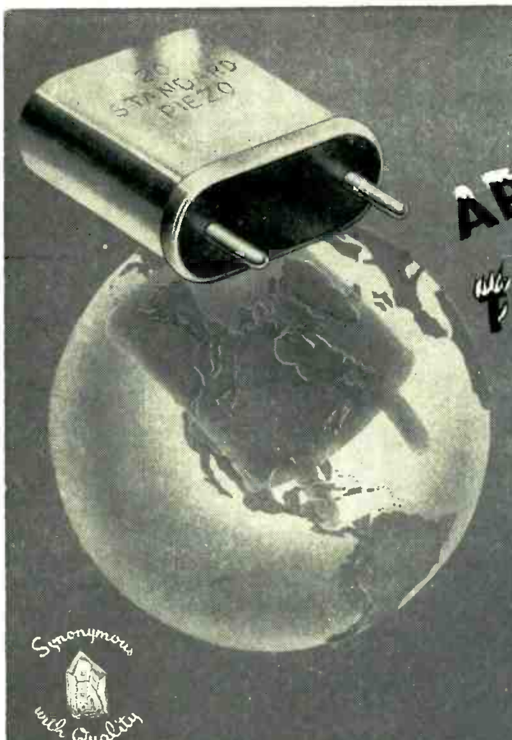

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N. J., and worked on the development and design of products.

He also directed engineering at Air Associates' aircraft products division in Teterboro, N. J. as chief engineer. He headed the development of a-c and d-c motors, electromechanical actuators and hydraulic components for systems.

Sereno was appointed chief engineer over all production divisions in March, 1953.

Seventeen More Companies Join RETMA

ADMISSION of 17 electronics firms to membership in RETMA brought the association's membership to an all-time high of 373. The new members are:

Acro Products, Philadelphia; The Bank of New York, New York; C-B-C Electronics, Philadelphia; Cubic Corp., San Diego; Davis Electronics, Burbank; Hydro-Aire (subsidiary of Crane Co.), Burbank; Kay-Townes Antenna, Rome, Ga.; Kline Iron and Metal, Columbia, S. C.; Litton Industries, Los Angeles; Phen-O-Tron, New Rochelle, N. Y.; Plamondon Magnetics, Chicago; Precision Electronics, Franklin Park, Ill.; Saffran & Arnold Electronics, Toledo, Ohio; Telechrome, Amityville, N. Y.; Thomas Associates, Los Angeles; Tristao Manufacturing, Kansas City, Mo. and Unitek Corp., Pasadena, Calif.

Ford Names Buchhold And Slawson

THEODOR BUCHHOLD, formerly chief of the guidance and control branch of the guided missile development division of Redstone Arsenal, has joined Ford Instrument as staff consultant to the vice-president for engineering. He will specialize on research and development projects.

Dr. Buchhold developed magnetic amplifier circuits used in electronic instrumentation and designed electric locomotives and automatic controls and regulators.

During World War II he was professor of electrical engineering at the University of Darmstadt and consulting engineer to Brown, Boveri and Co. of Mannheim, Ger-

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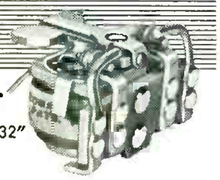

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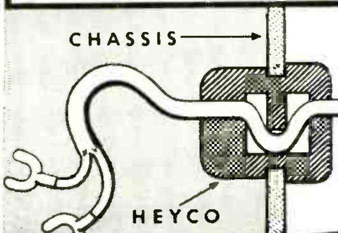

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Theodor Buchhold

many. During this period he contributed to the development of the V2 guided missile.

In 1946 Dr. Buchhold left Germany to join the missile group in Fort Bliss, Texas which included top rocket and missile experts from the Peenemuende laboratories. In 1950 the group moved to Redstone Arsenal, Huntsville, Alabama.

Kenneth Slawson has been appointed assistant to the president of Ford Instrument and is concerned with general administrative problems. He started with the firm in 1928. In 1946 he was appointed manager of E. G. Staude Manufacturing, another Sperry division. As a result of the recent sale of Staude to the Bryant Chucking Grinder Corp. he returned to Ford

Kenneth Slawson

John E. Nelson

gion which includes 21 states and part of Pennsylvania.

For the past year, he has been product manager for industrial and transmitting tubes in Schenectady. In that capacity he directed the planning and coordination of all the company's industrial and transmitting tube development. He joined GE in 1942 on the company's test engineering program, following nine years with the U. S. Department of Agriculture. In August, 1942, he joined the engineering section and later served as section leader responsible for the design and development of thyratrons and control ignitrons. In 1946 he was named sales manager for industrial and transmitting tubes. In 1951 he was named acting product manager for industrial and transmitting tubes and in 1952 was appointed product manager.

The tube department also formed a replacement tube southeastern sales region and appointed C. Bryon Farmer as regional sales manager.

Creation of a new field sales organization for GE germanium products was also announced. Six men were named as sales and applications engineers for the items to manufacturers of electronic equipment. They are: L. L. Emmel, C. J. Goodman, J. B. Jolly, H. F. Hodsdon, V. J. Huntoon and A. C. Oeinck.

Hallicrafters Builds New TV Set Plant

A $1.5 MILLION factory is being built in Chicago for Hallicrafters. The new plant will be used for ex-

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to his present position.

Robert Armstrong has joined the quality control division as assistant to its director, C. E. Ellis. He was formerly with Electrol as utility manager. Previously he was associated with Arma, Pioneer Instruments and the Aluminum Company of America.

Daven Promotes Head Engineers

J. P. SMITH, JR., formerly chief engineer of the Daven Co., has been promoted to director of engineering.

J. P. Smith, Jr.

Walter Voelker

Walter Voelker, formerly of Day & Zimmermann, Leeds & Northrup and Bell Labs, has been appointed chief engineer of the company.

GE Names Managers For Tubes and Germanium

JOHN E. NELSON was appointed central regional manager for GE equipment tube sales. He will direct all equipment tube sales and commercial engineering activities in the re-

panded tv manufacturing, warehousing and as a central shipping point for all of the firm's products. It will have 200,000 sq ft of floor space and will provide employment for an additional 1,000 people when completed in mid-July.

All administrative offices and the production of communications equipment, high-fidelity instruments and standard and short-wave home radios will continue in the main company plant in Chicago.

The new plant brings total space used by the company for manufacturing and storage to 422,000 sq ft. The new plant is expected to streamline and consolidate the firm's operations and at the same time allow for greater production.

Ryder Named Dean At Michigan State

JOHN D. RYDER, head of the electrical engineering department at the University of Illinois, has been named dean of the school of engineering at Michigan State College, effective July 1, 1954. He succeeds Dean Lorin G. Miller who retired July 1, 1953.

Dr. Ryder worked with GE in the development of electronic equipment. Later, he became supervisor of the electronic section of the Bailey Meter research laboratory in Cleveland. Two dozen patents reflect his work there.

In 1941, Dr. Ryder became assistant professor at Iowa State College and in 1944, as full professor, he was placed in charge of electronics courses. In 1947, he became assistant director of the Iowa Engineering Experiment Station. He became professor and head of the electrical engineering department at the University of Illinois in Sept., 1949.

Federal Telephone and Radio Plans Expansion

FEDERAL Telephone and Radio plans to expand its operations generally, to have a more diversified line of products and, although it has heavy military commitments, to make a larger proportion of its production available to commercial customers.

To make space for the expansion, the manufacture of monocolor tv

picture tubes has been discontinued. The area formerly devoted to this operation will be used mainly for greater production of power vacuum tubes for broadcast and industrial markets. The manufacture of magnetrons will be stepped up substantially.

The company plans expansion of its line of germanium diodes, selenium rectifiers and magnetic amplifiers. Other features of the company's expansion program include cable products, a line of low-band vehicular mobile radio, new pulse time modulation microwave equipment and new railroad electronic equipment.

Federal's distributor organization is now being extended and strengthened and a program of local warehousing has started.

Weston Names Lamb and Gilbert

THE Weston Electrical Instrument Corp. has appointed Frank X. Lamb vice-president and Roswell W. Gilbert as assistant to the president.

Lamb will retain his former title of chief engineer and will take on additional responsibilities in supervision of mechanical and electrical engineering activities. He joined the firm in 1921 and served as a design, project and liason engineer. He was resident engineer for the company, assigned to the Nippon Electric Co. in Japan, from 1937 to 1939.

Frank X. Lamb

Gilbert, in addition to his new post, will continue to serve as director of research. He joined Wes-

Roswell W. Gilbert

ton in 1934 as a research engineer and since has specialized in the development of ultra sensitive devices including combination electromagnetic and electronic types. The holder of 24 patents, he has served as both division chief and laboratory director.

RETMA Plans Connection Conference

PRELIMINARY plans for a conference on reliability of electrical connections to be held April 15-16 at the Illinois Institute of Technology in Chicago were announced by RETMA's engineering department.

The conference, which will be divided into four sessions and a demonstration period, will be devoted to a study of methods of connecting to the terminations of wires and cables to produce equipment free from difficulties caused by loose and broken connections.

Aimed at project engineers and production superintendent as well as the inspection personnel of electronic equipment manufacturers, the conference will be participated in by representatives of the Aircraft Industries Association and aircraft manufacturers engaged in producing electronic apparatus.

Volkert Completes Plant Expansion

JOHN VOLKERT METAL STAMPINGS has added 12,000 sq ft of floor

Newly enlarged Volkert plant

space to its plant in Queens Village, L. I., N. Y., bringing total plant area to more than 30,000 sq ft.

A new building has been constructed to house executive offices, a conference room, an apprentice training section, the production welding department and a new finishing room. The warehousing and shipping departments have been modernized and enlarged. A specially-built room has been set up with vaporized degreasing and Honite finishing equipment. Storage capacity at the plant has been tripled with the installation of storage racks having a capacity of 750,000 pounds.

Sylvania and Stanford Plan Project

AN "Honors Cooperative Program In Electronics", designed to aid outstanding college seniors who are interested in doing graduate work in electrical engineering combined with full-time electronics employment, has been planned by Sylvania and Stanford University.

Each student selected will receive a full year of graduate work and an M.S. degree from Stanford in two calendar years. Students will be employed in research and development work in Sylvania's Mountain View, Calif. laboratories, which are a short distance from Stanford at Palo Alto. All participants will be allowed the time necessary to attend regular classes at Stanford.

Men selected will be on a reduced working schedule of 35 hours per week at Sylvania labs but will receive full salary based on the standard 40-hour work week. In addi-

tion, as part of the firm's educational assistance policy, each student will be reimbursed for 50 percent of his tuition fee upon the satisfactory completion of each quarter's work.

In the parts division of the company, Albert Lederman was appointed engineering specialist and section head in a new mechanized circuits department for application of stamped and printed circuits.

Lederman was previously a technical representative for the firm in Washington, D. C. He has served as secretary of the Panel on Electron Tubes of the Research and Development Board for the Department of Defense and served with the Conference Committee on Electron Tubes for Computers in Atlantic City in 1950.

Feldmann Elected President Of National Union Radio

C. RUSSELL FELDMANN was elected president of National Union Radio. He is also chairman of the board, a position he has held since 1946. He succeeds Kenneth C. Meinken, who resigned.

"National Union's company policies and current program of expansion into new fields of electronics will continue unchanged," Feldmann said.

Huntoon Named Physics Director For NBS

ROBERT D. Huntoon was appointed associate director for physics of the National Bureau of Standards. The Bureau's organization now provides for four associate directors.

Dr. Huntoon, formerly director of NBS Corona, Calif. Laboratories, has also been designated acting chief of the NBS electronics division and of the bureau's central radio propagation lab.

As director of the Corona labs, which are now being operated by the Defense Department, he was responsible for a research and development program that included guided missiles, electronic ordnance devices, digital computers and infrared measurements. He joined the NBS staff in 1941 and was one of the principal NBS scientists concerned with the design and development of the proximity fuze. He was appointed chief of the NBS electronics section in 1945 and directed fundamental research on electronic circuits, control devices and other electronic ordnance components. In 1947 he became assistant chief of the atomic and radiation physics division and chief in 1948. During this period he also served as coordinator of atomic energy commission projects at NBS. During 1940 and 1941 he was a research physicist in the tube division of Sylvania.

Ralph A. Lemm has been appointed technical director of the Naval Ordnance Laboratory, Corona, California succeeding Dr. Huntoon.

Other recent promotions at NOL-Corona include the designation of four division chiefs: H. K. Skramsted, missile systems division; F. S. Atchison, physical science division; H. A. Thomas, fuze division and G. R. Sams, missile evaluation division.

The new Naval Ordnance Laboratory was formed last fall by transfer of the Corona Laboratories of the National Bureau of Standards to the Navy Bureau of Ordnance.

RCA Victor Division Appoints Conrad & Chiei

ANTHONY L. CONRAD has been appointed manager of the RCA missile test project in the government service division of the RCA Service Co.

Frederick Chiei has been appointed manager of the technical operations section in the division, the post formerly held by Conrad.

Conrad joined the company as a

tv service technician in 1946. He was promoted to manager of a factory service branch where he served until 1947. From 1947 to 1949, he was engaged in personnel work and systems engineering at RCA Service Co. headquarters. Then he served as manager, tube quality control group, and later manager, technical operations section. In 1953, he received the RCA Victor Award of Merit, the firm's highest award for salaried employees, for his work in the guided missile field.

Chiei also joined the company as a tv serviceman, serving in that capacity from 1947 until 1950, when he was made a field engineer in the government service division of the company. From 1951 until his present appointment, he served as manager, engineering group, in the field operations section of the division.

The engineering products division of RCA held a fourth color tv technical training program. A total of 101 broadcast engineers attended including 22 engineers from NBC, 15 from CBS, 13 from AT&T and 50 from independent broadcasting stations. It raised to more than 300 the total number of broadcasters given training in theory and operations of new color tv broadcast equipment.

The company also held its 19th black-and-white tv technical training program. A total of 56 broadcast engineers and consultants, including 9 foreign tv engineers, attended the clinic.

Admiral Corp. Makes New Moves

HARRY HANSON has been named chief designer for Canadian Admiral Corp. He has been directly connected with production design for the past 8 years.

Since 1945, Hanson has been supervisor of cabinet engineering at RCA in Ontario, Canada. Previously he was at the head office in Montreal. Starting with 12 years drafting experience, he gained general production experience from 1939 to 1945.

In the U. S., Admiral announced

plans for the construction of a million dollar consolidated warehouse on a 10-acre tract of land in Leyden Township, Ill. The new 152,000 sq ft structure will eliminate the use of seven warehouse locations in the area. It is scheduled for completion in June, 1954.

Television and radio receivers produced in Admiral plants in Chicago, Harvard, McHenry and Bloomington, Ill., as well as raw materials, will be stored in the new building, thereby simplifying and expediting shipments of mixed carloads to distributors.

The company also announced that it held a color tv training school for company field engineers and distributor service engineers. Each prospective student was given a color perception test before starting the course. Any service personnel found to be color-blind will confine their future service activities to black-and-white tv, it was said.

Burndy Engineering Names Engineers

At Burndy Engineering, I. F. Matthysse, formerly chief design engineer, has been appointed assistant chief engineer and W. F. Bonwitt, who was previously chief of planning engineering, has been appointed chief administrative engineer.

Matthysse has been in the engineering department of Burndy for 25 years, during which he has been engaged in the design of electrical connectors and cable limiters. A total of 14 patents have been granted to him and 12 patent ap-

I. F. Matthysse

W. F. Bonwitt

plications are still pending.

Bonwitt joined Burndy in 1938 and has been occupied largely in heading the firm's testing, research and quality control programs.

GPL Subsidiary Acquires Computer Company

LIBRASCOPE of Glendale, Calif., a subsidiary of General Precision Equipment Corp., acquired the Minnesota Electronics Corp. of St. Paul, manufacturers of digital computers and components. The Minnesota firm recently developed "subminiature magnetic decision elements" that consist of electronic units such as diodes, resistors, and related components pre-packaged in small plastic cubes. When used in proper combination they are said to provide flexibility and simplicity in computer design and construction. For special applications such as airborne computers they replace units of approximately ten times their size, the company said.

Librascope plans use of the elements in its computers. It is understood that Minnesota Electronics will continue to operate with present management and personnel.

Avien Forms New Electronic Firm

CONTROL LABORATORIES has been formed by Avien, manufacturers of aircraft fuel management systems and other aeronautical products.

President of the new company, which will be associated with Avien, is Stanley J. Smith, recently director of engineering and development at Simmonds Aerocessories.

R. J. Levine, formerly director of

Stanley J. Smith

Robert J. Levine

engineering at Avien, has been appointed vice-president of the new corporation and elected to the board of directors.

"The new company," L. A. Weiss, president of Avien, stated, "is planned to be a development facility specializing in the electronic control and servomechanical fields for aeronautical and other industries."

Smith is an inventor in the aircraft instrument field and particularly in the field of fuel quantity gages, in which he is credited with a large number of key patents.

Other officers of Control Laboratories, to be located in Valhalla, N. Y., will be L. A. Weiss, vice-president and H. H. Myers, secretary-treasurer.

Volkers & Schaffer Opens New Division

THE Volkers & Schaffer Manufacturing Corp. has been established by Volkers & Schaffer, Inc. to manufacture and promote the "Starved Direct Coupled Amplifier," a highly sensitive oscilloscope which incorporates the starved am-

plifier circuit invented by W. K. Volkers, vice-president of the company. President of the new manufacturing division is Roy B. Hoag.

Radio Receptor Names Mendel

RALPH MENDEL was appointed vice-president in charge of the engineering products division of Radio Receptor. He joined the company in 1948 and for the past few years has been manager of the division. Prior to 1945 he was with RCA International.

Sprague Appoints New Plant Manager

ROBERT L. PARRIS was named manager of the new plant of Sprague Electric, now under construction at West Jefferson, N. C.

The new plant, which will manufacture capacitors, will open late this spring. It is the sixth branch plant to be established by the concern.

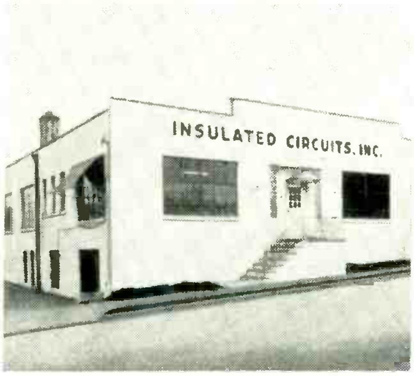
Parrish, who has been associated with the main plants of the company for some time, was formerly senior chemical engineer with Abbott Laboratories.

Printed Circuit Firm Begins Operations

THE OPENING of Insulated Circuits, a new printed circuit manufacturing company, took place in Belleville, N. J.

Officers of the firm are: R. A. Curran, president; Louis Eisenstein, vice-president and treasurer; Max Eisenstein, secretary and G. H. Ogens, sales manager.

The 7,500 sq ft plant has facili-



Insulated Circuits plant

ties for production and assembly of printed circuits without sub-contracting. Plant personnel and facilities are being increased to implement construction and to accommodate additional sub-assembly contracts.

Ward Products Names Engineering Director

THE WARD PRODUCTS CORP., division of Gabriel, announced the appointment of William H. Rickards to the newly created position of director of engineering. He will expand antenna engineering facilities for the firm. His most recent affiliations were with the Radiart Corp. and Cleveland Electronics. His work in recent years has been in the design and development of tv and automotive antennas.

Indiana Steel Names Two Executives

JAMES R. IRELAND, formerly staff assistant to the vice-president in charge of research and engineering for Indiana Steel Products, has been appointed assistant director of research. He will have direct responsibility for all research, including that to be done under a new contract with the Air Force for basic and applied research on magnetics.

Before coming to Indiana Steel, Ireland served seven years as chief engineer for Thomas & Skinner Steel Products Co.

James G. Richmond was named

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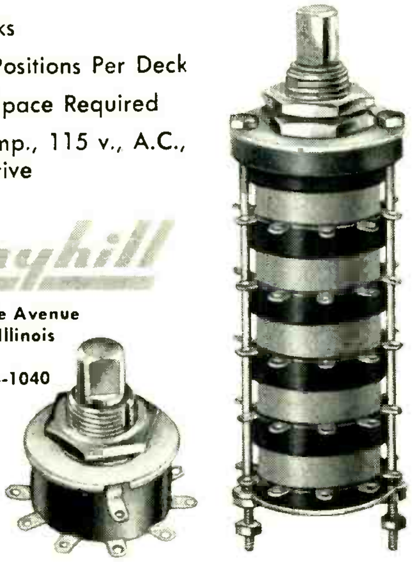

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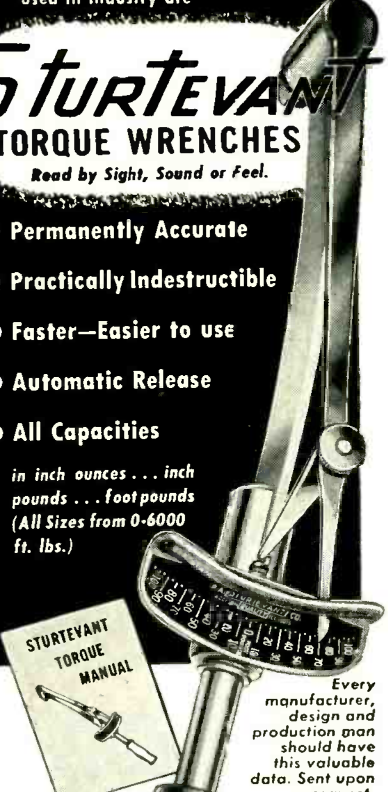

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assistant manager of the manufacturing division and will be responsible to the vice-president in charge of manufacturing for all functions of the division. Before joining the company as a staff assistant in 1953, he was employed by International Harvester as materials controller.

Breitwieser Elected Lear Vice-President

CHARLES J. Breitwieser, who recently joined Lear as director of engineering, was elected a vice-president of the company. He is also manager of the general development and engineering division.

Previously he was with P. R. Mallory & Co. as director of engineering in charge of its central engineering laboratories. Prior to joining Mallory, he was with Convair for over 9 years as chief of electronics and research laboratories, responsible for the electronics and guidance section, guided missile flight test section, engineering test laboratories and the missile and airplane instrumentation section.

Micamold Radio Elects Executive Vice-President

J. GERALD MAYER, attorney and senior partner in the law firm of Mayer, Rigby and Seeley, has been elected executive vice-president of Micamold Radio of New York City.

Mayer, an engineer and attorney, was associated for a number of years as an engineer with Western Electric. He was the World War II chief of the contract termination organization in the office of the Chief of Signal Officer and since that time has been counsel to various electronic industry groups.

A. P. Hirsch, president of Micamold, said that the step was taken in line with a policy of expansion both with respect to facilities and products.

Armour Research Names Disney

VIRGIL H. DISNEY was promoted to manager of the electrical engineering research department at Armour Research Foundation of Illinois Institute of Technology.

Disney joined the foundation staff in 1949, serving first as supervisor of the electronics section. He was promoted to assistant manager of the electrical engineering department in 1951.

Before coming to Armour, Disney was a project engineer with Sperry Gyroscope. He was with Curtiss-Wright from 1946 to 1947, serving as assistant section head of research. From 1943 to 1946 he was a project engineer for C. G. Conn. In 1942-43 he taught in the engineering and science management war training program at Illinois Tech, and from 1937-1942 he was an electrical engineer for American Can.

Beltone Makes Research Grant

A GRANT of $1,000 to the audiology department of Northwestern University for electronic research equipment was announced by Sam Posen, chairman of the Beltone Institute for Hearing Research in Chicago.

The equipment will be used in current studies aimed at improving techniques of clinical testing of hearing loss.

Designers For Industry Names Engineers

RECENT promotions and additions were made to the staff of Designers For Industry. Franklin L. Eger joined the firm on the technical survey staff as senior field investigator and Dante J. Domizi as senior project designer in electronics engineering.

Recent promotions include P. N. Bredesen to assistant project manager, electronics; and H. G. Gilbert, E. Holasek, E. F. Mazur and G. J. Prusha to project designers, electronics.

Ampex Names Read Assembly Head

STANLEY N. READ has been named superintendent of assembly operations by Ampex Corp. Before joining the firm he was engaged in the installation of manufacturing plants and management controls. He brings to his new position more than 16 years of administrative experience in the engineering and production of communication equipment for Magnavox, Centralab, Kellogg Switchboard and other firms.

Aerovox Division Names Whitton

RAYMOND WHITTON has joined the Burbank, Calif. factory of Cinema Engineering, a division of Aerovox. He will head the tool and die design department.

Whitton has been in the field a score of years, most recently as tool maker and shop foreman for West Coast Engineering and previously with the U. S. Navy ordnance plant as a tool maker and tool designer. An enlarged tool-design department has been installed in Cinema's new Burbank facility.

John A. Oliver has joined the division as a staff engineer. He had been with Hughes Aircraft for the past three years in research analytic activities and previously,

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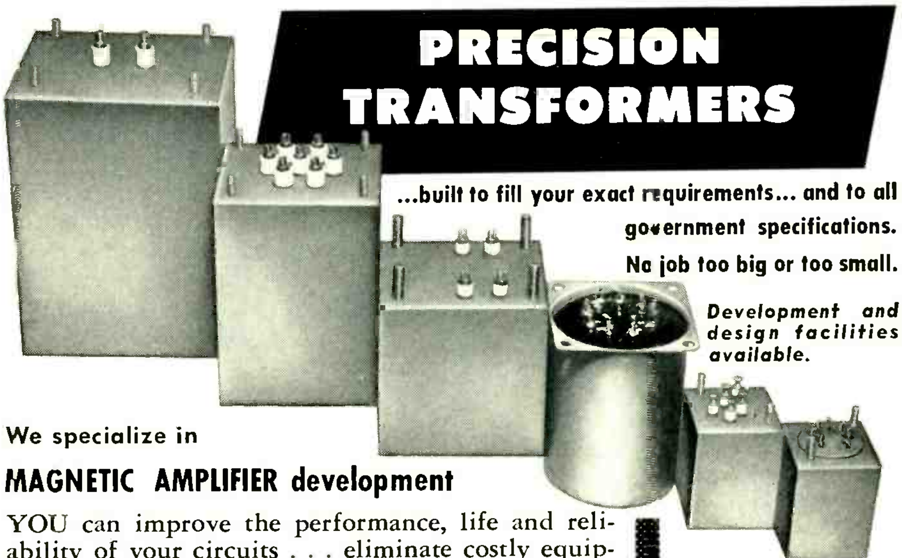

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for ten years, was at Oak Ridge, Tenn. in various projects and capacities.

Varian Elects Three Directors

JAMES B. DU PRAU, Theodore Moreno and Emmet G. Cameron were elected to the board of directors of Varian Associates.

Du Prau is vice-president and assistant to the president of Columbia-Geneva Steel Division of U. S. Steel and a member of their board of directors.

Dr. Moreno is manager of tube design and improvement at Varian. He has been with the company since 1951.

Cameron is works manager in charge of the firm's San Carlos, Calif. plant.

Directors reelected were: R. H. Varian, president; H. M. Stearns, executive vice-president and general manager; S. F. Varian, vice-president for engineering; R. M. Leonard, secretary; E. L. Ginzton, F. P. Farquhar, David Packard, D. G. McAllister, G. D. Merner and C. V. Heimbucher.

The company reported that its high-power amplifier klystron, designed and built for GE, is now in use in over 24 uhf tv stations. The Varian nuclear induction magnetometer, developed for Byron Jackson Co., was recently announced and is a portable device for the location of subterranean or undersea mineral bodies by detection of variations in the magnetic field of the earth.

New Research Lab Is Established

TECHNIQUES, a new electronics research and development laboratory, has been established in Goleta, Calif.

The firm occupies approximately 1,200 sq ft of space in Building 120 at the Santa Barbara, Calif., Airport. The company presently has a military subcontract with Goodyear Aircraft on radar design and a direct commercial contract with Goodyear on computer design.

For the present, the company consists of two engineers, Carl A. Wiley and Ben. R. Gardner, president, both of whom have had extensive experience in the field.

Reliance Plans Plant Addition

THE Reliance Electric and Engineering Co. plans a new 90,000 sq ft plant addition to its Ashtabula, Ohio division. The addition will increase plant and office area to a total of 220,000 sq ft. The company's new line of a-c motors will be built at the plant.

Robertshaw-Fulton Makes Plant Moves

CONSTRUCTION began on a new 237,000 sq ft plant in Long Beach, Calif. to house the Grayson Controls Division of the Robertshaw-Fulton Controls Co. The new $2.5 million plant will employ about 2,400 people with an annual payroll in excess of $7 million.

Proposed Robertshaw-Fulton plant

Construction of a $500,000 addition to another California plant of

Thomas H. Jeffers

the company began recently.

The firm also announced that Thomas H. Jeffers was named to the new position of assistant general manager of the Anaheim division and an assistant vice-president of the firm. T. T. Arden continues as general manager of the Anaheim division.

Jeffers was formerly chief engineer at Anaheim, which is one of eight of the company's divisions.

Lackman Joins Chester Cable

JOHN LACKMAN was appointed executive technical director of Chester Cable Corp. He has been employed in the technical department of E. I. DuPont de Nemours and also worked with major wire companies.

Chester Cable recently completed its fourth major plant expansion in the past five years.

University Of Michigan Sets Control Courses

THE COLLEGE OF ENGINEERING of the University of Michigan has planned two intensive courses in automatic control. The first is scheduled for June 14-19, the second for June 21-23, 1954. The courses are intended for engineers who wish to obtain a basic understanding of the field but cannot spare more than a few days for the purpose. The aim of the courses is to make it easier to learn by a coherent presentation of the fundamentals of modern automatic con-

trol and to provide a comprehensive set of notes to serve as a framework for further study. The role of analog computing methods will be emphasized.

Micromax Company Changes Its Name

THE Micromax Company of Brooklyn has changed its name to Computer Instruments Co. in order to describe the nature of its line of products. The company is manufacturing electronic computer and servomechanism components. Its manufacturing plant will remain in Brooklyn and facilities will be expanded. All Micromax personnel will be retained, according to the firm.

Union Electric Acquires TV Products Company

UNION ELECTRIC & MANUFACTURING of Jersey City, N. J. acquired all the resources of TV Products Co. of Paterson, N. J., manufacturers of television yokes and transformers.

The merger of the two companies was in line with Union Electric's policy of expansion of volume and curtailment of overhead so as to better meet a competitive market.

Scintilla Magneto Changes Its Name

THE Scintilla Magneto division of Bendix Aviation has dropped "Magneto" from its name and is now known as "Scintilla Division". "Magneto" was deleted from the Scintilla name as it is no longer descriptive of the size and scope of the division's operations.

New Magnetic Recording Company Organized

MAGNE-TRONICS, a New York corporation, has been formed to operate in the audio visual fields and promote magnetic tape sound recording and reproduction. The company will distribute musical tapes with playing times of from two to eight hours.

P. L. Deutsch heads the new company as president and J. F. Hards, formerly vice-president of

Audio Video Tape Libraries, is vice-president. Hards is also president of the Magnetic Recording Industry Association.

Weid Named Melpar Vice-President

ARTHUR C. WEID has been appointed vice-president of Melpar, subsidiary and central research lab of Westinghouse Air Brake. He has been chief engineer for Melpar since 1951 and executive assistant to the executive vice-president and general manager since 1952. After joining Melpar in 1947, he became project engineer in charge of the engineering development of microwave systems and other electronic and sonar devices.

He worked at Columbia University's Airborne Instrument Laboratory. During the post-war period, when the lab became an independent commercial organization, Weid was director of military engineering projects.

Waveline Appoints Chief Engineer

JOHN M. DEL VENTO has been named chief engineer of Waveline of Caldwell, N. J. He is enlarging the staff of the engineering department and plans to accelerate the firm's research and development programs.

Prior to joining the company he served in various capacities in the field of microwave research and development with organizations such as Federal Telecommunication

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John M. Del Vento

Labs and National Union Radio. He specialized in uhf and microwave at the University of Illinois and Brooklyn Polytechnic. During World War II he served with the Air Force in navigation and radar instruction.

New York Central Names Electronics Engineer

THREE appointments in the communications department of the New York Central were announced. Richard P. Corporon joins the Central as electronics engineer succeeding A. Auerbach, who has resigned. Roy A. Calendine, chief telephone and telegraph inspector at Detroit, became general plant supervisor at New York and William B. Anderson, commercial traffic supervisor at Detroit, was named communications traffic supervisor at New York.

Prior to his present appointment, Corporon was associated with Western Electric and was communication engineer of the Indiana and Michigan Electric Co. He was an engineer in the transmitter design section of RCA and was design and test engineer in guided missiles for Bendix Aviation. In his latest position he was manager of development engineering for Penn Controls of Goshen, Indiana.

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DEAN ELECTRONICS CO. has moved from Brooklyn to the Bronx, N. Y. The new quarters will permit the firm to produce radio and high-fidelity units in addition to their line of phonographs.

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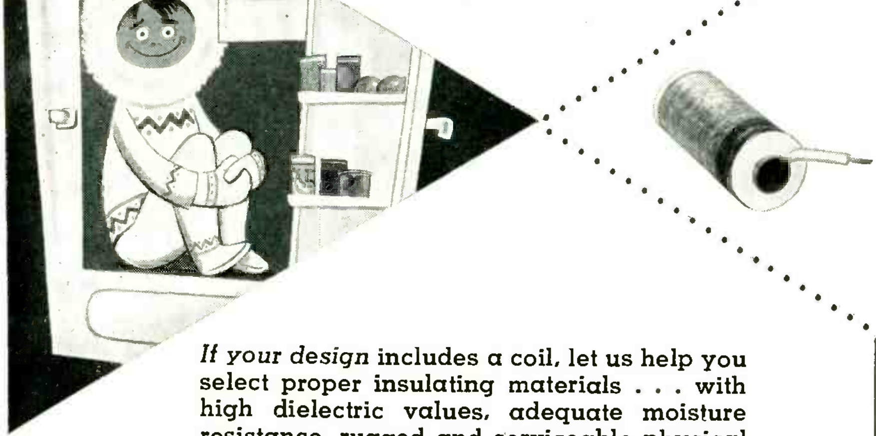

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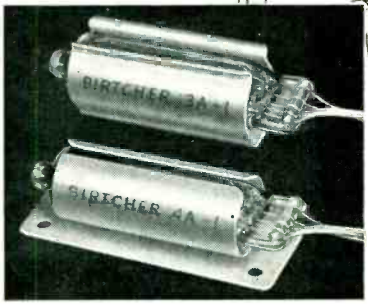

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NEW BOOKS

High Fidelity Techniques

BY JOHN H. NEWITT. *Rinehart Books, Inc., New York,* 512 *pages,* $7.50.

MR. NEWITT, it seems to this reviewer, has written a book full of excellent material which, however, does not take into account the real needs of his intended audience. Any writer on high fidelity has of course a serious problem in aiming his material effectively at some sizeable segment of the potential readership, spread as that readership is over such a wide spectrum of technical competence, from rank layman to practicing engineer. Mr. Newitt says in his introduction that he is writing for:

(1) the practicing engineer who doesn't know audio but wants to improve his home system;

(2) prospective constructors of home sound systems who need guidance on choice of equipment;

(3) the radio serviceman who wants to do custom sound work;

(4) recording studios and public address operators concerned with installing high-quality equipment;

(5) professional audio technicians, engineers, and home receiver designers "who desire a concise working reference to the noteworthy developments in the art."

In this reviewer's opinion readers in the five categories listed by Mr. Newitt, and particularly the last, will not find the book detailed enough in the engineering sense, nor indeed, sufficiently up to date, to serve as a guide to the most advanced practice in audio. This is all the more a pity because the author clearly has an unusually broad understanding of the subject and highly valuable practical experience.

The faults of the book can be generalized, with some unfair simplification, as (1) a lack of enough quantitative data to raise the various discussions above the level of description; much of it is a qualitative "more of this—less of that" which is of no help to the contructor; and (2) a failure to take his audience seriously enough. The first is partly a result of the second, of course. Apparently Mr. Newitt has missed the extent to which the classes of readers he is addressing have been exposed, in this year 1954, to the basics of audio.

There is a lot on the plus side. Mr. Newitt is very good on speakers, baffles and horns. He has notably wise things to say about constructing amplifiers at home, about price-versus-quality choices, about the ancient triode and tetrode battle, about listener tests and on many other points.

For this reviewer the best section of the book is Chapter 12, on the general planning of custom sound installations. Anybody in this business, or going into it, ought to read this chapter, which is full of good sense obviously based on experience.

With some deletions, the book could serve as an excellent "Basic Audio", intended for readers less demanding technically than those he has tried to reach. The coverage of the book is complete, as far as general topics is concerned, including the psychological factors in listening to reproduced sound, the basics of hearing and acoustics, the various components of the reproducing chain, a whole chapter on distortion, special high fidelity circuits, tuners, record players, magnetic recording and the above-praised chapter on custom installation work.—R. S. LANIER.

Television Broadcasting

BY HOWARD CHINN. *McGraw-Hill Book Company, Inc., first edition*, 700 *pages*, 1953, $10.00.

THIS book by one of the industry's experts is a contribution which seems likely to be an enduring reference. Any engineer engaged in either technical television operation or the engineering design of television broadcasting facilities will find it a valuable tool, both for study and for reference. The subject is not approached from the theoretical or mathematical viewpoint. The book is simply and clearly written, but at the same time it presupposes a good working knowledge of the fundamentals of communication engineering. It is not for the beginner; and the person who is seeking merely conversational knowledge in this field will probably be better served by other less comprehensive texts. This book is for the professional, and the professional will appreciate the thorough, authoritative, matter-of-fact style. The illustrations are well done, the type is easy to read, and the entire book is remarkably free from errors.

In the preface the author explains the organization of chapters with regard to the order in which the various topics are taken up. The stereotyped convention of starting in a studio, with camera and microphone considered first, and continuing with subsequent chapters on various portions of the system as traversed by the signal in conventional order, has been modified without losing continuity. The first chapter deals with the fundamentals of a television system, and as the successive chapters are studied in turn, the progression is one which provides a good unity to the entire book. On the other hand, any one chapter is complete if read separately.

The book contains a wealth of practical information based upon the actual operating and engineering experience of a large television network, much of which has not been published heretofore. The sections on lighting, communication facilities, switching systems and facilities and practices related to the audio portion of television broadcasting are especially noteworthy. The information on surveying and operating remote pickups should be invaluable to television broadcasters just entering this field. A great deal of practical, detailed information on the design and installation of television broadcast facilities is included. Anyone who has wrestled with video crosstalk in a multiple studio plant will appreciate the section dealing with the problem of ground connections in unbalanced video transmission systems.

The thoroughness with which the entire subject has been treated constitutes something of a challenge to the reviewer to find any omission worthy of note. It might be pointed out, however, that no treatment is included on the long-light- application-cycle type of intermittent pro-

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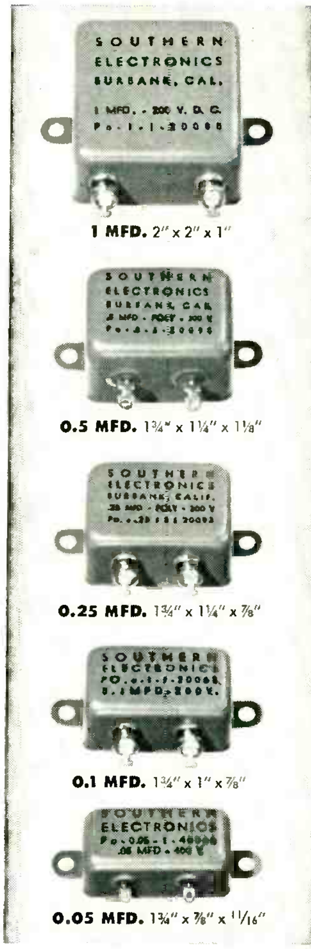

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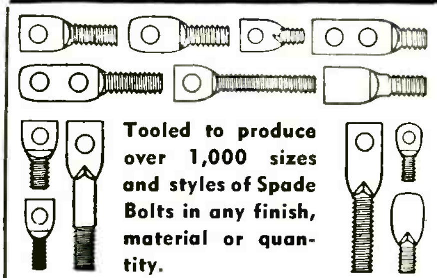

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jector for television film transmission, and the use of background projection or process shots has not been included—the latter perhaps because it is considered to be in a special effects category.

There is a final chapter on color television broadcasting equipment, and considering the fluid state of the color television art at the time the book was written, perhaps it might better have been omitted. In any event, a treatment of color television broadcasting as thorough as that given to monochrome would certainly call for a separate volume. These shortcomings are minor indeed, however, in the light of the over-all excellence of this significant contribution by Mr. Chinn to the literature of our profession.—ROBERT E. SHELBY, *National Broadcasting Co.*

Data and Circuits of Television Receiver Valves

BY J. JAGER. *Philips Technical Library. Elsevier Press, New York and Houston*, 1953, 228 *pages*, $4.50.

THE MAJOR part of this book is a catalog of receiving tubes and picture tubes suitable for television receivers. The tubes described are of Dutch manufacture and carry the Philips designations. While many of the tube types are very similar to American types there is no way of establishing such correspondence in the book, the only alternative being a point-by-point comparison of the socket connections, dimensions and electrical characteristics with those of tubes described in other catalogs. On this account the book is not likely to be of interest or use to American engineers, although it should be very useful to the large and growing corps of television engineers in Europe who operate within the Philips orbit.

The latter part of the book consists of about 70 pages of elementary circuit description, such as intercarrier sound and stabilized synchronization. Here also the circuit designs are tied to specific tube types carrying the Philips designations. Also described are typical tuner units, scanning yokes, output transformers and focusers carrying Philips catalog numbers. This book forms a part of the Philips Technical Library, and is put up in the impeccable style of that series. Its content, however, is closer to the commercial catalogs and application notes issued by American tube companies.—DONALD G. FINK, *Philco Corp., Philadelphia, Pa.*

THUMBNAIL REVIEWS

Data for X-ray Analysis, Volume 1, Charts for Solution of Bragg's Equation; Volume 2, Tables for Computing the Lattice Constant of Cubic Crystals, by W. Parrish, B. W. Irwin, and M. G. Ekstein, Philips, Eindhoven. Distributed in U. S. by North American Philips Co. Inc, Mt. Vernon, N. Y. Charts and graphs aimed at simplifying X-ray crystallographic analysis.

Research Operations in Industry. Edited by David B. Hertz and Albert H. Rubenstein. Columbia University, 1953, 453 pages, $8.50. Papers delivered at the third annual Conference on Industrial Research, June 1952, plus selected papers from the first and second conferences.

Television Tube Location Guide. Howard W. Sams & Co., Inc., Indianapolis, Ind., 1953, Vol. 4, $2.00. Gives 173 diagrams showing locations of tubes and fuses in late model television receivers, along with tube failure check chart for each receiver.

Receiving Tube Substitution Guidebook, Supplement No. 2. By H. A. Middleton. John F. Rider Inc., 480 Canal St., New York 13, N. Y. 48 pages, 8½ x 11, 1954, $.99. Contains 134 tv picture tube and 190 receiving tube substitutions.

Leaders in American Science. Edited by Robert C. Cook. Box 150, 110 Seventh Ave., Nashville, Tenn., 852 pages, 6 x 9, 1954, $12.00. Contains biographies of over 13,500 men of science, 1,600 photos, plus a 36-page list of distinguished scientists by field. Nicely produced and useful.

Transistor Research Bulletin, Vol. 1, December 1953. National Scientific Laboratories, 2010 Mass. Ave., N. W., Washington 6, D. C. To be published every alternate month on a subscription basis. No price given. Initial issue contains articles on new semiconductors, dynamic operation transistor test set, small-area junction diodes, German transistor and diode developments and a three-page bibliography of pertinent material.

Industrial Electronics. By R. Kretzmann. Philips; Eindhoven; distributed by Elsevier Press Inc., 155 East 82 St., New York 28, N. Y., 250 pages, 1953, $5.50. General principles of electronics as applied to modern industry.

TV Troubleshooting. By Robert G. Middleton. John F. Rider, Inc., 480 Canal St., New York 13, N .Y., 156 pages, 8½ x 11, 1954 $.99. Contains pages 8½ x 11, 1954, $3.30. Vol. 2, containing material not found in Vol. 1.

BACKTALK

Acknowledgment

DEAR SIRS:

THE SERIES of articles, "Transistors: Theory and Application," that appeared in consecutive issues of ELECTRONICS, from March 1953 to January 1954, was made possible by wholehearted cooperation of a number of our fellow workers.

We wish to acknowledge most gratefully the assistance of the many personnel of the Evans Signal Laboratory, as well as of the Signal Corps Engineering Laboratories in general, during the many phases of the preparation of this series. Particular acknowledgment is due to Mrs. H. L. Owens and Miss D. Coblenz for the typing; to members of the Solid State Devices Section, Thermionics Branch, for consultation; and to Dr. H. Zahl and Lt. Col. W. M. Van Harlingen of SCEL HQ for guidance and encouragement. Thanks are especially due to the clearance personnel, both at SCEL and Washington, D.C., for their expeditious handling of security details.

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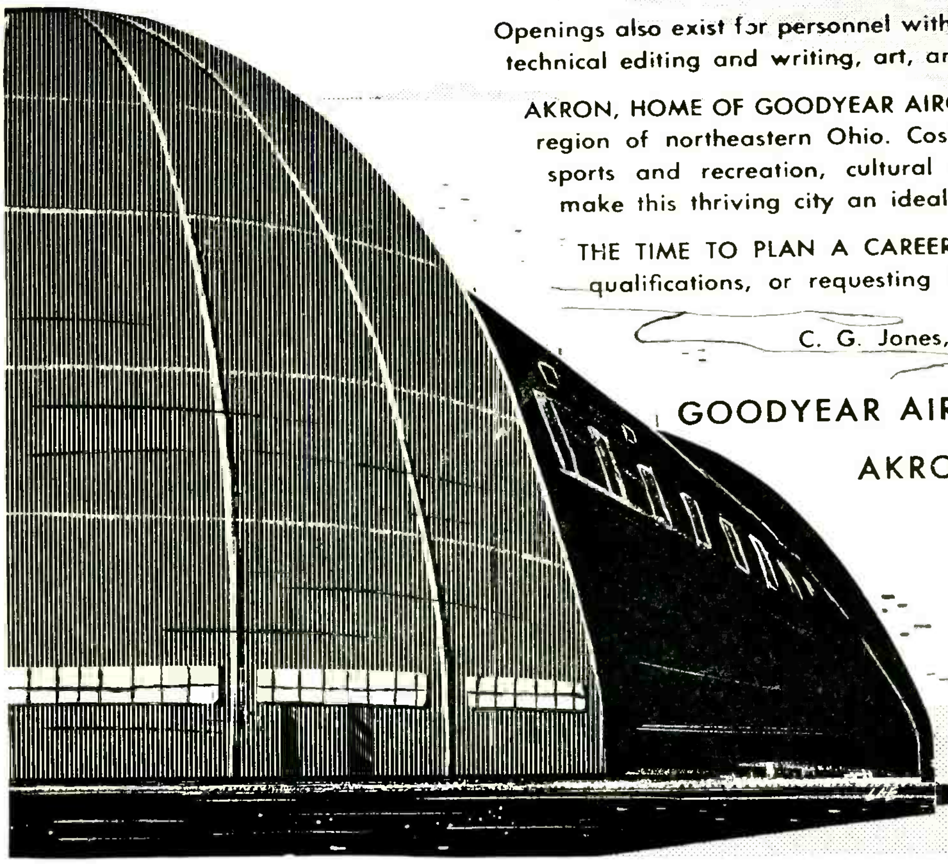

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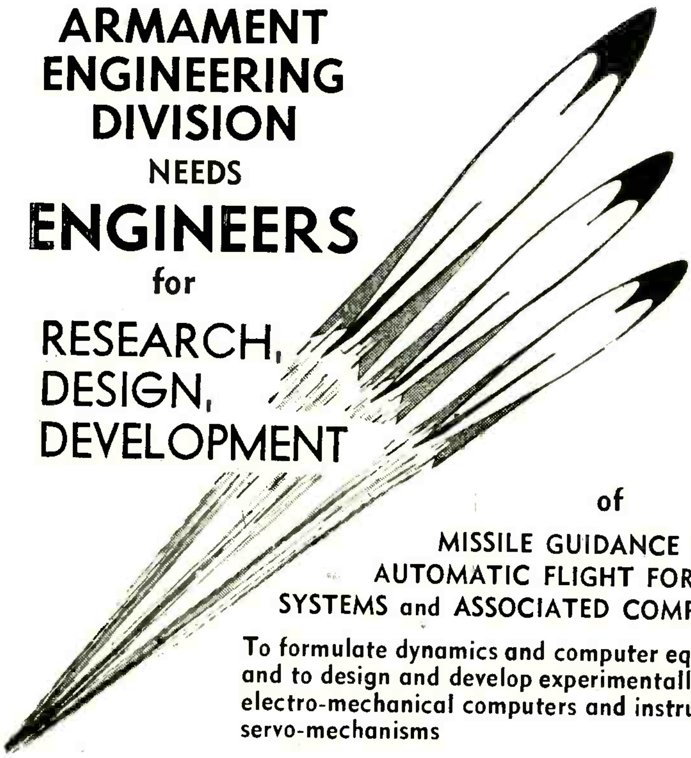


ARMAMENT ENGINEERING DIVISION NEEDS ENGINEERS for RESEARCH, DESIGN, DEVELOPMENT

of

MISSILE GUIDANCE SYSTEMS
AUTOMATIC FLIGHT FORMATION
SYSTEMS and ASSOCIATED COMPONENTS

To formulate dynamics and computer equations, and to design and develop experimentally electro-mechanical computers and instrument servo-mechanisms

SEND RESUME TO EMPLOYMENT MANAGER
1201 CASS AVE. ST. LOUIS 6, MO.

URGENT

Will Buy BC348R Reciver @ $75.00
BC348H—K and L Receivers $70.00
Ship via EXPRESS C.O.D., subject to inspection to

H. FINNEGAN
49 Washington Ave., Little Ferry, N. J.

WANTED – BC-221

Heterodyne Frequency Meters

Any quantity, any model—we will purchase for cash, provided only that each unit is complete with original Calibration Book, tubes, crystal and cabinet.

Large numbers needed.
Write, wire or telephone

Weston Laboratories, Inc.
HARVARD MASSACHUSETTS

WILL BUY

All ART13/type T47A $200.00; ART13 type T47 $150.00; BC348 unmodified $65.00; BC348 modified $50.00; APN9 $200.00; ARC3 complete $350.00; R77 Receiver $200.00; ARC1 Radio $200.00; BC312 $60.00; BC342 $60.00; ship via Express C.O.D., subject to inspection to

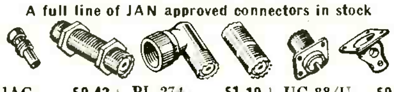
H. FINNEGAN
49 Washington Ave. Little Ferry, N. J.

IF there is anything you want
that other readers can supply—
OR . . . something you don't want—
that other readers can use—
Advertise it in the SEARCHLIGHT SECTION

Reliance Specials

COAXIAL CONNECTORS

A full line of JAN approved connectors in stock

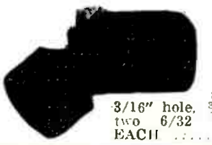


18-1AC	$0.42	PL-274	$1.10	UG-88/U	$0.90
83-1AP	.30	PL-275	2.10	UG-89/U	1.10
83-1BC	.35	SO-239	.40	UG-102/U	.80
83-1F	1.10	UG-13/U	1.70	UG-103/U	.68
83-1H	.12	UG-18B/U	1.05	UG-104/U	1.40
83-1HP	.22	UG-20B/U	1.60	UG-105/U	1.50
83-1J	.73	UG-21/U	.85	UG-106/U	.15
83-1R	.40	UG-21B/U	1.00	UG-107B/U	2.75
83-1RTY	.65	UG-21C/U	1.05	UG-146/U	2.00
83-1SP	.45	UG-21D/U	1.45	UG-167/U	3.75
83-1SPN	.50	UG-22/U	1.30	UG-175/U	.12
83-1T	1.30	UG-22A/U	1.60	UG-176/U	.12
83-2AP	1.95	UG-22B/U	1.20	UG-185/U	.95
83-2J	2.10	UG-23/U	1.20	UG-196/U	1.05
83-2R	1.65	UG-23B/U	1.50	UG-203/U	.65
83-22AP	1.40	UG-23C/U	1.10	UG-224/U	1.15
83-22F	2.10	UG-24/U	1.30	UG-255/U	1.95
83-22J	1.40	UG-27/U	1.25	UG-260/U	.85
83-22R	.68	UG-27A/U	2.25	UG-261/U	1.10
83-22SP	.80	UG-27B/U	2.95	UG-262/U	1.10
83-22T	1.95	UG-28A/U	2.95	UG-273/U	1.45
83-168	.12	UG-29B/U	1.75	UG-274/U	2.30
83-185	.12	UG-30/U	2.30	UG-290/U	.90
CW-123A/U	.45	UG-57B/U	1.85	UG-291/U	.95
M-358	1.30	UG-58/U	.70	UG-306/U	2.65
M-359	.30	UG-58A/U	.90	UG-414/U	1.95
M-359A	.65	UG-59A/U	1.90	UG-499/U	1.25
PL-258	.75	UG-88/U	1.75	UG-625/U	1.35
PL-259	.45	UG-85/U	1.65		
PL-259A	.50	UG-87/U	1.40		

NEW COAXIAL CABLES Jan approved

	Price per 1000 ft.		Price per 1000 ft.
RG5/U*	$140.00	RG22/U*	$150.00
RG6/U	180.00	RG22A/U	285.00
RG7/U*	85.00	RG24/U	675.00
RG8/U*	100.00	RG26/U	475.00
RG9/U*	250.00	RG-29/U*	50.00
RG9A/U	330.00	RG34/U*	300.00
RG10/U	240.00	RG35/U	900.00
RG11/U*	100.00	RG41/U*	295.00
RG11A/U*	150.00	RG54A/U	97.00
RG12/U	240.00	RG55/U*	110.00
RG13/U*	216.00	RG57/U*	325.00
RG17/U	650.00	RG58/U*	60.00
RG18/U	900.00	RG58A/U*	70.00
RG19/U	1250.00	RG59/U*	60.00
RG20/U	1450.00	RG62/U*	75.00
RG21/U*	220.00	RG77/U*	100.00

Add 25% for orders less than 500 feet.
*No minimum order—other 250 minimum.



UNIVERSAL JOINTS ALUMINUM

¼" hole, ½" O.D. 1-⅛" long with two 6/32 tapped set-screw holes EACH 85¢

3/16" hole, ⅜" O.D. 1-⅛" long with two 6/32 tapped set-screw holes EACH ....80¢

FIXED COMPOSITION RESISTORS

Type EB ½W 10%	5¢ ea.	$4.00 per C
EB ½W 5%	10¢ ea.	8.00 per C
Type GB 1W 10%	8¢ ea.	6.00 per C
GB 1W 5%	16¢ ea.	12.00 per C
Type HB 2W 10%	11¢ ea.	9.00 per C
HB-2W 5%	22¢ ea.	18.00 per C

AVAILABLE IN ALL STANDARD RMA VALUES

POSTAGE STAMP MICAS

Available in All Standard RMA Values

PLAIN		SILVER	
5 mmf to 910 mmf	5¢	5 mmf to 910 mmf	10¢
.001 to .0013 mfd	8¢	.001 to .002 mfd	20¢
.0015 to .0056 mfd	15¢	.0022 to .0091 mfd	50¢
.0062 to .0091 mfd	20¢	.01 mfd	95¢
.01 mfd	28¢		

AIRCRAFT GENERATORS

OUTPUT—115 VAC 10.4 AMPS 800-1400 CY 1 PH. PLUS 30 VDC 60 AMPS....$29.50
OUTPUT 30 VDC 15 AMPS 2500-4500 RPM 9" L x 5" DIA SPLINE SHAFT ¾ x 1-½" WT 16 lbs....$15.50
OUTPUT 28 VDC 140 AMPS 2500-4500 RPM....$38.50

STORAGE BATTERIES

BB-54 Willard 2 volt 20 amp. hrs. built in charge indicator 4 x 3 x 5½ high—BRAND NEW **$1.95 ea.** 100 lots ......**$1.75 ea.** 1000 lots......**$1.50 ea.**
BB-212/U 2 volt 40 amp. hrs. 6⅞ x 2⅜ x 4½ high BRAND NEW ....**$2.35 ea.**
NT-6 6 VOLT 3.5 AMP Hrs. 3 x 1-¾ x 2-¾" **$1.95 ea.**

ALL BATTERIES SHIPPED DRY

PULSE TRANSFORMERS

UTAH 9262 3 windings-peak 200 VDC Current 10 MA. Turns Ratio 1-1-1 Impedance Variable 0-5000 ohm **$12.50 ea.**

MANY OTHER PULSE TRANSFORMERS IN STOCK DATA UPON REQUEST

W.E. D-150734 PHASE SHIFT CAPACITOR

.75 to 2.75 mmfd 4 stators—single rotor—continuously variable phase shift 0-360 deg....$22.50 ea.

TERMS — Cash with Order or 25% Deposit — Balance C.O.D. Net 10 Days to Rated Accounts. All Prices are Net F.O.B. Our Warehouse.

PRECISION RESISTORS

at Bargain Prices—Wire Wound Spool Type

½ watt 1% tolerance WW3 or equal Only 35¢ ea.

.250	5	14.98	125.	723.1	7000	32.7K
.334	7.4	16.37	130	750	7500	32.89K
.502	9.1	25	147.5	855	8000	33.3K
.557	10.48	30	180	1000	8500	35K
.627	10.84	46	210	2193	8800	35.89K
.760	11.1	52	220.4	2200	10K	36K
1	11.25	55.1	235	2250	12K–2%	37K
1.01	11.74	62.54	260	2500	14.82K	40K
1.53	12.32	75	270	2850	15K	46K
2.	13	79.81	298.3	3427	15.75K	47K
2.04	13.02	87	301.8	4000	16.7K	50K
2.5	13.15	90	366.6	4451	17K	59K
3.	13.3	97.8	400.	5000	20K	59.15K
3.5	13.52	105.8	414.3	5900	25K	79.01K
4	13.89	123.8	705	6500	30K	125K

1 watt 1% tolerance WW4 or Equal 45¢ ea.

.861	5.21	75	800	2200	8000	35K
1.01	12	82	1100	3300	9000	40K
2.55	20	120	1250	4800	10K—2%	
2.58	28	150	1750	6000	12K—2%	55K
3.39	38	250	2000	6800	20K	80K
5.1	50	270		7000	25K	
		425				

1 watt 1% tolerance WW4 or Equal 60¢ ea.

100K	128K	150K	240K	320K	500K	600K
120K	130K		250K			

1 watt WW5 or Equal 65¢ ea.

84K–2%   522K–1%   645K–1%   700K-1%   1 meg-5%

1 MEG 1 WATT 1% WW5 $1.50

SOUND POWERED HANDSET

Brand New

TS-10 Type—includes 5 ft. cord. USES NO BATTERIES OR EXTERNAL POWER SOURCE ....$9.48 ea.

SOUND POWERED HEAT & CHEST SET

Navy Type M Head and Chest Set. For Work Requiring Free Use of Hands. Heavy Duty—Consists of Headset with 2 Phones and Chest Mike. Includes 20 Ft. Rubber Cord. BRAND NEW.......**EACH $14.88**
Same as above except used exc. condition. **Each $5.95**

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
5.2	50	$0.89	0.5	2,000	$1.65
6	400	.85	8	2,000	7.95
3 x 3	400	1.00	12	2,000	8.95
1	600	.55	0.25	3,000	2.52
0.5-0.5	600	.40	0.5	3,000	2.40
2	600	.69	2	3,000	4.50
4	600	1.65	2	4,000	7.95
8	600	1.85	0.01	5,000	.95
10	600	3.25	1	5,000	4.88
4 x 3	600	2.50	0.03-0.03	6,000	1.50
4	1,000	1.59	1	6,000	9.95
1	1,000	.69	0.02-0.02	7,000	1.55
2	1,000	.95	0.1	7,000	1.79
3	1,000	1.70	0.1-0.1	7,000	5.95
1	1,500	1.45	0.1	7,500	2.25
0.02	2,000	.65	0.075-0.075	8,000	6.50
0.1-0.1	2,000	1.30	0.15-0.15	8,000	6.95
0.1-0.5	2,000	.95	0.25	20,000	19.95

OIL FILLED AC CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
7.5	220	$1.95	15	440	$5.25
20	220	3.95	1	660	2.95
1	236	.49	2	660	3.50
4	236	1.60	3	660	3.60
8	236	1.95	4	660	3.75
3	330	1.45	5	660	3.85
4	330	2.25	6	660	4.25
20	330	6.75	8	660	4.50
25	330	7.50	0.2	750	.69
4.4	375	2.15			

High Current Filament Transformer

Amertran type W Pri. 105-125 V. 60 cy. 1 Phase—Sec. 5V. 190 amps.—.97 KVA 35 KV. RMS Insul. Test 7x10x 12; Ft. 80 lbs. Ideal For Use As Arc Welder. **SPECIAL $29.50 ea.**

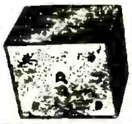
Kenyon S-14940 S.C. #2Z9943-1073 Pri. 105-125 V. 60 Cy. Sec. 5V. 115 Amps....$19.50 ea.

RAYTHEON PLATE TRANSFORMER

TYPE U8355A

PRI. 110V/220V/440V/60 cy.
SEC #1 300V @ 4 AMPS. SEC. #2 300V @ 4 AMPS. 1780 RMS TEST, 9¾"x9½"x8½" HIGH. **$19.95**

Choke 10 hy 400 MA 90 OHMS HERMETICALLY SEALED 5¼ x 4½ x 4H.



$4.88

MERKLE-KORFF GEAR REDUCTION UNITS

Type SG15-3B Flexo-Action. High torque. Precision gears. #RM-10 ratio 103-1 input shaft 3/16 output 3/16 **$3.95 ea.**
#RM-11 ratio 296-1 input shaft 3/16 output 1/4 **$3.95 ea.**

10 MA DC METER 3" rd DeJur #310....$3.95
1 MA DC METER 3" rd DeJur #310....$5.75
1 MA DC METER Fan type 4" scale....$3.95
5 AMP AC METER 4" rd JBT #432....$4.11
500 MA DC METER 2½" rd G.E....$2.95
30 VDC METER 2½" rd G.E....$3.95
500 MICROAMP DC METER 2½" rd SUN....$4.30
AT-4/ARN-1 ALTIMETER ANTENNA NEW....$9.75
RT-7/APN-1 ALTIMETER EXC. USED....$25.00
WE D 171584 MERCURY RELAY....$8.75
AT-48/UP 3 CM HORN ANTENNA....$9.95
INVERTER 6VDC to 110VAC 60 CY 75W....$22.95
IN34 CRYSTAL....66¢
1 RPM TIMING MOTOR HAYDON 115 VAC....$1.95
8 RPM TIMING MOTOR INGRAHAM 115 VAC....$1.79
.05 **MFD** 600 VDC bathtub cond. side term....30¢
.06 **MFD** 1000 VDC bathtub cond. side term....35¢
.1 **MFD** 600 VDC bathtub cond. bottom term....39¢
2 x .1 **MFD** 600 VDC bathtub cond. side term....39¢
3 x .1 **MFD** 600 VDC bathtub cond. side term....49¢
.25 **MFD** 400 VDC bathtub cond. side term....35¢
.5 **MFD** 600 VDC bathtub cond. side term....49¢
1 **MFD** 600 VDC bathtub cond. side term....59¢
2 **MFD** 600 VDC bathtub cond. side term....$1.25

RG 8/U COAX CABLE New Gov't Surplus 100 Ft—$5.95

BC-221 FREQ. METER uncalibrated....$80.00
VERNIER DRUM for BC-221 0-50 180°....95¢
VERNIER DIAL for BC-221 0-100 360°....$1.50
BLANK CALIBRATION BOOK for BC-221....$4.95
BC-221 MAIN TUNING COND. specify model....$19.95
BC-221 CASE used good condition....$4.95
PRECISION POT. 12 ohm 3 watt G.R. #301....$1.75
PRECISION POT 12 ohm 4 watt DeJur #292....$1.75
PRECISION POT 20 ohm 4 watt DeJur #292....$1.75
PRECISION POT 50 ohm 4 watt DeJur #292....$1.75
PRECISION POT 500 ohm 4 watt Centralab #48-501 $1.75
PRECISION POT 2000 ohm 6 watt DeJur #260....$2.50
PRECISION POT 6000 ohm 6 watt DeJur #260....$2.50
PRECISION POT 5000 ohm 8 watt Muter #314A...$2.50
PRECISION POT 6000 ohm 8 watt Muter #314A...$2.50
PRECISION POT 5000 ohm 12 watt DeJur #271-T..$3.50
SET SCREWS Allen 4-40 x ⅛"....$1.75/C
SET SCREWS Allen 4-40 x 3/16"....$1.75/C
SET SCREWS slotted 8-32 x 3/16"....$1.35/C
SET SCREWS square head 8-32 x 5/16"....$1.35/C
LINESMAN'S PLIERS 8" with side cutters....$1.69
DUCK BILL PLIERS 5½"....$1.59

CK-5517/1013 cold cathode tube....$2.25

32 **MFD** 2500 VDC photoflash cond....$15.80
30 **MFD** 2500 VDC photoflash cond....$14.75
2X2 TUBES RCA....2 for $1.00
6SN7 TUBES Syl. or KenRad....3 for $2.20
5 BPI Cathode ray tube....$5.50
200 ½W **RESISTORS** Ass't. all insulated....$2.50
5 lbs. **HARDWARE** Ass't. nuts, bolts etc....$2.00
GEAR ASS'T. 100 gears, bushings etc....$6.50
RHEOSTAT 25 W 145 ohm 7/16" shaft....85¢
RHEOSTAT 25 W 370 ohm 7/16" shaft....85¢
RHEOSTAT 25W 400 ohm 7/16" shaft....85¢
RHEOSTAT 50W 8 ohm S.D. shaft....$1.09
RHEOSTAT 50W 12 ohm 7/16" shaft....$1.15
RHEOSTAT 50W 90 ohm 1" shaft....$1.15
RHEOSTAT 50W 123 ohm 7/16" shaft....$1.15
RHEOSTAT 50W 200 ohm 7/16" shaft....$1.15
RHEOSTAT 50W 300 ohm 7/16" shaft....$1.15
RHEOSTAT 50W 2000 ohm 7/16" shaft....$1.59
SELENIUM RECTIFIER 200 MA 115V full wave...$1.79
SELENIUM RECTIFIER 100 MA 115V half wave...91¢
DM33A dynamotor new....$5.95
THROAT MIKE MT81-A new with PL-68....$1.99
GLYPTAL CEMENT G.E. #1286....Qt. can $1.15
FERRIS SIG. GEN. #47A 40 mc xtal controlled..$69.95
W-110B Field Wire twisted pair ½ mile coil....$7.95
W-110B Field Wire twisted pair 1 mile reel....$14.95

SELSYN MOTORS

50 V. 50 Cy. High Torque. Connect in Series. For Use On 110 V. 60 Cy. Approx 3-⅜" dia. x 5-⅜" L. Like New .... **ONLY $12.95 PAIR**
Army Ordnance Type C-78248 115V, 60 Cy. Transmitter. Approx. 3-⅜" dia. x 5-⅜" L. Like new..**EACH $27.50**

DIFFERENTIAL Used $4.95

115 V., 60 Cycle #C78249 **New $9.95**

3⅜" dia. x 5⅜" long
Used between two C78248's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)....$5.50
Mounting Brackets—Bakelite for selsyns, and differentials shown above....35¢ pair

ALUMINUM CHASSIS etched finish

Size, Inches	Price	Size, Inches	Price
4 x 17 x 3	$1.83	10 x 12 x 3	$1.83
5 x 10 x 3	1.20	10 x 14 x 3	2.40
7 x 7 x 2	99¢	10 x 17 x 2	2.28
7 x 9 x 2	1.08	10 x 17 x 3	2.56
7 x 11 x 2	1.20	11 x 17 x 2	2.37
7 x 13 x 2	1.26	11 x 17 x 3	3.00
7 x 15 x 3	2.04	12 x 17 x 3	3.18
7 x 17 x 3	2.10	13 x 17 x 2	2.82
8 x 17 x 2	1.89	13 x 17 x 3	3.36
8 x 17 x 3	2.27	13 x 17 x 4	3.80

ALUMINUM MINIBOXES etched finish

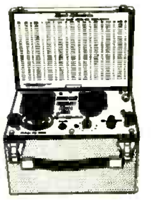
L	W	H	Price	L	W	H	Price
2 3/4	2 1/8	1 5/8	57¢	6	5	4	$1.11
3 1/4	2 1/8	1 5/8	57¢	7	5	3	1.25
4	2	2 3/4	76¢	8	6	3 1/2	1.81
4	2 1/8	1 5/8	60¢	10	2	1 5/8	90¢
4	2 1/4	2 1/4	79¢	10	6	3 1/2	2.25
4 1/4	2 1/4	1 1/4	79¢	12	2 1/2	2 1/4	1.22
5	2 1/4	2 1/4	81¢	12	7	4	2.65
5	4	3	90¢	17	5	4	3.11
5 1/4	3	2 1/8	85¢				

A COMPLETE LINE OF CAD. STEEL CHASSIS IN STOCK. SEND US YOUR INQUIRIES WRITE FOR BARGAIN BULLETIN

RELIANCE MERCHANDIZING CO.

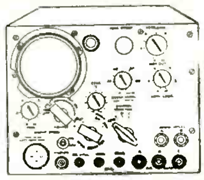
Arch St., Cor. Croskey Phila. 3, Pa. *Telephone Rittenhouse 6-4927*

FREQUENCY METER 375 to 725 MCS



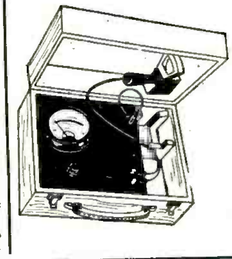
Model TS-127/U is a compact, self-contained, battery powered, precision (± 1 Mc) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-5 Min. time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, 1S6 and 3S4 Tubes. Complete new with inst. book, probe and spare kit of tubes. Less batteries............ **$47.50**

PANADAPTER and SCOPE AN/APA-10



A combined Panoramic Adapter and Oscilloscope. Has 3 coax input connectors for feeding in from receivers having I.F. of 455kc., 5.2 mc or 30mc. Designed also to be used as regular oscilloscope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc. Complete with 21 tubes including 3" CR scope tube.
For operation on 115V. 400 Cy. Price...........$99.50
For operation on 115V. 60 Cy. Price...........$145.00
80 page inst. manual of AN/APA-10 available separately for those who wish to study circuits etc. before purchasing $2.75

FLUXMETER



Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at........... **$24.50**

MOTOR GENERATORS

2 KVA O'Keefe and Merritt. 115DC to 120AC, 50 cy., 1 Ph., Export Crated. New $149.50
MOTOR GENERATOR, TYPE CGU-2 Unit of U. S. Navy TCK-7 Transmitter Motor; 2 H.P. 230V. D.C., 10 amps. Generator; 1800V. D.C., 0.4 A, 500V. D.C., 0.35A, 115V. D.C., 1.5A, 12 V. D.C., 2A. 3480 R.P.M. Self excited. Brand new including spare armature. $169.50
ALLIS-CHALMERS 230DC to 115AC. 60 cy., 1 Ph., 1.25 KVA........$225.00

INVERTERS

Onan M-G-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 1.2Kw and 26V DC at 4 amps. New.................$295.00
Onan M-G.-0-75. Navy type PU/11 Input: 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 5.3 amps. and 26 VDC @ 3.8 Amps. New.........$225.00
Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output, 80V, 800 cy, 1 Ph., 485V. New $22.50
G.E. J8169172. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. New $32.50
G.E. 5AS1315511A. Model 218J. Input: 28DC. Output: 115. 400 cy., 1 Ph., 1.5 KVA. Regulated. New.......$89.50
Elcor. 74DC to 110AC, 60 cy., 1 Ph. at 2.4 Amps. New....................$39.50

DYNAMOTORS

Navy type CAJO-211444. Input: 105 to 130VDC. Output: either 26VDC at 20 amps. or 13VDC at 40 amps. Radio filtered and complete with line switch. New $89.50
Type PE94CM. For SCR-522. Brand new in overseas cases. Has wide band input and output filters..........$19.50

AMPLIDYNES

5AM21JJ7. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5 4600 RPM. New $22.50
5AM31NJ9A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 7500 RPM. New $23.50
5AM31NJ18A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 8300 RPM. New $12.50

SMALL D.C. MOTORS

G.E. 5BA50LJ2A. Armature 27VDC at 8.3 Amps. Field 60VDC at 2.3A RPM 4000. H.P. 0.5. New............$27.50
Oster E-7-5. 27.5DC. 1/20HP. 3600RPM Shunt Wound. New...............$9.50
Dumore Co. type ELBG. 24VDC. 40-1 gear ratio. For type B-4 Intervalometer. New $6.75

400 CY. BLOWERS

Westinghouse Type FL. 115V. 400 cy., 6,700 RPM. Airflow 17C.F.M. New. $3.95

SYNCHROS

Ford Inst. Co. Synchro Differential Generator. Mod. 3 Type 5SDG. 90/90V. 400 cy., Ord. Dr. 173020. New...$12.50
Armor. Synchro Differential Generator. Type 6DG. New $29.50
Hobart Mfg. Co. Synchro Differential Generator Type XIX 115V. 60 cy. New. $4.95. 5F, 5G, 5CT also in stock.

D.C. SELSYN MOTOR

Step by step type for use with potentiometer in D.C. Selsyn Control Systems. **Bendix**—Type CAL 14810 (MK1 Mod 0). 70 Volts DC input..................$8.95

300-1200 MC. XMITTER

AN/APT-5 Brand New in original cases. $139.50

AN-APR-1 RECEIVERS

Less tuning units. Excellent conditon. $195.00

METER SPECIALS

G.E. Type DO-50. 3" Sq. Scale reads 0-3 D.C. Basic Mov. 10 MA. F.S.V.=3. New ....Price $2.45
G.E. Type DO-50, 3" Sq. Scale reads 0-3/0.9 V. D.C. Basic Mov. 10 MA. F.S.V.=3. New ....Price $2.45
G.E. Type DO-50, 3" Sq. Scale reads 0-80 Amps. D.C. and F.S.V.=.050. New ....Price $2.45
G.E. Type DO-50, 3" Sq. Scale reads 0-100 Amps. D.C. and F.S.V.=.050. New ....Price $2.45

SCR-522 EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals.

RADAR SETS

MODEL SQ. Portable radar set, 10CM. Operates on 90-130 volt. 60 cy., 1 Ph. "A", "B", and "PPI" presentation. Complete with tech manual and full set of operating spare parts.
MODEL SG-1. Consists of complete equipment including Radar Transmitter-Receiver CRP-43AAK-3. Range and Train Indicator CRP-55ABC-3, Control Amplifier CRP-50AAT-1, Motor Dynamo-Amplifier (Amplidyne) CG-21AAY and Antenna Assembly CRP-66ABJ-1.
MODEL ASG-1 Radar unit consisting of transmitter and converter assembly CPR-43ABC, Antenna Assembly CRP-ACZ. Mounting Base CPR-10ABE, etc.
Spare Parts available for Model SQ and SG-1 Radar.

RADAR ANTENNAS

Type SO-1 (10CM) assembly with reflector, waveguide nozzle, drive motor, etc.
Type SO-3 (3 CM.) 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.

MISC. RADAR EQUIPMENT

Modulator Units for SO-11(CUZ-50AGD)
Pulse Timer units for SD-5
Transmitter-Receiver units SO-13
Spare Parts for SG-1
Spare Parts for SQ
Marker Oscillator crystals in holders 98.35KC
Bearing Control Units CRP-23AEK
Synchro Amplifiers—Bendix
90° Waveguide Bends 10CM Bronze
Signal Monitors CRP-60AAN
Repeater Amplifiers CBM-50AFO
Oscillator Tube Cavities for SO-1, 13 etc., RF303
10CM Horns. 1½" x 3" waveguide, standard contact, flange input, circularly polarized horn output
Duplex Tees #2Z3005-17
Auxiliary Rectifier CABM-20237 (SO 2 Radar)
SO-1 Antenna R.F. Nozzle Assemblies (RF502)
SO-1 Antenna Reflector Assemblies (RF503)
SO-1 Antenna Reflector Assemblies (RF503)
SO-1 Antenna Waveguide Resonance Chamber Assemblies (RF515)
SO-1 RF Coupling Waveguide to Transmitter (Z304)
SO-1 RF System and duplexing cavity (RF301 with V309)

Radar Repeater Adapters NAVY TYPE CBM-50AFO

A repeater unit for video signals and trigger pulses designed to work in conjunction with standard Navy radar equipments wherein provision is made for operation of remote P.P.I. sets. This adapter provides four video and trigger pulse lines for operating one or more remote P.P.I. control installations. 115 Volts, 60 cycles A.C. Dimensions are 31½ x 21 x 15 in.............New $97.50

G. E. BATTERY CHARGER

Charges 54 Cell Battery at from 1 to 10 ampere rate

Input 115V., 60 cy. 1 Phase.
The model 6RC89F16 Copper Oxide battery charger consists of a transformer, a secondary reactor, a copper oxide rectifying element, a ventilating fan, control circuits and auxiliary equipment necessary for proper operations. Transformer tapped for various supply voltage. Eight secondary taps for adjusting changing rate. Built into metal cabinet. Metered.
Complete with spare fan and fuses. New in original packing cases. Shipping weight approx. 305 lbs.
Price $149.50

REPAIR PARTS FOR BC-348

(Models H, K, L, R)

Also BC 224 Models F. K., Coils for ant., r.f., det., osc., I.F., c.w. osc. xtal filters, 4 gang cond., front panels, dial assemblies, vol. conts. etc. Write for complete list and free diagram.

9 CONDUCTOR CABLE

Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels.......**Price $.15 ft**
Sample 100 ft Coil..............$15.00

G. E. SERVO AMPLIFIERS

Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed in 1st column. New less tubes.......$29.50

PARABOLOIDS

17½" diameter, spun magnesium dishes. 4 inches deep. Reinforced perimeter. Two sets of mounting brackets on rear. Opening at apex for waveguide dipole assembly 1½ x 1⅝".
Brand New ....**Per Pair $12.50**

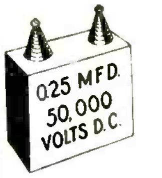
TUBE SPECIALS

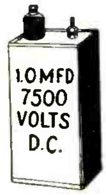
1N21B	$1.95	3BP1	$3.25
1B24	6.95	3CP1	1.85
2J62	23.50	7BP7	2.95
2J531	4.50	861	9.50
3B22	1.95	C6J	4.95

SAWTOOTH POT

Continuous winding 2 rotating and two take off brushes varies voltage to linear sawtooth wave. W.E. No. KS 15138. New $3.95

HIGH VOLT OIL CAPS





MFD.	Volts	Price
.001	50 KV	$22.50
.025	50 KV	34.50
2 x .025	50 KV	34.50
.135	7.5 KV	6.95
.2	50 KV	67.50
.25	15 KV	15.50
.25	20 KV	19.50
.25	50 KV	67.50
1.	15 KV	49.95
2.	5.5 KV	13.75
2.	6 KV	14.50

SPECIAL! 1.0 MFD. 7500 VDC Oil filled capacitor. Cat. No. 26F681. Only......................... **$9.75**

MICA CAPACITORS

High voltage Transmitting types, thousands in stock. Wide selection of sizes, types & ratings. All new and made by top manufacturers. Write for complete listings.

SWEEP GEN CAPACITOR COAXIAL TYPE

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new ....SPECIAL $1.95

SYNCHRO CAPACITORS

.6-.6-.6 mfd Mark 12, Mod. 2, type 1C $1.75
10-10-10 mfd Mark 1, Mod. 2, type 3C $5.65

HIGH POT TRANSFORMER

Westinghouse. Pri: 115, 60 cy. Sec: 15,000V C.T., @ .060A, C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price...$29.50

PULSE TRANSFORMERS

KS-9563 Supplies 3500V peak from 807 tube $3.95
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

60 CYCLE TRANSFORMERS

G. E. Step-Down. 6KVA. Pri: 230/460. Sec: 115/125, 60 cy. Size: 20" x 11" x 9½". Weight 225 lbs. Navy grey finish, integral junction box and mounting brackets $125.00
Plate Trans. Raytheon U-5815. Pri: 440/220, 60 cy. 3 phase. Sec: each phase 1310V @ 0.67A test 6000V......$110.00
Plate Trans. Pri: 115V., 60 cy., 1 Ph. Sec: 1470V. C.T. @ 1.2A tested at 5500V. RMS. Raytheon. Size 12¼ x 10 x 10 in. Shipping wt: 150 lbs. New. Price $27.50

400 CYCLE TRANSFORMERS

Auto. KVA .945S—.520P Volts 460/345/230/115 New. G.E. Cat. 80G184. Weight 22 lbs. $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=1200 V DC @ 1.5MA. Sec: #2=400V DC @ 130MA. Fil Secs: 6.4V4.3A/6.35V. 8A (Ins. 1500V) 5V2A/5V2A. $4.95
Plate. Thordarson T46889 500 cy. Pri: 105/120. Sec: 2800-0-2800. 7KV Inc. 1.5KVA $29.50
Misc. types: G.E. #68G665X, #68G666X, #68G667, #68G668X, #80G200, #80G199 each $2.00

REACTORS

KS9589 Retard. 4HY @ 100MA...$1.00
#2C2270/R2 For Kever 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

30-10,000 CYCLE MODULATION TRANSF.

For RCA, Type 250-K Broadcast Transmitter (MI-7242) P to P Primary Imp. 15,000 ohms. Secondary Load 5,030 ohms. Size 11¼x9½x13". Wt. 143 lbs. New $49.50

ALTITUDE INDICATOR

Type ID-14A/APN-1. Brand New in original cartons. Special..........$2.95

FREQUENCY STANDARD

Complete self contained, dual 100/1000 kc crystal, multivibrator and harmonic amplifier. Calibrates with WWV and provides 1000, 100, and 10 kc check points from 100 to 45,000 kc. 115V. 60 cycles. New with instructions. **$23.95**

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.

PHONE: BRONXVILLE 2-0044

ELECTRONICRAFT INC.

Cable Address: Electraft, N.Y.

27 MILBURN ST. BRONXVILLE 8, N. Y.

COMPLETE LINE OF RECEIVING TUBES | GUARANTEED BRAND NEW

TUBE SPECIALS!!

STANDARD BRANDS ONLY | WRITE FOR OUR NEW BULLETIN

Type No.	Price
OA2	$ .95
OA3	1.15
OA4G	1.25
OB2	1.10
OB3	1.19
OC3	1.10
OD3	.95
EL-C1B	3.95
1B21A	2.65
1B22	2.50
1B23	9.60
1B24 West.	12.95
1B24 Sylv.	18.95
1B24A	39.50
1B26	3.73
1B27	14.95
1B29	2.75
1B32	3.75
1B35	11.00
1B36	12.50
1B37	14.70
1B38	32.50
1B40	4.95
1B41	51.94
1B42	9.80
1B49	50.33
1P21	35.00
1P23	4.10
1P24	1.27
1P28	10.00
1P29	2.89
1P30	2.85
1P34	1.90
1S21	9.50
1Z2	3.75
2A4G	1.22
2AP1	8.95
2AP5	8.95
2B4	2.10
2C21	.65
2C26	.39
2C26A	.49
2C33A	4.95
2C34	.49
2C39	22.00
2C39A	29.00
2C40	12.00
2C42	23.75
2C43	17.75
2C44	1.20
2C46	21.50
2C51	5.75
2C53	11.75
2D21	1.55
2E22	1.85
2E24	4.10
2E26	3.79
2J21	8.75
2J21A	9.50
2J22	8.95
2J26	24.75
2J27	22.95
2J31	27.00
2J32	36.50
2J33	39.50
2J34	27.00
2J37	13.70
2J38	17.50
2J39	36.50
2J40	34.50
2J48	49.50

Type No.	Price
2J49	$65.00
2J50	39.50
2J54	67.50
2J56	148.50
2J61	45.25
2J66	165.00
2K23	37.50
2K25	28.50
2K26	78.50
2K28	29.50
2K29	27.50
2K33	185.00
2K33A	195.00
2K39	135.00
2K45	129.50
2K55	135.00
3AP1	8.95
3AP4	10.25
3B22/ EL-1C	2.60
3B24	5.20
3B24W	7.50
3B25	4.50
3B26	3.75
3B27	4.20
3B28	7.75
3BP1	5.75
3C22	89.50
3C23	9.65
3C24	1.85
3C27	6.95
3C31/ EL-C1B	3.95
3C37	32.50
3C45	12.95
3CP1	2.25
3D21	2.98
3DP1	4.85
3DP1A	6.75
3E29	13.75
3EP1	4.75
3FP7	2.90
3FP7A	6.95
3GP1	3.95
3HP7	3.95
3JP12	11.50
3J31	145.00
4-125A	29.50
4-250A/ 5D22	35.00
4AP10	4.40
4B22/ EL-5B	8.95
4B24	5.75
4B25/ EL-6CF	8.95
4B32	10.50
4C27	17.50
4C35	27.00
4E27	21.50
4J36	150.00
4J38	120.00
4J52	275.00
4X150A	36.00
4X500A	118.50
4X 1000A	129.36
5AP1	5.95
5AP4	4.75
EL-C5B	3.95
5BP1	5.50
5BP4	5.50
5C22	47.75

Type No.	Price
5CP1	$4.95
5CP7	9.50
5D21	19.50
5D22/ 4-250A	35.00
5FP7	1.95
5HP1	5.50
5HP4	5.75
5J26	325.00
5J29	18.50
5JP1	26.50
5JP2	26 50
5JP4	26.50
5LP1	21.75
5LP5	19.75
5MP1	10.50
6-8B	.85
C6A	6.75
6AN5	3.58
6AR6	3.25
6C21	27.50
6C24	52.50
6F4	5.95
C6J	9.95
6J4	6.85
C6L/ 5528	12.50
7-7-11	1.19
7BP1	8.65
7BP7	6.50
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	11.75
9LP7	4.50
10FP4	22.50
10T1	.88
10Y	.39
12DP7	14.50
12GP7	18.50
12HP7	14.75
13-4	.80
13T4	.85
15E	1.95
15R	.65
FG-17 5557	4.95
RK-19	1.85
21-2	.65
RK-21	1.65
24G	1.85
24-4	1.05
FG-27A	8.25
HY-31Z	3.60
FG32/ 5558	6.75
FG33	22.54
RK34	.49
35T	4.95
35T ION gauge	5.95
35TG	4.95
REL 36	.45
T-40	3.75
RK-47	4.92
CE-48	1.90
EF-50	.79
VT-52	.45
53A	5.60
RK59	2.44
QK-60	65.00
SK-60	6.62
QK-61	65.00

Type No.	Price
QK-62	$65.00
VT-62 Br	1.15
RK-63	22.50
FG-67	14.80
HY-67	2.85
VT-67	.48
72	1.32
73	1.32
RK-75	4.25
75T	5.80
VR-75	1.15
VR-78	.64
FG-81A	3.95
VR-90	1.19
91	14.80
FG-95/ 5560	25.00
VT-98/ Br	19.50
C100A	2.30
C100E	2.30
100TH	9.95
WE-101F	3.62
WE-102F	2.85
FG-104/ 5561	29.95
FG-105	19.50
VR-105	1.10
VU-111S	1.60
WE-113A	1.32
HY-114B	.75
WE-117A	.95
F-123A	7.75
WE-124A	3.80
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150	.95
FG-166	48.50
FG-172	29.50
FG-178	14.50
FG-190	12.15
HF200	16.50
L-200B	65.00
203A	7.40
203B	6.33
204A	47.50
CE-206	3.15
211	.95
WE- 211D	12.50
WE- 211E	12.50
212E	42.50
WE-215A	.24
217C	8.95
221A	1.95
227A/ 5C27	4.60
WE-231D	2.25
232CH	240.00
RX-233A	4.95
FG-235A/ 5552	94.50
WE-245A	2.35
WE-249B	6.50
WE-249C	5.50
250R	17.50
250TH	22.50
250TL	22.50
WE-254A	5.90
WE-257A	3.77

Type No.	Price
FG-271/ 5551	$62.50
WE-274A	5.50
274B	2.85
WE-281A	8.90
WE-283A	4.25
WE-294A	5.75
304TH	8.75
304TL	12.95
307A	4.25
WE-310A	6.25
312A	3.95
316A	.89
TR-317	18.50
327A	4.25
WE-331A	9.75
WE-346A	2.75
350B	4.95
WE356B	5.45
368A	6.95
371A	.95
371B	.95
388A	2.95

Type No.	Price
394A	$4.50
WE-399A	4.70
410R	185.00
WE-412A	3.75
417A	16.95
434A	24.50
446	1.75
446A	1.95
446B	2.95
451	1.25
471A	2.65
473	140.25
481A	4.31
502A	1.67
503AX	1.28
506AX	1.25
507AX	1.47
527	17.50
530	22.00
531	7.50
532A	3.75
559	2.20
561	3.50

Type No.	Price
575A	$20.58
579B	14.70
KU610	21.66
HY615	.49
616	213.75
KU-623	39.50
624	47.00
KU-627	19.80
KU-629	11.70
631P1	5.00
WL- 632B	26.10
KU-634	42.50
WL-651/ 656	94.50
WL-652/ 5551	62.50
WL-654/ 659	82.00
WL-670A	8.70
WL-672	22.00
672A	34.30
KU-676	52.25

Type No.	Price
677	$52.25
WL-681/ 5550	44.10
700A	24.50
700B	24.50
700C	24.50
700D	24.50
701A	6.95
703A	5.95
704A	.95
705A	2.25
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	7.95
707B	14.90
708A	4.75
709A	3.85
713A	1.35
714AY	10.75
715A	6.25

Type No.	Price
715B	$8.95
715C	19.50
717A	1.47
718AY	45.00
718BY	45.00
720DY	95.00
721A	3.95
722A	2.25
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	12.95
726A	14.50
726B	45.00
726C	65.00
730A	25.00
788Y	1.40
800	1.75
801A	.45
802	3.30
803	4.95
805	4.50
806	33.50
807	1.65
808	2.65
809	3.60
810	10.95
809	3.60
810	10.95
811	3.60
811A	4.25
812A	3.50
813	10.50
814	3.95
815	5.25
826	1.25
828	9.60
829	9.95
829A	11.95
829B	12.95
830B	2.95
832	7.95
832A	9.95
836	4.10
837	1.45
838	3.75
841	.49
843	.59
849	29.50
852	19.50
857B	204.78
858	498.00
860	4.95
861	22.50
864	.35
865	1.28
866A	1.48
866A Jr./ 2B26	1.25
868	1.74
872A	3.95
874	1.35
876	1.60
878	1.85
880	460.00
884	1.75
885	1.75
889A	179.00
889RA	289.10
891	218.54
892R	355.76
893A	617.40

Type No.	Price
893AR	$1127.00
895	931.00
895R	1274.00
902P1	9.95
905	3.50
913	11.25
917	3.43
919	1.95
923	1.35
924	2.97
925	2.16
926	2.61
927	1.85
928	2.57
931A	5.00
954	.39
955	.55
956	.49
957	.49
958A	.69
959	2.25
991	.45
CK-1005	.69
CK-1006	3.30
CK-1013/ 5517	2.25
1201	.79
1203	.45
1290	.90
1291	.57
1294	.69
1299	.57
1602	2.25
1613	.89
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.25
1623	3.99
1624	1.90
1625	.39
1626	.30
1629	.30
1630	.95
1631	1.38
1632	.75
1633	1.00
1636	3.10
1642	.65
1644	.95
1655	1.90
1656	6.50
1665	1.80
1904	14.80
1960	.70
2002	4.85
2050	1.70
2051	1.10
5516	7.70
5517/CK- 1013	2.25
5518	514.59
5528/ C6L	12.50
5549	362.00
5550	44.10
5551	62.50
5552	94.50
5553	236.20
5554	170.00
5555	314.00

Type No.	Price
5557	$4.90
5558	6.75
5559	19.15
5560	25.01
5561	24.60
5581	2.00
5582	2.63
5583	2.90
5584	3.89
5588	117.68
5592	1204.40
5593	85.72
5604	529.20
5610	2.10
5611	115.09
5621	13.20
5622	12.23
5623	13.25
5624	13.23
5626	22.03
5627	26.45
5628	25.46
5629	20.48
5651	2.78
5654	2.95
5663	1.86
5670	4.10
5671	1225.00
5674	98.00
5675	14.90
5685	3.24
5686	3.68
5687	4.80
5691	8.55
5692	8.55
5693	6.95
5696	1.87
5713	173.48
5718	5.84
5719	8.33
5720	22.54
5725	3.19
5726	1.42
5727	2.64
5734	17.63
5740	86.24
5741	83.30
5742	14.21
5743	13.72
5749	1.96
5750	2.45
5751	2.29
5763	1.72
5770	975.10
5771	532.14
5779	78.40
5786	76.44
5794	16.43
5796	13.47
5814	3.29
5822	127.40
5826	1274.00
5830	196.00
5840	8.68
5855	75.46
5876	18.38
5879	1.72
5890	25.48
5893	19.20
5896	7.10
5899	8.72
5902	8.72
5915	1.18

Type No.	Price
5934	$14.70
5936	1078.00
5939WA	47.04
5974	215.60
6005	3.48
6012	4.41
6026	2.89
6072	4.46
6082	5.19
6095	1.45
6096	1.65
6099	3.95
6101	2.95
6135	1.87
6136	2.12
6137	2.12
6159	4.80
6201	5.39
UX6653	.65
7193	.45
8000	10.15
8003	13.72
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8016	1.05
8020	1.25
8025	6.95
8025A	4.75
9001	1.50
9002	.95
9003	1.50
9004	.45
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

Crystal Diodes

Type No.	Price
1N21	$1.19
1N21A	1.69
1N21B	3.00
1N22	1.25
1N23	1.95
1N23A	2.75
1N23B	3.45
1N25	4.50
1N26	7 75
1N27	1.79
1N31	7.90
1N34	.66
1N34A	.90
1N38	1.50
1N38A	2.55
1N39	6.10
1N41	9.85
1N42	18.00
1N43	1.65
1N45	.94
1N52	1.05
1N55	3.05
1N60	.55
1N72	.85

"X" BAND ACCESSORIES

AT-48/UP Pick Up Horn Antenna.............$9.95
Type "N" Mating Connectors available

UG-81/U Waveguide to Co-ax Adapter........$12.95

UG-163/U Adapter $2.85

SYNCHROS

Size 1, 3, 5, 6, 7 and 8 generators, motors, control transformers, differential generators, and differential motors in stock.

AY-101D	5F	M	C-69406-1
AY-120D	5G	N	C-78248
AY-130D	5N	X	C-78249
1CT	6DG	2J1F1	C-78410
1F	6G	2J1G1	C-78411
5B	7DG	2J1H1	C-78415
5CT	7G	C-44968-6	C-79331
5D	A	C-56701	C-78254
5DG	B	C-69405-2	C-78670

SEND FOR COMPLETE LISTING

SYNCHRO CAPACITORS IN STOCK

PULSE TRANSFORMERS

IN STOCK—IMMEDIATE DELIVERY

UTAH OA-18; X-124T; 9262; 9278; 9280; 9318; 9340; 9341; 9350

G.E.—K2464; K2468; K2469; K2744B; 68G627; 68G828; 68G929G1; 80G13; 80G152

WESTINGHOUSE—132AW2; 139DW2F; 166AW2F; 176AW2F; 187AW2F.

RAYTHEON—UX-7350; UX-10066.

PHILCO—352-7071; 352-7149; 352-7150; 352-7178; 352-7190; 352-7224.

W.E.—D-161310; D-163247; D-163325; D-164661.

REVERSIBLE GEAR HEAD MOTORS

G.E. 5BA10AJ65—27.5 VDC .66A 2.35 RPM 8 oz-ft Torque $27.50

G.E. 5BA10FJ18—24 VDC .51A 9.5 RPM 10 oz-in Torque $22.50

G.E. 5BA10FJ19—24 VDC .51A 56 RPM 12 oz-in Torque $22.50

G.E. 5BA10AJ41—PM 24 VDC .55A 140 RPM 10 oz-in Torque $22.50

G.E. 5BA10AJ52—27 VDC .7A 145 RPM 14 oz-in Torque $19.50

Delco 5069230—PM 27VDC 145 RPM........$19.50

Delco 5068750—27 VDC 160 RPM............$22.50

G.E. 5BA10AJ51—27 VDC 160 RPM .65A 8 oz-in Torque $19.50

Delco 5069600—PM 27 VDC 250 RPM.........$22.50

G.E. 5BA10AJ8—27 VDC 250 RPM .72A 8 oz-in Torque $19.50

Delco 5067127—PM 27.5 VDC 250 RPM.......$22.50

Delco 5068820—PM 27 VDC 250 RPM........$22.50

G.E. 5BA10AJ37B—27 VDC 250 RPM .8A 8 oz-in Torque $19.50

TACHOMETER GENERATOR

Ellinco type PM-1M, DC Tachometer Generator—New **$27.50**

MERCURY RELAY

SPDT 5 Amp mercury wetted, glass sealed contacts; Oper. coil-36 VDC, 4500 ohms, pulls in at 8 MA; Non-induct. heater Coil-27.5 VDC, 250 ohms, 0.11 A. Hermetically Sealed—Octal plug-in base—Useful for hi speed keying & computing operations. Mfd. by Western Electric.

EA. $8.75 — Lots of 10 $7.75

2 φ LOW INERTIA SERVO MOTORS

Diehl FPE-25-11—75V 60 cy. .11 Amp 4 Watts. Each........$34.50

KOLLSMAN—45 Volt 60 cycle 4 watts 1500 RPM—new $22.50

PIONEER—10047-2-A 26 volt 400 cycle with 40:1 reduction gear........$14.50

Minn Honeywell type—115V 60 cy. 13.5W—Brown Instr. 76750-1 162 RPM; 76750-2 54 RPM; 76750-3 27 RPM. Any Type........$19.50 ea.

OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price
2	400	$ .55	30	2500	$14.75
5-5	400	1.65	32	2500	15.80
1	600	.55	.5	3000	2.40
2	600	.69	1	3000	3.40
2-2	600 R'd	1.65	2	3000	5.85
3	600	.95	3 x .2	4000	2.95
4	600	1.65	2	4000	7.95
4	600 R'd	1.65	1	5000	5.75
5	600	1.75	2	5000	12.50
6	600	1.85	5	5000	29.50
8	600 R'd	1.85	.01-.03	6KV	1.65
8	600	2.50	1	6000	9.95
4-4-4	600	2.50	.1	7000 R'd	1.79
4 x 3	600	2.50	.1-.1	7000	5.95
10	600	3.25	.1	7500	2.85
1	1000	.65	.5	7500	7.95
2	1000	.90	1-1	7500	26.50
2	1000 R'd	.95	.075-.075	8 KV	6.50
3.5-.5	1000	1.85	1	10KV	29.50
4	1000	1.95	.1	12KV	8.95
6	1000	2 50	1	15KV	47.50
8	1000	3.25	.25	20KV	19.95
1	1200	.85	1	20KV	54.00
1-1-1	1200	1.85	1	25KV	85.00
.1	1500	.69	.001	50KV	24.50
1	1500 R'd	1.45	.005	50KV	34.50
4	1500	2.95	.025	50KV	37.50
.1-.5	2000	.95	.2	50KV	67.50
.25	2000	1.50	.25	50KV	70.00
.3	2000	1.30	7.5	220VAC	1.95
.5	2000 R'd	1.65	20	236VAC	3.95
1	2000	1.95	1-3	330VAC	1.95
2	2000	2.75	12.75	330VAC	4.10
12	2000	8.95	15	330VAC	4.50
1	2500	2.75	5	440VAC	3.10
1-1	2500	3.85	2.9	660VAC	3.50
4	2500	6.95	7	660VAC	4.25
			8	660VAC	4.50

OILMITES

MFD	V.	TYPE	Price
.02	600	OM-6002	$ .45
.05	600	OM-6005	.48
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.60
1.0	600	OM-601	.85

COAXIAL CONNECTORS

83-1AC	$ .42	83-1SP	$ .45	83-22SP	$ .80
83-1AP	.30	83-1SPN	.50	83-22T	1.95
83-1F	1.10	83-1T	1.30	83-168	.12
83-1H	.12	83-2AP	1.95	83-185	.12
83-1HP	.22	83-22AP	1.40	86-765	.24
83-1J	.73	83-22F	2.10	83-776	.65
83-1R	.40	83-22J	1.40		
83-1RTY	.65	83-22R	.68		

UG-7/AP	$6.30	UG-58/U	$ .70	UG-185/U	$ .95
UG-12/U	.95	UG-58A/U	.90	UG-191/AP	.80
UG-15/U	1.25	UG-59A/U	1.90	MX-195/U	.75
UG-18/U	1.25	UG-60A/U	1.65	UG-197/U	2.80
UG-18B/U	1.05	UG-61A/U	2.10	UG-201/U.	1.95
UG-19/U	1.60	UG-83/U	1.75	UG203/U	.65
UG-20B/U	1.60	UG-85/U	1.60	UG206/U	1.40
UG-21/U	.75	UG-86/U	2.25	UG-224/U	1.15
UG-21A/U	1.50	UG-87/U	1.40	UG-226/U	3.85
UG-21B/U	1.00	UG-88/U	.90	UG-245/U	2.25
UG-21C/U	1.05	UG-89/U	1.10	UG-246/U	2.35
UG-22/U	1.30	UG-90/U	1.15	UG-254/U	2.75
UG-22B/U	1.20	UG-98/U	1.85	UG-255/U	1.95
UG-22C/U	1.20	UG-102/U	.80	UG-260/U	.85
UG-23/U	1.20	UG-103/U	.68	UG-261/U	1.10
UG-23B/U	1.50	UG-104/U	1.40	UG-262/U	1.10
UG-23C/U	1.10	UG-106/U	.12	UG-273/U	1.45
UG-24/U	1.30	UG-107B/U	2.75	UG-274/U	2.30
UG-25/U	1.35	UG-108/U	2.60	UG-275/U	5.50
UG-27/U	1.25	UG-109/U	2.60	UG-276/U	5.50
UG-27A/U	2.25	CW-123A/U	.45	UG-290/U	.90
UG-28A/U	2.95	UG-146/U	1.95	UG-291/U	.95
UG-29/U	.95	CW-159/U	.60	UG-306/U	2.45
UG-29A/U	1.85	UG-166/U	32.50	UG-349/U	2.65
UG-29B/U	1.65	UG-167/U	3.30	MX-367/U	.85
UG-30/U	2.30	UG-171/U	2.25	UG-414/U	1.95
UG-34/U	9.75	UG-173/U	.35	UG-498/U	1.80
UG-36/U	12.50	UG-175/U	.12	UG-536/U	1.65
UG-37/U	17.50	UG-176/U	.12	UG-625/U	1.00
UG-57B/U	1.85	UG-177/U	.24		

Full line of JAN Approved coaxial connectors in stock UHF-N-BN-BNC-pulse—Prices on request.

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$120.00	RG-22/U	$150.00
RG-6/U	180.00	RG-22A/U	285.00
RG-7/U	85.00	RG-24/U	675.00
RG-8/U	100.00	RG-26/U	400.00
RG-9/U	250.00	RG-29/U	50.00
RG-9A/U	330.00	RG-34/U	300.00
RG-10/U	240.00	RG-35/U	900.00
RG-11/U	100.00	RG-54A/U	97.00
RG-12/U	240.00	RG-55/U	100.00
RG-13/U	216.00	RG-57/U	325.00
RG-17/U	650.00	RG-58/U	60.00
RG-18/U	900.00	RG-58A/U	70.00
RG-19/U	1250.00	RG-59/U	55.00
RG-20/U	1450.00	RG-62/U	70.00
RG-21/U	240.00	RG-77/U	80.00

ADD 25% TO PRICE SHOWN FOR QUANTITIES UNDER 500 FEET.

Terms 25% cash with order, bal. COD unless rated. All prices net F. O. B. warehouse. Phila., Penna., subject to change without notice.

CABLE ADDRESS "ELECTRONIC PHILADELPHIA"

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

"S Band," RG48/U Waveguide

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors. .$22.50 EACH

DIRECTIONAL COUPLER. Broad-band type "N" Coupling, 20 db. with std flanges, Navy #CABV47AAN-2 (as shown) $37.50

LHTR, LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15, Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG, To Recvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $32.50

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $32.50

MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $45.00

721A TR BOX complete with tube and tuning plungers $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28 .... $4.00

WAVEGUIDE TO 7/8" RIGID COAX "DOORKNOB" ADAPTER CHOKE FLANGE SILVER PLATED BROAD BAND $32.50

AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50

OAJ ECHO BOX, 10 CM TUNABLE $22.50

HOLMDELL-TO-TYPE "N" Male Adapters, W. E. #D167284 .... $2.75

I.F. AMP. STRIP: 30 MC. 30 d.b. gain, 4 MC Band-width, uses 6AC7's—with video detector, A.F.C. less tubes $24.00

POLYROD ANTENNA, AS31/APN-7 in Lucite Ball, Type "N" feed $22.50

ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50

"E" PLANE BENDS, 90 deg. less flanges $7.50

X Band—RG 52/U WAVEGUIDE

HORN FEED, Mounted at end of 1' run. Designed to be used with dish reflector $15.00

VSWR Measuring Section. Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks, Mounted ½ Wave apart $8.50

1" x ½" waveguide in 5' lengths, UG 39 flanges to UG40 cover .... per length $7.50

Rotating-joints supplied either with or without deck mounting. With UG40 flanges .... each, $17.50

Bulkhead Feed-thru Assembly $15.00

Pressure Gauge Section 15 lb. gauge and press nipple $10.00

Pressure Gauge, 15 lbs. $2.50

Directional Coupler, UG-40/U Take off 20db. . $17.50

TR-ATR Duplexer section for above $8.50

Waveguide Section 12" long choke to cover 45 deg twist & 2½" radius, 90 deg. bend $4.50

Waveguide Section 3 ft. long silver plated with choke flange $4.50

Rotary Joint choke to choke with deck mounting $17.50

90 degree elbows. "E" plane 2½" radius $12.50

Microwave Receiver, 3 CM. Sensitivity: 10-13μ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits, 6 I.F. Stages give approximately 120 DB. gain at a bandwidth of 1.7 MC. Video Band-width: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator $175.00

ADAPTER, waveguide to type "N", UG 81/U, p/o TS 12, TS-13, Etc. $14.50

ADAPTER, UG-163/U round cover to special bfl. Flange for TS-45, etc. .... $2.50 ea.

1¼" x ⅝" WAVEGUIDE

VSWR SECTION. 6"L, with 2-type "N" pickups mounted ¼ wave apart $7.50

GG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD. $10.00

X Band Wave GD 1¼" x ⅝" O.D. 1/16" wall aluminum .... per ft. 75¢

Slug Tuner Attenuator W.E. guide, gold plated. $6.50

Bi-Directional Coupler. Type "N" Takeoff 25 db. coupling $27.95

Bi-Directional Coupler. UG-52. Takeoff 25 db. coupling $24.95

Waveguide-to-Type "N" Adapter. Broadband. . $22.50

½" X ¼" W.G.—1.25 CM.

APS-34 Rotating joint $49.50

Right Angle Bend E or H Plane, specify combination of couplings desired $12.00

45° Bend E or H Plane, choke to cover $12.00

Mitered Elbow, cover to cover $4.00

TR-ATR-Section, Choke to cover $4.00

Flexible Section 1" choke to choke $5.00

"S" Curve Choke to cover $4.50

Adapter, round to square cover $5.00

Feedback to Parabola Horn with pressurized window $27.50

90° Twist $10.00

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.65
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.65	UG 52A/U	$3.40

—IN STOCK—

AIA	APS-4	APT-4	SJ-1
APA-9	APS-6	MKIV	TAJ
APA-10	ASD	MKX	TBK
APN-3	ASH	RC145	TBL
APN-7	BG	RC148	SCR520*
APN-9*	DAS†	SO-1	SCR521
APS-2	DBS†	SO-8	SCR518
APS-3	APT-2	SG-1	

* COMPONENTS. † LORAN EQUIPMENT

—TEST SETS—

TS-10	TS-12	TS-159
TS-36	TS-56	TS-268
TS-47	TS-34	TS-270

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345–9405	50		$8.75
2J22	3267–3333	265		7.50
2J27	2965–2992	275	.002	19.95
2J31	2820–2860	285	.002	24.50
2J32	2780–2820	285	.002	28.50
2J38*	3249–3263	5		16.50
2J39*	3267–3333	8.7		24.50
2J48	9310–9320	50	.001	24.50
2J49	9000–9160	50	.001	59.50
2J56*	9215–9275	50	.001	132.50
2J61†	3000–3100	35	.002	34.50
2J62†	2914–3010	35	.002	34.50
3J31	24–27KMC	50	.001	85.00
4J34	2740–2780	900		125.00
5J23	1044–1056	475	.001	49.00
700B	690–700	40	.002	22.50
700D	710–720	40	.002	39.75
706EY	3038–3069	200	.001	32.50
706CY	2976–3007	200	.001	32.50
725-A	9345–9405	50	.001	Write
730-A	9345–9405	50	.001	24.50
4J38	3550–3600	750	.001	169.45

*—Packaged with magnet.
†—Tunable over indicated range.

KLYSTRONS

723A	$12.50	2K25/723A/B	$27.50
723A/B	19.50	417-A (Sperry)	17.50

70 WATT MAGNETRONS

These tubes provide a simple, rugged, inexpensive source of C.W. energy. An inexpensive power supply is all that's required.

CHARACTERISTICS:

Heater: 6.3 v, 3.8 A.	Power out: 70 W. CW
Anode V. 1250 V.	Anode current: 125 ma.
Pk. Input: 200 Watts	Av. input: 100 W

Each tube is packaged with an integral magnet, and is tunable over the range shown below:

TYPE	RANGE (MC.)	TYPE	RANGE (MC.)
QK 60	2840-3005	QK 61	2975-3170
QK 62	3135-3330		

Price $85 ea.

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

Stock	Ratings	Price
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4V/3.9A, 5V/2A, 6.5V/.3A, P/O 1D-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
KS9584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3VO.9A, 6.3V 25.A 6.3V/.08A, 5V/CA	6.95
352-7070	2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100/750V. @ .005A	7.45
352-7196	1140/1.25MA, 2.5V/1.75A, 2.5V/1.75A —5KV Test	3.95
352-7176	320VCT/50MA, 4.5V/3A, 6.3VCT/20A, 2x6.3VCT/6A	4.75
RA6400-1	2.5/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V 9A	2.49
901699-501	2.77V @ 4.25A	3.45
901698-501	900V75MA, 100V/.04A	4.29
Ux8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/806MA5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300, VCT, 135MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 63.V/.66A, 6.3VCT/21A	4.25
KS8984	27V/4.3A, 6.3/2.9A, 1.25V/.02A	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A ALL CT	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
352-7069	2-2.5V Wdgs. at 2.5A, Each Lo-Cap., 22Kv Test	5.95
352-7096	2.5V1.79A, 5V/3A, 6.5V/6A, 6.5V/1.2A, D/O BC800	4.95

THERMISTORS

D-164699	Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F, Coefficient: 2% Per Deg. Fahr. Max. Current 25 MA AC/DC	$2.50
D-167332	Bead Type, DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC	1.35
D-167613	Disk Type DCR:355 Ohms @ 75 Deg. F. P. M. 2.5%, 1 Watt	1.35
D-166228	Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F. 1640 Ohms @ 120°F	1.35

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 KW Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1, or 2 microsec. duration at duty cycle of 001. Unit requires 115V. 400-2400 Cycles, 1 Phase @ 3.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120V Reg'd. Brand New. Complete with schematic and all tubes $375.00

PULSE NETWORKS

15A—1,400-50: 15 KV, "A" CKT, 1 microsec, 400 PPS, 50 ohms imp $37.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit: Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp $6.50

7-5E3-1-200-67P. 7.5 KV, "E" Circuit, 1 microsec, 200 PPS 67 ohms impedance 3 sections $7.50

7-5E4-16-60, 67P. 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS. 67 ohms impedance $15.00

7-5E3-3-200-67P. 7.5 KV. "E" Circuit, 3 microsec. 200 PPS. ohms imp. 3 sections $12.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32-40H @ .08A. 30,700V Corona Test, 21KV Test $37.50

G.E. 25E5-1-350-50 P2T. "E" CKT. 1 Microsec, Pulse @ 350 PPS. 50 OHMS Impedance $69.50

KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR, 9000 Vac Test $14.95

G.E. 6E3-5-2000 50 P2T; 6 KV., "E" Circuit 0.5 usec/2000 PPS/50 ohms/2 sections $7.50

SPRAGUE H-615 "E" Circuit 10KV, 0.85 microsec. pulse at 750 PPS-50 ohms $27.50

SPRAGUE H-616, "E" Circuit, 10KV 2.2 microsec. pulse at 3.755 PPS—50 ohms $27.50

PULSE EQUIPMENT

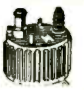
MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-715, 4-89-B, 3-'72's, 1-'73. New ...... Less Cover—$135

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50

PULSE TRANSFORMERS

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP. DUTY RATIO: .001 400 CYCLE FIL. TRANS. "BUILT-IN" $42.50

W E C O: KS 9948; Primary 700 ohms; Sec: 50 ohms. Plate Voltage: 18 KV. Part of APQ-13 .... $12.50



GE #K-2449A Primary: 9.33 KV, 50 ohms Imp. Secondary: 28 KV, 450 ohms. Pulse length: 1.0/5 usec @ 635/120 PPS, Pk Power Out: 1,740 KW Bifilar: 1.5 amps (as shown) $62.50

GE #K-2748-A. 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well $39.50

K-2745. Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well $42.50

K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar: 1.3 Amp. Fitted with magnetron well $39.75

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR $7.50

UTAH X-150T-1: Two sections, 3 Wdgs. per section. 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg. ... $7.50

68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA $4.50

TR1049 Ratio: 2:1 Pri. 220 MH. 50 Ohms. sec. 0.75 H. DCR 100 Ohms $6.75

K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohms. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95

Ray UX 7896—Pulse Output Pri. 5v sec. 41v ... $7.50

Ray UX 8442—Pulse Inversion—40v + 40v $7.50

PHILCO 352-7250, 352-7251, 352-7287

RAYTHEON: UX8693, UX5986 .... $5. ea.

W.E.: D-166310, D-166638, KS9800, KS9948.

UTAH #9262, with Cracked Beads, but will operate at full rated capacity $5.00

UX 8693 (SCS #2Z9627-54): 3 Wdgs. 32 turns #18 wire. DCR is: 362/.372/4 ohms. Total voltage 2500 vdc $5.00

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Entire unit consists of 2- 250 watt amplifiers mounted in a 7 ft. rack, together with tube check device, alarm signal generator, and distribution panel. Both amplifiers feature variable volume compression. Output stage consists of P-P parallel 809's. Used, but in excellent condition, complete with all tubes; operates

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CT-138 520-0-520V/500 MA, 6.3V/3A, 6.3V/ 17A, 2 X 5V/3A 14.75

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CT-341 1050 10MA,—625V @ 5MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A 9.95
CT-071 110V .200A 33/.200, 5V/10, 2.5/10 .... 4.95
CT-403 350VCT .026 A 5V/3A 2.75
CT-931 585VCT .086 A 5V/3A, 6.3V/6A 4.25
CT-456 390VCT 80 MA 6.3V/1.3A, 5V/3A 3.45
CT-442 525VCT 75 MA 5V/2A, 1 CT/2A, 50V/200 MA 3.85
CT-43A 600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/ 1A 6.49
CT7-501 650VCT 200MA, 6.3V/8A, 6.3V/5A 6.49
CT-444 230-0-230V/.085A. 5V/3A, 6V/2.5A 3.49

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Item	Rating	Each
FT-140	5VCT @ 10A 25KV Test	$22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A. 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A	2.79
FT 650	2.5V/10A-3KV TEST LO-CAP	7.50

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PT 159 900-0-900 VAC (750VDC) or 800-0-800 VAC (600VDC) at 225 MADC 10.35
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PT 062 2900-0-2900 VAC (2500VDC) or 2385-0-2385 VAC (2000VDC) at 300MA 48.00

GE #M-7470689 Input: 115 V, 60 Cycle, Single Phase
1 WDG 3700V Tapped at 710V
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Lo-Cap Donut Construction $24.75

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CH-189	Swing. 4-16H, 250MA, 125 ohms, 3KV Test	6.60
CH-190	Swing. 3-14H, 300MA, 80 ohms, 3KV Test	6.90
CH-CEC117:	9-60H/.05-400MA, 10KV Test	14.95
CH-366	20H/.3A	6.95
CH-322	.35H/350MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA 5KV DC Test	4.69
CH-119	8.5H/125 MA	2.79
CH-69-1	Dual 120H/17 MA	2.35
CH-8-35	2/.5H/380 MA/25 Ohms	1.79
CH-776	1.28H/130 MA/75 ohms	2.25
CH-344	1,5H/145MA/1200V Test	2.35
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-445	0.5 HY/200 MA, 32.2 OHMS, 3000 V.T.	1.39
CH-170	2x0.5H/380 MA, 25 OHMS	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5KV INS	29.95

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DM 33A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
23350	27	1.75	285	.075	3.95
B-19 Pack	12	9.4	275	.110	8.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	22.50
BD 69‡	14	2.8	220	.08	12.95
D-402†	13.5	12.2	300	.200	
			8.8VAC		12.50
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MINIATURE RELAYS

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POTTER BRUMFIELD KR11D; 6VDC; DPDT; 75 ohm; #R923 .... 1.95
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ALLIED FID; 8 ma; 1A; 3000 ohm; #R916 .... 1.50
RBM 23024; 6 ma; 4PST n.o. (4A's); 6500 ohm; #R802 .... 2.95
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SIGMA 41F; 12VDC; SPDT; 340 ohm; #R925 .... 1.95
SIGMA 4F8000S; 1 ma; SPDT; 8000 ohm; #R287 .... 5.95
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SIGMA 41F80000S; 2.5 ma; SPDT; 8000 ohm; #R1002 .... 2.75
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ADVANCE K1504; 220VAC; DPDT; #R531 .... 2.00
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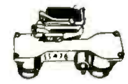
RIO COOK, 12-24VDC, 3PST n.o. (3As). One contact 10A, 250 ohm, #R427 .... 1.75

ARC 3 & ARC 5 RELAYS



55251 (K403, K405) Telechron; 24VDC; SPST; n.o. (1A); 300 ohm; #R174 .... 1.25
55340 (K203) Price; 24VDC; SPST n.o., (1A); 300 ohm; #170 .... 1.25
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55837 (K401, K402) G. E.; 24VDC; Double Make (2A); 300 ohm; #R108G 1.25
55837 (K401, K402) RBM; Same as #R108G; #R108R 1.50
55837 (K401, K402) Allied; Same as #R108G; #R108 .... 1.75
23012-0 RBM; 24VDC; SPDT; 250 ohms; #R172 .... 1.50
6385 ARC; 12-24VDC; SPST n.o. (1A), 10 Amp Contacts; 200 ohm; #R213 .... 2.00
7251 ARC; 24VDC; SPDT; (1C); 300 ohm; #R406 .... 1.50
7252 ARC; 24VDC; DPST n.o. (2A); 300 ohm; #R354 .... 1.50
7735 ARC; 24VDC; Antenna Relay; SPDT (1C); 200 ohm; #R799 .... 3.50

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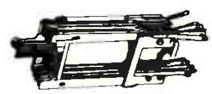

Number	Coil Rating	Contact Arrangement	Stock No.	Price Each	10 for
UE2CG	800	2A, 1B, 1D	R 756	1.75	15.00
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UR2JL	1500	3A, 1C, 1D	R 758	2.25	20.00
UR2YD	650	2A, 1B, 1C	R 759	1.75	15.00
UR2YC	80	1C, 2A, 1B	R 760	1.75	15.00
UH4AL	400/400	2D, 1A, 1B	R 761	2.25	20.00
U1243	2000	3A	R 762	1.75	15.00
UR2TR	200	1C	R 763	1.25	11.25
U1PS	100	1C	R 764	1.25	11.25
UR2TL	800	3C, 1A	R 765	2.25	20.00
UE2KN	1200	2A, 1B	R 766	1.75	15.00
UR4HM	150/150	2A	R 767	1.25	11.25
UR2S	1.8	2A	R 768	1.25	11.25
UR2SH	1500	1C, 2D, 2A, 1B	R 769	3.00	25.00
UE2HR	100	1A	R 770	1.25	11.25
UR2XK	1500	1C, 1D, 3A, 1B	R 771	3.00	25.00
UR2GC	1500	3B, 1C, 2A	R 772	3.00	25.00
UR2DG	1500	2C, 3A, 1B	R 773	3.00	25.00
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UT2B4	700	2A	R 775	1.75	15.00
UR2HX	1500	2C, 2A, 1D	R 776	3.00	25.00
UE2B	700	2B	R 777	1.75	15.00
UR2YE	1500	4A, 1B, 1C, 1D	R 778	3.00	25.00
UE2KX	1000	2A, 1B, 1C	R 779	2.25	20.00
7040MT	100	1C	R 780	1.25	11.25
UR4LK	1000/1000	3A, 2C, 1D	R 781	3.00	25.00
UR2KX	400	1C, 3A	R 782	2.25	20.00
UR4JP	1000	2C, 2D, 1A	R 783	2.75	22.50
UR2RE	10	1C	R 784	1.25	11.25
UR4E	1000	6A	R 785	3.00	25.00
UE4BE	200	1C, 1A	R 786	1.50	12.50
D166042	1000	1C	R 787	1.50	12.50
UH4AK	500/500	2A	R 788	1.50	12.50
UR2XH	1500	2C, 2D, 2A	R 789	2.75	22.50
UT2B	800	1C, 2A	R 790	1.50	12.50
UE2A	1800	2A	R 791	1.50	12.50
UR2TG	1500	2B, 2D, 1A	R 792	2.75	22.50
UR2XC	100	2A	R 793	1.50	12.50
7040HA	500	2A	R 794	1.50	12.50

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This equipment is used for navigation, surveying, and automatic blind bombing. Operates in conjunction with AN/CPN-2 ground-beacons. Operating frequency of this equipment is 290mc. The accuracy is plus or minus 10 feet up to its range of 300 miles. We can supply bombing computers, if desired we can supply APN-3 spares. AN-CPN-2 ground-beacons also available .... POR

SCR—536 HANDI TALKIE

Freq. range 3.7-5.5mc crystal controlled battery operated handitalkie. The range of this equipment is approximately 2 miles. We can supply these sets to your specified freq. within its range. Completely reconditioned and guaranteed. Large quantity available .... POR

AN-GSQ/1A SPEECH SCRAMBLER

This is a very compact unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambled. This provides an excellent privacy system. Complete equipment available consisting of: scrambler, code card set, cables, etc. This equipment can be used with any field or airborne communications equipment.
Mfg. Western Electric .... POR

AN/TPL-1

10cm mobile light weight radar set used to direct anti-aircraft searchlight and to search for aircraft. Technical characteristics as follows: range 35 miles, presentation 7" PPI, 5"A scope plus 2 tracking scopes. This set gives direct indication of target height directly in feet. Complete anti jamming facilities included. These sets can be very easily modified to increase the range. These sets are built on a very very small 4 wheel trailer. Complete installations available with or without spare parts .... POR

SCR-522

Airborne Transceiver, Freq. 100-156 Mc. This unit is crystal controlled 4 channel. Power output approx. 10 watts. Consists of: BC-624 Receiver, BC-625 Transmitter, FT-244 mount, BC-602 control box, PE-94 dynamotor, antenna, plugs $137.50

AN/TPQ-2 K-BAND GROUND RADAR

Very late model set. Used to plot trajectory of artillery and mortar shells and to enable counter battery fire with extreme accuracy. This Radar is so accurate and sensitive it will pick up movements of personnel on the battlefield. It can also be used to measure height of cloud cover for weather forecasting. Mfg: WESTERN ELECTRIC. Write

AN/APR-4

38-4000 mc precision receiver consists of receiver and five tuning units to cover the full range. Each tuning unit is calibrated directly in mc. Input 115v 60 cyc .... POR

RF-3A/AP X-BAND FREQUENCY SWEPT MANUALLY TUNED ECHO BOX

Frequency range 8500-9600mc. This equipment consists of an echo box with a motor mounted on one end which provides a frequency swept response from the echo box enabling it to be easily observed on the Radar indicator. Input 28v DC .5 amps. Can be supplied in 110v 60 cyc AC .... POR

AN/ART-13 AUTO-TUNE AIRCRAFT TRANSMITTER

This equipment covers the frequency range of 2-18mc. and is automatically tuned 10 channel. Power output is 75 watts CW. 60 watts phone. This equipment consists of T-47 or T47A transmitter, dynamotor power supply, control box, racks, antennae loading unit, etc. .... POR

AN/PPN-1 REBECCA GROUND BEACON

This equipment operates on 215 mc and is used in conjunction with AN/APN-2 or SCR-729. Provides a signal enabling the aircraft carrying the APN-2 to home on it. This equipment is completely portable and operates from a 12 volt battery. Complete installations avail. .... POR

AN/APN-2 and SCR-729 equip. avail.

BC-348R CAA and Military approved model. .... POR

AN/APT-5 300-1200 mc transmitter 30 watts output $169.50

AN/APR-5 1000-3100 mc receiver

BC-639 100-156 mc .... POR

AN/APS-10 3cm airborne Radar .... POR

BC 610 TUNING UNITS

TU 49 New 9.75
TU 53 New 9.75

SPECIAL PURPOSE TUBES

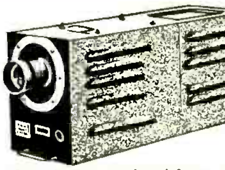
1B24	6.75	3DP1	2.50	RX-21	7.50	328A	4.00	709A	1.75	832A	7.50
1B27	11.00	3E29	9.00	RK-23	2.00	329A	7.50	715A	3.00	833A	28.50
1B32	1.25	3EP1	4.00	RK-62	2.00	348A	7.50	715B	4.00	836	2.50
1B42	7.25	3GP1	2.50	RK-72	1.00	349A	7.50	715C	16.50	837	1.00
2AP1	5.50	4B27	7.50	RK-73	1.00	350A	4.00	719A	15.00	838	2.75
2C33	2.25	4C27	10.00	F-128A	75.00	352A	15.00	721A	1.75	846	125.00
2C39A	13.50	4E27	13.75	HK-154	5.00	354A	15.00	723A/B	12.00	849	20.00
2C40	5.75	4J34	75.00	VT-158	30.00	355A	15.00	724A	1.50	860	2.00
2C44	1.00	4J35	125.00	FG-190	9.50	F-375A	12.50	724B	1.75	861	13.50
2D21	1.00	5BP1	3.00	HF-200	13.50	393A	6.50	725A	4.00	866A	1.00
2E22	1.75	5BP4	3.00	C-202	12.50	394A	2.00	726A	7.50	869B	55.00
2J21A	6.50	5CP1	3.75	204A	25.00	417A	7.50	726B	35.00	872A	2.00
2J26	10.00	5D21	11.00	205B	1.00	GL-434A	12.00	726C	35.00	878	1.25
2J27	9.25	5FP7	1.00	F-207	100.00	446A	1.00	728CY-GY	13.50	884	1.00
2J31	19.00	5FP14	7.00	217A	3.50	446B	3.00	802	3.00	885	1.50
2J32	20.00	5JP1	13.00	WL-218	25.00	450TL	37.50	803	3.00	892R	250.00
2J33	20.00	5JP4	13.00	250R	5.00	WL-460	12.00	805	3.00	902-P1	7.50
2J34	18.00	5JP11	35.00	251A	100.00	464A	7.00	807	1.25	913	10.00
2J36	75.00	5J30	23.50	253A	6.00	WL-468	20.00	808	1.50	918	2.00
2J38	8.25	5J32	60.00	267B	7.00	527	15.00	809	2.50	923	1.00
2J56	75.00	5R4GY	1.00	271A	5.75	WL-530	10.00	810	9.75	931A	3.75
2J61	28.50	C6A	7.50	274B	2.00	WL-531	4.75	811	2.50	959	1.50
2K25	19.75	C6L	5.50	276A	7.50	559	1.00	812	2.50	CK-1006	1.50
3AP1	5.00	6BL6	50.00	282A	7.50	631-P1	4.75	813	10.00	1614	1.50
3BP1	3.00	6BM6	60.00	283A	3.75	700A-D	8.50	814	2.75	1624	1.00
3B22	2.25	6C21	15.00	286A	6.50	701A	4.00	815	2.75	2050	1.25
3B24	3.75	6G4	4.75	304TH	6.75	702A	1.50	822	17.50	ZB-3200	125.00
3B24W	7.50	6J4	4.75	304TL	5.00	702B	2.50	826	1.00	8002R	85.00
3B25	3.50	7BP7	3.00	307A	2.00	705A	1.00	828	9.00	8012	1.75
3B26	2.75	9GP7	7.50	310A	3.00	706AY-GY	25.00	829A	6.00	8013	2.00
3B28	4.00	9LP7	3.00	311A	5.25	707A	5.00	829B	9.00	8020	1.00
3C23	6.75	12DP7	12.50	313C	3.00	707B	8.75	830B	2.00	8025	3.00
3C24/24G	1.00	12GP7	13.50	323B	9.75	708A	2.50	832	6.50	PD8365	50.00

- *Prices do not include transportation*
- *Usual terms apply*

western engineers

ELK GROVE, CALIFORNIA
GEORGE WHITING, OWNER

- *Unconditional guarantee extended*
- *Subject to prior disposition*



TELEVISION CAMERA

Mfr. R.C.A. Type CRV-ATK or ATJ . . . For training and experimental work in the instruction of TV techniques. Television studios can adapt it for movie pick-up chain, titles, slides and test patterns. SCANNING: vertical 40-60 FPS., horizontal 13,500-15,800 C.P.S. VIDEO AMPLIFIER: Use 1846 conoscope . . . six stage amplifier and clipper. CAMERA DIMENSIONS: 12¼" x 10½" x 25". WEIGHT: 49 lbs. Used, good condition $295.00

SINE-COSINE GENERATORS
(Resolvers)

Diehl Type FJE-43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two output sequel to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle........**$30.00 ea.**
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor....................**$25.00 ea.**

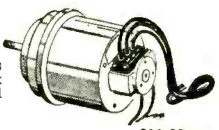
VOLTAGE GENERATORS (RATE)

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-35-D $17.50
ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-44-D $17.50
A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase, .015 Amps. Type PM-1, 1200 R.P.M.............$15.00

400 CYCLE 3-PHASE GENERATOR

120 Volts, 11.7 amps and 28 VDC @ 14.3 amps. Mfg. by HOMELITE . . . equipped with dual V-belt pulley $275.00

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.
Quantities Available.
REPEATERS ....$20.00 ea.
TRANSMITTERS ....$20.00 ea.

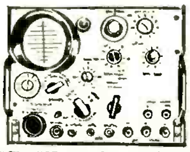
AUTOSYN MOTOR TYPE 1

115 VAC; 60 cycle; 1-phase; DR. #4279 Foot mounted; Mfg. Bendix Aviation Corp...........$15.00 ea.

SYNCHROS

General Electric MOD. 2J15M1; 115-57.5 Volts 400 Cycle ....$22.50 ea.
AUTOSYN MTR. KOLLSMAN Type #403; 32 VAC; 60 cycle; single phase..................$22.50
AUTOSYN MTR. BENDIX Type #851; 32 VAC; 60 cycle; single phase..................$22.50
MICROSYN UNIT. Type 1C-006-A...........$35.00
IF Special Repeater (115V-400 Cy.).......$15.00 ea.
2JIF 3 Generator (115-400 cyc.)...........$10.00 ea.
5CT Control Transformer: 90-50 Volt; 60 Cy..$45.00
5F Motor (115/90 Volt—60 cyc.)...............$45.00
5SDG Differential Generator (90-94 volts — 400 cyc.) ....$30.00 ea.
TRANSMITTER, BENDIX C-78248: 115 Volt, 60 Cycle ....$25.00 ea.
Differential—C-78249: 115 V., 60 Cy...........$5.00
5N MOTOR (115 Volts/60 Cycle)...............$22.50
REPEATER, BENDIX C-78410: 115 Volt, 60 Cycle ....$37.50 ea.
REPEATER, AC synchronous 115 V., 60 cycle, C-78863 ....$15.00 ea.
REPEATER, DIEHL MFG. No. FJE 22-2; 115 Volt; 400 Cy., Secondary 90 V.....................$27.50
5G GENERATOR (115/90) 60 cycles..........$45.00
7G Synchro Generator (115/90 volt; 60 cycle)..$75.00
6G Synchro Generator (115/90 volt; 60 cycle)...$60.00
6DG Synchro Differential Generator (90/90 volt; 60 cycle) $50.00
2J5F1 Selsyn Control Transformer: 105-55 Volts; 60 Cycle $22.50
2JD5HA1 Selsyn Generator: 115-105 Volts; 60 cycle $50.00
2J1F1 GENERATOR: 115—57.5 Volt; 400 cycle. $12.50 ea.
2J1H1 DIFFERENTIAL GENERATOR: 57.5—57.5 Volt; 400 cycle ....$12.50 ea.
2J1G1 CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle ....$7.50 ea.
2J5H1 SELSYN GENERATOR: Mfg. G. E., 115-105 Volts, 60 Cycle $27.50

PANORAMIC ADAPTER
Model AN/APA-10



Provides four types of presentation . . . (a) Panoramic (b) Aural (c) Oscillographic (d) Oscilloscopic. Designed for use with AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or other equipment with I.F. or 455 kc., 5.2 mc or 30 mc. Includes 21 tubes with 3" scope tube. PRICE $99.50

Immediate Delivery
ALL EQUIPMENT FULLY GUARANTEED
All prices net FOB Pasadena, Calif.

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase, 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp......$59.50

PIONEER 12117

OUTPUT: 26 volts; 400 cycles; 6 volt amperes, 1-Phase. **INPUT:** 24 VDC; 1 amp..........**$25.00 ea.**

ALTERNATOR, CARTER

Mfg. Carter Motor Co.; OUTPUT: 7 VAC; 9.7 amp.; 650 cycles, and 295 VDC, 200 amps. INPUT: 26.5 VDC; 10.5 amps; 6500 rpm..............**$49.50 ea.**

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle; 1500 VA. **INPUT:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts, 27.5
BRAND NEW ....**$39.95 ea.**

PE 109 LELAND ELECTRIC

Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 RPM. **Input:** 13.5 VDC; 29 amp..........$65.00

MG 153 HOLTZER-CABOT

Input: 24 V. DC. 52 amps; **Output:** 115 volts — 400 cycles, 3-phase, 750 VA. and 26 Volt — 400 cycle, 250 VA. Voltage and frequency regulated......**$95.00 ea.**

PIONEER 12130-3-B

Output: 125.5 VAC; 1.5 amps. 400 cycle single phase, 141 VA. Input: 20-30 VDC, 18-12 amps. Voltage and frequency regulated $75.00

12116-2-A PIONEER

Output: 115 VAC; 400 cyc.; single phase; 45 amp. **Input:** 24 VDC 5 amp......................$65.00

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF. and 26 volts, 50 amps. single phase, 400 cycle, .40 PF. **Input:** 27.5 VDC, 60 amps, cont. duty, 6000 RPM. Voltage and Frequency regulated......$95.00

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input:** 27.5 DC; 12.5 amp; Cont. Duty. **$90.00 ea.**

PIONEER 10042-1-A

DC INPUT 14 Volts; **OUTPUT:** 115 Volts; 400 Cycle 1-Phase; 50 Watt..........................$75.00

94-32270-A LELAND ELECTRIC

Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle, .40 PF. **Input:** 27.5 Volts DC 18 amps cont. duty, voltage and freq. regulated $95.00

PIONEER 12147-1-B

OUTPUT: 115 VAC 400 cycle; Single phase. **INPUT:** 24-30 VDC; 8 amps..........................$79.50

MG 149F HOLTZER CABOT

OUTPUT: 26 VAC @ 250 VA; 115V @ 500VA; Single Phase; 400 cycle. **INPUT:** 24 VDC @ 36 amps. $69.50

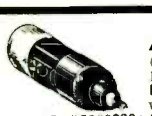
EICOR CLASS "A" NO. 1-3012/08-7

OUTPUT: 125 VAC; 400 cycle; single phase; 100 VA. **INPUT:** 24-30 VDC; 11 amps; Duty int. Voltage and Frequency Regulator $99.50

HAZELTINE PULSE GENERATOR
MODEL 1017

Electrical Characteristics: Pulse Freq: initiating and sliding pulse-external. Pulse Width: initiating and sliding pulses, 10 microseconds. Pulse Amplitude: initiating and sliding pulses, plus 150 volts. Sliding Pulse Delay: variable over full trace length. Sweep Duration: 50, 200, and 1000 microseconds. TUBES: 16-6SJ7; 3-6AG7; 3-6L6; 2-6J5 gt; 2-6SN7 gt; 1-5U4 G; 1-6SK7; 1-6Y6G; 1-991; 1-9002. Power input: 110-125 volts, 60 cyc. single phase; batteries none. Dimensions: 13½" x 20½" x 23". Weight 85 lbs. PRICE $149.50

1 MFD, 25,000VDC CAPACITORS
Mfg. by Cornell-Dubilier
TYPE 25100 .... $59.50 ea.



ALNICO FIELD MOTORS

(Approx. size overall . . . 3¾" x 1¼" diameter)
DELCO TYPE #5069600: 27.5 volts DC; 250 RPM........$15.00
DELCO #5069230: 27.5 VDC; 145 rpm........$15.00
PM Motors Delco Type #5069371: 27.5 volts; DC Alnico Field; 10,000 R.P.M.; dimensions 1" x 1" x 2" long; shaft extension ½" diameter 0.125".....$15.00

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes.........$22.50

AC CONTROL MOTOR

A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 2; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝". **$15.00 ea.**

400 CYCLE MOTORS

EASTERN AIR DEVICES #133 Synchronous Motor 115 Volt; 400 cycle..........................$17.50
PIONEER: TYPE CK5 2 Phase; 400 cycles.$25.00 ea.
EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle..........$17.50 ea.
AIRESEARCH: 115V; 400 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP. .03. **$10.00 ea.**
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM.....$12.50 ea.
EASTERN AIR DEVICES, TYPE J31B: 115 V. 400 1200 Cycle. Single Phase..................$12.50 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps.......$79.50 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 12 H.P. 6500 RPM; 1.5 amps..........$25.00
Electric Motor: PNT—1400—A1—1A Serial No. 207, 208 V., 400 Cycles, 3 Phase Kearfott Co., Inc. **$17.50 ea.**

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle, with 40-1 Reduction Gear $17.50

SMALL DC MOTORS

GENERAL ELECTRIC #5BA10AJ18 . . . 27 VDC; RPM 110; 1 oz. FT..........................$12.50
DELCO #5069625 . . . 27 VDC; 120 RPM; Governor controlled $22.50
EMERSON 175: 12 Volt DC; 1/6th HP; 10 amp; 3800 RPM; Approx. size: 2½" x 5"........$9.95 ea.
DELCO #5072000: 27.5 VDC; 11.75 rpm.....$15.00
DELCO #5068750: 27 VDC; 160 RPM; built-in reduction gears ....$12.50 ea.
J. OSTER: series reversible motor 1/50th H.P.; 10,-000 RPM; 27½ VDC; 2 amps; **SPERRY** #806069; approx. size 1⅝" x 3½"..................$7.00 ea.
General Electric Type 5AB10AJ37: 27 volts, DC; 5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads; reversible $12.50
General Electric, Mod. 5BA10FJ33: 12 oz. inches torque, 12 DC. 56 RPM. 1.02 amp..........$15.00 ea.
General Electric Type 5BA10AJ52C: 27 volts DC; 5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible $12.50
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ-64. 160 r.p.m.; 65 amp; 12-oz.-in. torque 27V DC. $12.50
2¼ H.P. MOTOR—Mfg. LEECE-NEVILLE Co; Type 1454-MO; 24VDC; 4000 RPM; 100 amp.........$35.00

115 VOLT GENERATORS

Brand new Eclipse generators; 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles, 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited $29.95

MICROPOSITIONER

Barber Colman AYLZ 2133-1 Polarized D.C. Relay: Double Coil Differential sensitive. Alnico P.M. Polarized field. 24V contact; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc.$12.50 ea.

BLOWER

Eastern Air Devices, Type J31B: 115 volt; 400-1200 Cycle; single phase; variable frequency; continuous duty; L. & R. #2 blower; approx. 22 cu. ft./min. $15.00

BLOWER: Mfg. John Oster; Type C2A-1B; 27 VDC; .63 amps; 1/100 H.P.; 7000 RPM; Series Wound .....$9.95 ea.

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL, 17CFM, complete with capacitor. New..............$12.50 ea.

TEST EQUIPMENT TS-45/APM

For measuring relative output power and transmitted freq. of radars and adjusting receivers. Components of the set are a thermistor-type power meter, coaxial line-type freq. meter, a 723A oscillator, attenuator, and a choke coupling. Set is designed for continuous wave operation, with jack provided for external pulsing.
Electrical Characteristics: Freq. Range . . . Airborne X Band. **Accuracy:** Freq. Meter plus or minus 5 mc.; Power Meter plus or minus 1.5 db. (relative only). **Signal input:** rf power; minus 10 to plus 37 dbm. **Signal Output:** C. W. av. power 10 mw (plus 10 dbm). **Attenuator:** Calibrated, adjustable 0-30 db loss. **Power:** 110-130 volts, 60-2400 cycles, 55 watts. **TUBES:** 1-723, 1-6V6, 2-6ZY5G, 1-6SL7GT, 1-VR-150-30. Batteries: None. Mechanical Characteristics: 10" x 9½" x 8". Weight: 18 lbs.
PRICE $295.00

C and H Sales Company
BOX 356-X EAST PASADENA STATION • PASADENA 8, CALIFORNIA

Harjo SAVES YOU MORE IN '54!

Check your needs on this list of specially priced aircraft and electronics equipment.

COMPARE PRICES! COMPARE VALUES!

TEST EQUIPMENT

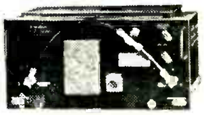
TS-11	$45.00	1E-19	$200.00
TS-34	300.00	I-222	89.50
TS-47/APR	225.00	I-139A	12.50
TS-50/U	14.95	I-183A Frequency Meter	17.50
TS-89	32.50	I-185A Oscillator	24.50
TS-100	85.00	BC-221 Meter	89.50
TS-101	7.50	BC-1287A (S Band)	125.00
TS-126	75.00	LM	85.00
TS-131	14.95		
T5-184	45.00		
TS-268	37.50		

FLUX METER

500-4000 Gauss—Brand new in lab hardwood cases **$27.50**

APS 13 COMPLETE 420 MC RADIOPHONE

when converted with our easy-to-follow schematics and instructions. Range in most cases equal to 2 meters. Fine for short-distance communication, ranches, farms, etc. . . .



$4.95 $14.95 value

Complete with RF sections, conversion booklet, and 30 MC I.F. strip, less tubes, dynamotor.

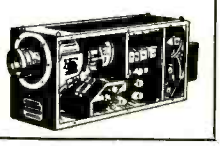
TRANSMITTERS & RECEIVERS

ARC-3 complete, certified	$850.00
BC-640 and BC-639, RA-42	750.00
AN/TRT-I Mine trans.	100.00
ART-13	350.00
BC-797 ground stas	900.00
SCR-284	100.00
BC-1333 Marker Recvrs., certif.	75.00
BC-733D CAATC	35.00
BC-348	145.00
DZ-1 Compass, new	20.00
ARQ-8 Search-Jam Equipment Receiver Trans-mitter Control Box (less tubes and blower)	$35.00
ASB-7 Transmitters—Complete with tubes. Fine for 420 MC and TV relay work	7.95
ARB Receivers—Minor parts missing	12.95

FIRST TIME EVER!

RCA Surplus TV CAMERA!

only **$295**



Complete with 1848 iconoscope and 6-stage video amplifier and clipper. Perfect for use in movie pickup chains and for training and experimental work. UNBEATABLE BARGAIN! Write for complete information!

RADAR EQUIPMENT

APS-4 Complete Radar Set	$550.00
SN complete	400.00
MD-12/ APQ-13 with tubes	25.00
T25/TPS-2	75.00
R65/APN-9	700.00
AN/PPN-1 (Eureka)	50.00
AN/PPN-2 (Eureka)	75.00

TS 45/APM X BAND SIGNAL GENERATOR

Only $250.00

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954	.24
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6K4	4.69
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High Voltage Pulse Transformers. G.E. Types 95G2023, K2748A, K2759

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COMPLETE. 12rpm clockwise, rotation, 115V 60 cy GE motor, incl sine potentiometer & bearing indicator. $137.50
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MOTOR DRIVE ASSY. 115-VDC motor 1/20 hp. 1725 rpm. Gear box 172 rpm, 11 in. lbs. torque. cpld to 9 in. step down gear. $35.00
SCR 584 J-K sect. High speed Rotary Joint. $35.00

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PARABOLIC REFLECTOR 4ft. dia. RCA hi gain dish $84.50
VARIA. COND. 4 gang. 7 to 144 mmf/sect. Ball brg. shaft. $3.25
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COMPLETE STOCK 400 CY. TRANSFOR.

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AN/URA-8A Frequency Shift Convertor Comparator. Compares and selects best of two convertor outputs for maximum operation. New with Tubes. Recent production. Includes Mounting Rack. $135.00 ea.

3 CM. "X" Band

CRYSTAL MOUNT. Holds any IN23 type xtal. 1" x ½" guide std coax output, UG40 flg input. $15.00
DIRECTIONAL COUPLER. Uni dir. 20db. type "N" output, UG39flg. to UG40chk. JAN type CG-176/AP. $25.00
WAVEGUIDE. Std RG-52/U sharp internal corners. Any lgth up to 12 ft. $1.25 per ft.
FLEXIBLE SECTION. Apx 6". UG39 flgs. $10.00
TR-ATR SECTION. Duplexer assy w/ UG-39 to UG40 run, iris cplg. cplg to 1B24 type TR tube, ATR cavity 724 type compl. w/tuning slugs. SO-3 Radar component. $8.50
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TEST EQUIPMENT

Spectrum Analyzer. Model TSX-4SE-8500-9600 MC., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 I.F. stages, 3 video stages, overall gain 125 db., regulated power supply.
Spectrum Analyzer, same as above but modified for 100 to 1000 MC frequency range.
X Band VSWR Test Set. TS-12, complete with linear amplifier, direct reading VSWR meter, slotted waveguide with gear driven traveling probe, matched termination and various adaptors, with carrying case.
R. F. Power Meter—1 to 600 MC 0-15 and 0-60 Watt scales. May be used as dummy load for 0 to 1000 MC.—100 W maximum. VSWR less than 1.1 from 0 to 600 MC., less than 1.3 from 600 to 1000 MC.
X Band Pick up Horn. AT48/UP with coax fitting.
TS-45/APM-3 Signal Generator 8700-9500 MC. 110V 60-800 cps.
TS-35A/AP X Band Signal Generator. pulsed, calibrated power meter, frequency meter, calibrated attenuator. 110V 60-800 cps.
30 MC I.F. Strip. Video and Audio Amplifier and 115 volt 60-2600 cps Power Supply. Bandwidth 10 MC. new, part of SPR-2 receiver.
High Pass Filter F-29/SPR-2. Cuts off at 1000 MC. and below; used for receivers above 1000 MC.
TS-125 Calibrated S Band Power Meter with attenuator.
TS-110 S Band Echo Box 2400 to 2700 MC., Portable.
S Band Signal Generator Cavity with cut-off attenuator. 2300 to 2950 MC., 2C40 Tube, with modulator chassis.
VD-20K Voltage Divider for measuring high video pulses. 20 KV max. ratio's 1:10 and 1:100. transmission flat within 2db. 150 cps to 5 MC.
Waveguide Below Cut-off Attenuator L101-A. UHF connectors at each end. calibration 30-100 db.
TAA-16 Tuned Linear Audio Amplifier. 300 to 8000 cps. output meter reads direct in VSWR or Power DB. Regulated power supply. 110V 60 cps.
FPM 3 X Band Power and Frequency Meter. frequency meter 8500 to 9600 MC., accuracy ± 4 MC absolute. ± 0.5 MC on frequency difference up to 60 MC. Calibrated attenuator 0-30 db, power measuring range .1 to 1000 MW. pulsed or CW without external attenuator. video detector, self-contained battery powered, portable. with coaxial and waveguide adaptors.
T85/APT 5. 300 to 1600 MC. 40 watt noise modulated transmitter.
110-330 MC Oscillator Butterfly.
80-300 MC. Mixer Butterfly with socket for 955 (used as diode)
400-800 MC. Oscillator Butterfly with 703 tube mounted on it.
Field Intensity Meter. RCA 308A, 120 to 18000KC.
S Band Signal Generator—2K28 Klystron, self-pulsed or ext. triggered.
Mark 5, "S" Band Signal Generator—2.4 to 3.4 KMC 2C40 Oscillator, Motor tuned.
X Band Receiver. tuneable, waveguide input 9200-9600 MC.
QX Checker. Boonton, Type 110.-A.
Synchroscope—Sylvania Model 5.
Synchroscope—Model P4.
D.C. Amplifier—TS 580/U-GR Model 715 AM.
Hetrodyne Frequency Meter—GR616C, 100 to 5200 KC.
Noise Distortion Analyzer—H.P. Model 325B.
Sweep Speed Calibrator. 200 KC. 1 MC, 5 MC.
Tuning Units P/O APR-4 TN16 30-80 MC. TN17 80-300 MC., TN18 300-1000 MC. TN19 1000-2200 MC., TN54 2200-4000 MC.
AN/APR 1 Receiver. used with above tuning units. 110 V 60 cycle.
Measurements 75 Standard Signal Generator. Calibrated output. 124 to 510 MC.
Rotary Joints. ⅞" Coaxial. S Band.
Antenna. Coaxial. pressurized. S Band. Can be used with parabolic reflector.
Microvolter—Ferris Model 10B + 10C.
Frequency Standard—James Knight Co. 1, 5 and 10 MC check points.
F. M. Test Set—X Band. with wavemeter and wattmeter. 110V 60 cycle AC.
Recording Ammeter — Esterline Angus 0-5MA.
TS-36-8.5 to 9.6 KMC Power Meter .1—1000 MW.
TS-33-8.7 to 9.5 KMC Frequency Meter and Video Detector.
K Band—slotted line, gear driven traveling probe.
K Band—Attenuator 27 to 34 KMC.
K Band—Low Power Dummy Loads. 1 Watt.
TS-13/AP Consists of Signal Generator "Xa" Band. Wavemeter + wattmeter.
TS-155 Test Set for S Band radar—uses 2C40 oscillator, self-contained. power monitor, self-pulsed 115V 60-800 cycles.
Impedance Bridge—Type TBX-1BR 8.5 to 9.6 KMC—CRT Indicator.
S Band directional couplers 3½" waveguide.
S Band Coaxial to Waveguide door know transition 1 ⅝ coaxial to 3 ½ waveguide.
S Band Low power waveguide terminations.
CN 29 S Band Coaxial Attenuator. Type N Connectors. 20 db.
Model P 142 Signal Generator 1200-4000 mc—with wavemeter and wattmeter.
High Power U.H.F. Attenuator 100-Watts 20 db. 30 db or 40 db. 51.5 OHMS impedance, type N connectors, dissipates 100 watts of power. uses tapped load resistor as above. frequency range 1-700 Megacycles.
P M 12 Peak reading power meter 50 KW maximum, 2-700 Mc. can be used for dummy load up to 100 Watts average power.
TPS-52-PB S Band Attenuator. variable. ⅞" coaxial with type N adaptors.

HIGH POWER DUMMY LOADS

X Band, 1¼" x ⅝" guide, choke or plain flange, dissipates 350 watts average power continuously in still air. VSWR less than 1.15 between 7 and 10 KMC, weight 5¼ pounds.
X Band, ½" x 1" guide, choke flange, dissipates 250 watts average power continuously in still air, VSWR less than 1.15 between 8.2 x 12.4 KMC, weight 3¼ pounds.
X Band, 1¼" x ⅝" guide, plain flange, dissipates 200 watts average power continuously in still air, VSWR less than 1.15 between 7-10 KMC, weight 3¼ pounds.
X Band, 1¼" x ⅝" guide, plain flange, dissipates 250 watts average power continuously in still air, weight 2 pounds 4 ounces.
S Band, 1½" x 3" guide dissipates 1,500 watts average power in still air, VSWR less than 1.15 between 2.5 to 3.7 KMC, choke flange, weight 13 pounds.
TS 231 X Band Dummy Load 7-10 KMC Max VSWR 1.1, dissipates 200 Watt average power in still air.
TS 108 X Band Dummy Load 9300 MC, Max VSWR 1.15.
X Band, High power attenuator 8-12 KMC, 250 watts dissipation Fixed attenuation from 6-50 db.
L Band Coaxial Dummy Loads, 500 Watts Dissipation 1½ coaxial.
Coaxial Dummy Load—DC to 300 MC 1000 Watts in still air, type N Input connector, VSWR less than 1.2.
TS 235 Coaxial High Power Dummy Load "L" Band—1½" coaxial.
High Power Dummy Load—3 inch coaxial.
TS 338 S Band, dummy load—2.5 D 3.7 KMC, Maximum VSWR 1.1 dissipates up to 700 watts in still air.

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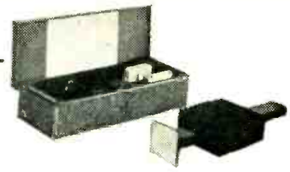

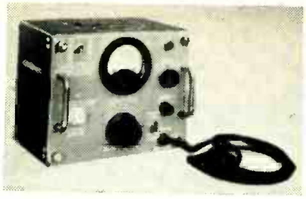

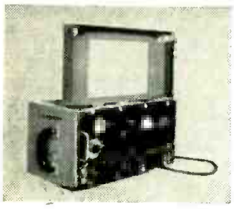

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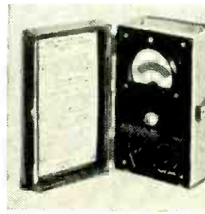

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AS-23
AT-67
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AT-48
BE-67
BC-221*
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BC-438
BC-439
BC-638
BC-639
BC-906D
BC-918B
BC-923A
BC-936A
BC-949/A

BC-595-TU
BC-1060A
BC-1066A
BC-1201A
BC1203
BC1236/A
BC-1255/A
BC-1277
BC-1287A
1-48B
1-49
1-56
1-61B
1-83A
1-86A
1-95A
1-96A
1-97A
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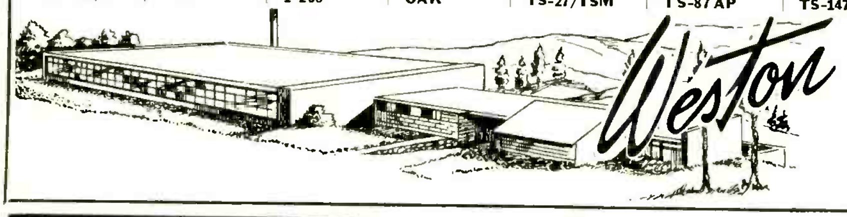

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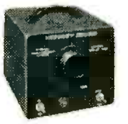

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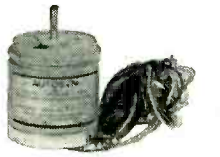

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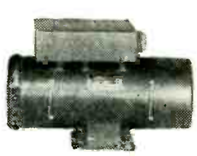
Precision motor generator with ball bearings. 115 volts d-c on the motor. We have various models with the following generator outputs: .6 volts/M, 3 volts/M, 9 volts/M, 4.5 volts/M. Please specify which generator output you desire. Motor speeds approximately 7500 rpm.

SA-427 . . . . $24.50

1500 VA INVERTER



GE — 5AS131-NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 ϕ at 1500 VA. PF 0.8 W.E. Spec. Ks-5601L1.

SA-286 . . . . $14.50

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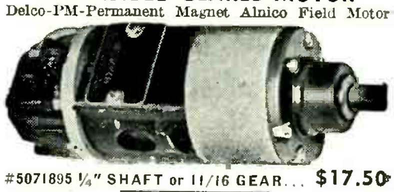
PRODUCTS CO.
INCORPORATED
1086 Goffle Rd. Hawthorne, N. J.
HAwthorne 7-3100

REVERSIBLE GEARED-MOTOR

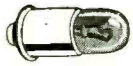
Delco-PM-Permanent Magnet Alnico Field Motor



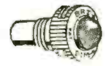
#5071895 1/4″ SHAFT or 11/16 GEAR . . . **$17.50**
#5069600 . . . . **$18.50**
Clamps to hold motor: $1.50 ea.

GRAIN OF CORN LAMPS

28 VOLTS

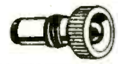


#328 #321



10 for $3.00 100 for $25.00

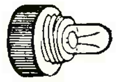
#318 3V AMBER OR CLEAR



10 for $1.80
100 for $15.00

LM32 10 for $4.50
Bausch & Lomb 10 for $6.50

EXTENSION SOCKET ON CORD & TRANSFORMER FOR LM 32 **$3.50**



#326 2½ Volts 10 for $3.00

REDMOND Powerful 5″ Blower or Ventilator 115 volts AC 60 cycles 18 watts. For Kitchen — Laboratory. Heat or Cold or Chemicals . . . **$8.95**

Ford Spark Coil by Delco-Remy 1/2″ $2.75

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A Miracle Switch that will not leave you in the Dark. Delayed Action Light Switch **$1.95**

3″ Round Elapsed Time Meter **$13.75**

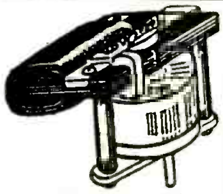
MARKTIME 5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE **$4.90**

Also available in 15 min., 30 min., 1 hr. at $5.90

10 Seconds to 24 Minutes Timer

A hand wound electric TIMING SWITCH, Pointer moves back to ZERO and shuts off RADIO—TV—Electric Mixer—Photographic Devices—Time Delay etc. Furnished with Calibration Chart and Pointer Knob. Biggest bargain we ever had **$1.25**



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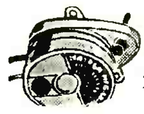
3 RPM	3.90
4 RPM	2.90
3.6 RPM	3.15
1 RPM	3.95
60 RPM	4.30
3 R.P. Hr.	2.85
1 R.P. 2 HP	2.80
1 R.P. 12 Hr.	3.25

Laboratory Special 1 of Each Above . **$25.00**

HAYDON SYNCHRONOUS TIMING MOTOR



110v. 60 cycle 30 RPM . . . **$2.60**
110v. 60 cycle 1 RPM **$2.85**
230V 60C 1 RPM **1.00**
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MFD	V.D.C.	Price	MFD	V.D.C.	Price
1	1000	$0.32	4	800	.75
1	6000	7.50	5–5	400	.70
2	600	.45	7	600	1.05
2	1000	.55	10	600	1.10
3–3	600	.85	.25	600	.22
4	1000	.80	.25	6000	.75
4–4	1000	1.10			

BATHTUB CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.05	600	$0.19	.1–.1–.1	600	.24
.05–.05	600	.22	1	400	.25
.1–.1	600	.20	1	600	.28

HEADSETS

	Excellent USED	BRAND NEW
HS-23 high impedance......	$2.95	$4.75
HS-33 low impedance......	2.45	5.75
HS-30 low imp (featherwt)..	1.49	2.45
H-16/U high imp (2 units)......		4.95
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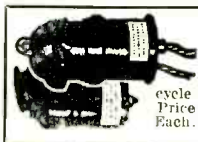
BC-221 FREQUENCY METERS

Reconditioned. PERFECT! Complete with tubes and crystal **$129.50**



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Operates from 57½ V 100 cycles. Suggested wiring for 110 V 60 cycle included. New, tested. Price Each.......... **$4.50**

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Type	Input		Output		Excellent Used	Brand New
DM-32A	28V	1.1A	250V	.05A.	$4.90	$7.50
DM-33A	28V 28V	5 A. 7 A.	575V 540V	.16A. .25A.	2.25	3.95
DM-34D	12V	2.8A.	220V	.080A.	14.50	....
DM-40	14V	3.4A.	172V	.138A.	....	7.95
DM-28	28V		224V	.07A.	3.95	6.95
DM-21	14V		235V	.09A.	6.85	16.50
PE-73	28V	20A.	1000V	.350A.	9.50	12.50
PE-86	28V	1.25A.	250V	.060A.	2.95	5.50
PE-94A	28V	10A.	300V 150V	.200A. .101A.	7.50	11.50
PE-94C	28V	10A.	300V 150V	.200A. .101A.	10.00	12.75
PE-98	14V	21A.	300V 150V	.200A. .101A.	22.50	37.50
PE-101	13V 26V	12.6A. 6.3A.	400V 9V AC.	.135A. 1.12A	3.75	4.85
PE-103	6V 12V		500V 500V	.160A. .160A.	27.50	44.50
PE-104 (Vibrator)	6V 12V	1A. 5A.	84V 51V	.09A. .03A.	12.50	14.50
DM-414 (with filter)	14V	2.8A.	1.4V 220V	.400A. .080A.	....	12.50
PS-225 (with filter)	28V	3.2A.	375V	.150A.	....	10.50
EICOR Dynamotor D-401	27V	6.05A.	300V 18V AC	.200A. 2.2A.	....	9.95
PE-135AX (with filter)	24V	12A.	500V	.200A.	....	34.50

GENERATOR

GN-39-F (16" L, 8" dia. 50 lbs.)	14.6V	25A.	1000V	.350A	....	39.50

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PE-206 Inverter—Leland
In: 28V DC—38A.
Out: 500V 800 cyc. 80VA. 1 Ph....... 9.75 12.50

PE-218 Inverter—Leland-Wincharger—GE.
In: 28V DC—92A.
Out: 115V 380/500 Cyc. 1500VA. I Ph. 16.50 24.50

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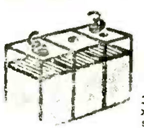

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3-amp hr. BRAND NEW. 3⅝" x 1-13/16" x 2⅜". Uses standard electrolyte. **$2.65**

WILLARD 2-Volt Storage Battery
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1-QUART ELECTROLYTE For Above. Enough For TWO CELLS. BOTTLE **$1.45**

7-Prong 2-Volt VIBRATOR. For Portable And FARM SETS (GE LB530). **$1.49**

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Three term, bot. mtg. channel type. Dims. 3¾"x2½"x2". Two 5 mfd. sections rated 400 V at 72 deg "C". 1800 V test. Meets commercial specs. for 600 V operation up to 40 degs "C". Ideal for filter or power factor application. Repeat sales prove this rugged high quality condenser to be of outstanding value. Carton of 24, weight 42 lbs. Large qua. available **$.89**

4 mfd.—600 v Type TLA $1.45
Brand New-Orig. Cartons—4½ x 1½.

1 mfd.—6 kv......... $7.95

1 mfd.—25 kv...... $59.50

16 mfd.—600 v....... $1.75
Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket.

Mfd.	Volts	Price	Mfd.	Volts	Price
.0016	15KV	55.75	2	600V	.59–.79
.0023	16KV	5.95	2	1000V	.85
.005–.005–			2	1000V TLA	1.29
.01	10KV	4.75	2	1500V	1.69
.012	25KV	22.50	2	2000V	2.80
.02	10KV	5.25	2	2500V	3.95
.02	20KV	17.90	2	3000V	5.80
.025–.025–			2	4000V	7.95
	50KV	55.00	2	5000V	12.50
.03	7500V	4.50	2	7500V	32.95
.03	16KV	15.95	2	12.5KV	59.50
.035	10KV	12.95	2	32KV	P.U.R.
.05	5KV	2.49	2–2	600V	1.25
.05	7500V	2.95	3	600V	.59
.08	12.5KV	15.95	3	4000V	11.95
.1	1500V	.59	3–3	150V	.35
.1	2000V	.49	3–3–3	400V	1.05
.1	2500V	1.39	4	600V	1.25
.1	3000V	1.89	4	600VTLA	1.45
.1	5000V	1.95	4	600VTLAD	1.40
.1	7500V	1.75	4	100V	1.95
.1	7500V	3.50	4	1500V	2.65
.1	10KV	9.50	4	2000V	4.35
.1	10KV	12.95	4	2500V	5.95
.1	12KV	14.95	4	3000V	7.55
.1	12KV	14.95	4	4000V	13.95
.1	25KV	29.50	4	5000V	24.95
.1–.1	2000V	.98	4	7500V	52.50
.1–.1	7500V	3.50	4–4–4	600V	2.40
15–.15	8000V	1.95	5	330VAC	1.75
.2	10KV	10.95	5	600V	1.75
.2	15KV	17.95	5	1000V	1.99
3x 2	4000	2.85	5	1500V	2.98
.25	2000V	1.35	6	330VAC	1.75
.25	2500V	1.29	6	600V	1.85
.25	6000V	1.75	6	1000V	2.49
.25	4000V	3.25	6	1500V	3.65
.25	3000V	1.45	6	2000V	3.95
.25	15KV	15.95	7	600V	1.45
.25	20KV	19.95	7	800V	1.99
.25	32.5KV	59.50	8	500V	1.35
.25	50KV	85.00	8	600V	2.25
.3	2000V	1.45	8	600V Rg	1.79
.4	10KV	19.95	8	660VAC	3.50
.5	1500V	1.20	8	1000V	3.25
.5	2000V	1.85	8	1500V	4.25
.5	2500V	2.20	8	2000V	7.25
.5	3000V	2.39	8–8	600V	1.75
.5	1000V	3.15	8–8–8	500V	2.25
.5	5000V	4.15	10	600V	2.75
.5–.1	2000V	.90	10	660VAC	5.90
.5–.5	600V	.69	10	1000V	4.55
.5–.5	1000V	.69	10	1500V	6.25
.5	25KV	55.50	10	6000V	99.50
1	400V	.45	12	1000V	4.95
1	500V	.59	12	1500V	6.75
1	1000V	.69	12	2000V	6.95
1	1500V	1.35	15	330VAC	3.95
1	2000V	1.95	15	440VAC	4.95
1	2500V	2.50	15	600V	3.25
1	3000V	3.35	15	1000V	5.35
1	5000V	6.85	15	1500V	6.35
1	6000V	8.25	15	5000V	63.50
1	7000V	12.60	16	1500V	8.95
1	10KV	27.95	20	600V	5.85
1	15KV	49.50	20	330VAC	4.69
1	16KV	49.50	28	1000V	7.50
1	20KV	59.50	30	330VAC	5.25
1	25KV	70.00	80	4000V	49.50

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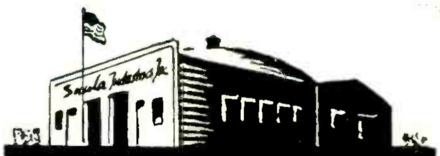

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RT-18 (ARC-1) Transceiver	495.00
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BC-639 Receiver	245.00
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BC-611 Handy Talkie	110.00
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BC-221 Freq. Mtr.	99.50
ID-60/APA-10 Ind.	145.00
CRT-3 Dual Channel	75.00
BC-733D Receiver	34.50
APN-9 Loran	850.00
TS-251 Loran Test	650.00

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IE-36 Test Set	49.50
TS-35/UP Test Set	495.00
M-299 Mike Adaptor	3.95
AN-104B Antenna	6.75
AS-27A Antenna	27.50
MG-153 Inverter	115.00
MG-149F Inverter	52.50

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OB3	.85	204A	37.50	918	2.25
OC3	.85	211/VT4C	.75	921	1.75
OD3	.85	FG235A	75.00	923	1.75
1B24	6.75	W.E. 282A	9.75	931A	3.95
1B29	2.40	W.E. 283A	3.25	954	.35

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1B32/WL 532A 1.00

1P23	2.50	W.E. 285A	4.25	955	.35
1P32	3.95	W.E. 290A	3.25	957	.45
1P36	3.95	W.E. 292A	3.25	CK1005	.45
1P40	1.50	W.E. 293A	3.25	CK1006	1.45
2C40	7.75	W.E. 303A	3.75	2050	1.40
2C42	7.50	307A	3.75	2051	1.00
2C43	14.50	CE 309	4.75	5654	1.75
2C46	7.50	W.E. 310A	4.25	5691	6.75
2C51	3.95	394A	2.50	5693	5.25
2C52	3.50	446A	1.00	9001	.85
2D21	.95	WL460	12.00	9002	.80
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2J62	32.50	703A	2.95	2AP1	6.95
2K22	19.50	706B	18.50	3AP1	4.95
2K23	11.25	715C	15.00	3AP1A	8.95
2K28	25.00	717A	.65	3BP1	3.50
2K33A	99.50	801A	.35	3DP1	2.75
2K54	99.00	807	1.45	3GP1	2.75
2K55	99.00	811A	2.95	3JP1	9.75
C3J	3.75	813	9.25	5BP1A	9.00
C6J	8.75	814	2.50	5HP1	4.25
6C21	18.00	815	4.50	5HP4	4.25
10Y	.45	832A	7.50	7BP7	4.25
28D7	1.45	845	6.75	9GP7	4.25
RK60/1641	1.95	860	2.95		

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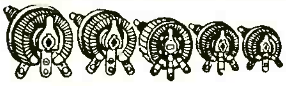

"Be Right with" **MODELS H-J-G-K-L-P-R**

FAMOUS MAKE

Ohms	Watt	Mod	Each	Ohms	Watt	Mod	Each	Ohms	Watt	Mod	Each
.1	150	L	4.89	40	225	P	6.41	500	300	N	6.93
.5	150	L	4.89	50	50	J	2.10	585	150	L	4.63
1	50	J	2.34	75	25	H	1.86	750	25	H	1.86
2	25	H	1.86	75	75	G	3.25	780	100	K	3.60
2	100	K	3.86	80	50	J	2.10	1000	25	H	2.10
2	300	N	6.93	100	25	H	1.86	1000	50	J	2.22
3	100	K	3.86	100	100	K	3.60	1200	225	P	6.41
3	225	P	6.41	100	150	L	4.63	1250	50	J	2.22
5	50	J	2.10	125	25	H	1.86	1250	150	L	4.90
5	100	K	3.86	150	50	J	2.10	1500	25	H	2.10
6	25	H	1.86	175	25	H	1.86	1500	50	J	2.22
6	50	J	2.10	175	500	R	9.88	1600	50	J	2.22
6	75	G	3.25	200	25	H	1.86	1800	50	J	2.22
7.5	75	G	3.25	200	100	K	3.60	1800	150	L	5.15
7.5	225	P	6.41	200	150	L	4.63	2000	25	H	2.10
8	50	J	2.10	225	50	J	2.10	2250	150	L	5.15
8	500	R	9.88	250	25	H	1.86	2500	50	J	2.22
10	25	H	1.86	300	50	J	2.10	2500	100	K	3.71
12	25	H	1.86	300	75	G	3.25	2500	150	L	5.15
12.5	500	R	9.88	300	100	K	3.60	3000	100	K	3.71
13	100	K	3.60	350	25	H	1.86	5000	25	H	2.22
15	25	H	1.86	350	150	L	4.63	5000	50	J	2.34
15	75	G	3.25	378	150	L	4.63	5000	100	K	4.11
20	25	H	1.86	400	75	G	3.25	7500	50	J	2.34
20	50	J	2.10	500	25	H	1.86	7500	100	K	4.40
25	25	H	1.86	500	75	G	3.25	10K	50	J	2.50
25	300	N	6.93	500	100	K	3.60	10K	100	K	4.75
25	500	R	9.88	500	150	L	4.63	20K	150	L	6.98

OTHER STANDARD BRANDS

Ohms	Watt	Each	Ohms	Watt	Each
1	50	1.64	185	25	1.30
1.1	50	1.64	200	25	1.30
5	25	1.30	200	50	1.47
7	25	1.30	250	50	1.47
8	50	1.47	300	50	1.47
10	50	1.47	350	25	1.30
10	100	2.52	370	25	1.30
12	50	1.47	400	25	1.30
15	25	1.30	500	25	1.30
15	100	2.52	500	50	1.47
16	50	1.47	500	150	3.24
30	50	1.47	750	150	3.24
37.5	50	1.47	800	25	1.30
50	25	1.30	1000	25	1.47
50	50	1.47	1200	300	4.85
60	25	1.30	1500	25	1.47
75	25	1.30	2000	50	1.55
75	50	1.47	2500	25	1.47
75	300	4.85	3000	25	1.47
100	25	1.30	10K	50	1.75
100	50	1.47	15K	25	1.93
125	25	1.30	20K	4	.75

AVAILABLE IN ALL SHAFT SIZES—Knob Type or 1/8" Screw-driver. Specify type shaft required.

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HIGH POWER TRANSMITTING MICAS

G-1 TYPE

.0001	6 KV	12.18	.0008	6 KV	14.00
.00015	5 KV	12.18	.001	6 KV	14.00
.00015	6 KV	12.18	.0015	6 KV	14.67
.0002	6 KV	12.18	.02	3 KV	15.44
.00024	6 KV	12.76	.032	2 KV	15.44
.00025	6 KV	12.76	.04	1 KV	17.55
.0004	6 KV	13.31	.051	1.5 KV	18.21
.0005	6 KV	14.00	.08	1.5 KV	19.72
.00075	6 KV	14.00	.09	1.5 KV	20.25

G-2 TYPE

.0001	10 KV	19.67	.0005	10 KV	19.67
.00015	10 KV	19.67	.00065	10 KV	1
.0002	10 KV	19.67	.0008	10 KV	19.67
.00027	12 KV	19.67	.001	10 KV	19.67
.0003	10 KV	19.67	.01	5 KV	20.75
.000375	10 KV	19.67	.03	2 KV	21.00
.0004	5 KV	19.67	.045	2 KV	21.00

G-3 TYPE

.00005	20 KV	33.27	.0011	20 KV	43.50
.0001	20 KV	36.30	.0012	20 KV	44.62
.0001	25 KV	37.80	.00124	15 KV	44.75
.00015	20 KV	37.80	.0015	20 KV	45.38
.00025	20 KV	39.33	.0016	15 KV	42.96
.0003	20 KV	39.33	.002	12 KV	42.35
.0004	20 KV	41.15	.0025	12 KV	45.00
.00045	15 KV	41.15	.004	12 KV	45.38
.00047	20 KV	41.15	.005	5.5 KV	28.50
.0005	20 KV	41.15	.006	10 KV	45.38
.0008	20 KV	41.15	.015	3 KV	45.38
.00095	5 KV	42.35	.015	7 KV	45.38
.001	15 KV	42.35	.05	3 KV	45.81
.001	20 KV	42.35	.25	1.6 KV	45.81

G-4 TYPE

.00025	30 KV	66.35	.0025	25 KV	68.73
.0003	25 KV	66.35	.005	20 KV	75.68
.00032	25 KV	66.35	.006	15 KV	75.68
.00032	30 KV	66.35	.0066	15 KV	75.68
.0005	30 KV	66.35	.0075	12.5 KV	78.00
.0006	35 KV	67.50	.01	15 KV	81.73
.00062	30 KV	66.35	.01083	12 KV	81.73
.00065	35 KV	67.50	.01163	5 KV	30.60
.0008	30 KV	66.35	.03	8 KV	81.73
.001	25 KV	68.73	.056	5 KV	83.17
.0015	25 KV	68.73	.05668	2 KV	30.75

G-5 TYPE

.000155	30 KV	139.20	.000533	30 KV	151.25
.0004	30 KV	139.20	.001	30 KV	163.20

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MFD	VOLTS	EACH	MFD	VOLTS	EACH
.3	600	.93	2	600	.75
.5	600	1.19	3	240AC	1.95
1	250AC	.70	3	600	2.09
1	330AC	.79	4	220AC	1.85
1	500	.65	4	400	1.75
1	600	.68	4	600	1.95
1.25	220AC	.75	4	700	2.25
1.25	330AC	.80	5	50	1.25
1.5	400AC	.87	5	600	2.35
2	200	.49	6	400	2.49
2	220AC	.69	6	600	2.85
2	250AC	.79	8	600	3.38
2	330AC	.89	10	600	3.75
2	400	.65	15	600	2.79
2	500	.69	30	90AC	4.75

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3-1/2" mounting centers

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.0025	1500	1.59	.5	7500	8.95
.004	10 KV	2.25	.75	1 KV	1.25
.0075	7 KV	2.95	1	1 KV	1.59
.0075	10 KV	3.75	1	1500	1.85
.02	7500	5.30	1	2 KV	2.35
.05	2500	1.65	1	2500	3.49
.1	2 KV	1.65	1	3 KV	4.95
.1	3 KV	3.49	1	6 KV	12.95
.1	3500	3.90	2	1 KV	1.98
.1	6 KV	7.95	2	1500	2.49
.1	7500	11.25	2	2 KV	2.75
.1	20 KV	39.50	2	2500	5.49
.25	1500	1.40	2	4 KV	10.95
.25	2 KV	1.80	4	800AC	3.75
.25	3 KV	3.49	4	1 KV	2.50
.25	3500	3.95	4	1500	3.49
.25	4 KV	6.50	6	440AC	3.75
.25	5 KV	7.49	8	440AC	3.90
.3	2 KV	1.85	8	1 KV	3.95
.5	1500	1.59	10	1 KV	4.25
.5	2 KV	1.85	10	2500	14.95
.5	2500	2.90	12	1 KV	4.59
			15	1 KV	7.49

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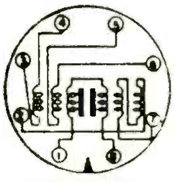

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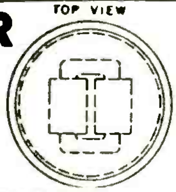
Each Coil—50-T#36E
Max. DC Res. Ohms
1 & 8= 4.02Ω
2 & 7=4.542Ω
3 & 4=2.357Ω
5 & 6=2.185Ω



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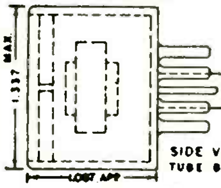

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Type No.	Price	Type No.	Price
0Z4	$ .54	6X4	.36
1A7	.49	6X8	.74
1AX2	.61	7B4	.44
1B3	.67	7L7	.59
1L4	.45	12AT6	.39
1LN5	.59	12AT7	.64
1R5	.48	12AU6	.39
1S4	.58	12AV7	.69
1T4	.48	12AX4GT	.59
1U4	.48	12AX7	.59
1U5	.48	12BX7	.65
1X2A	.63	12BZ7	.63
3A5	.93	12C8	.34
3Q4	.48	12K8	.58
3S4	.48	12K8GT	.85
3V4	.51	12SA7GT	.64
5Y3GT	.36	12SF7GT	.69
5Z3	.44	12SH7	.75
6AC7	.85	12SK7GT	.62
6AF4	.89	12SL7GT	.49
6AG5	.46	12SQ7GT	.56
6AK5	.73	14A5	.59
6AT6	.37	25BQ6GT	.75
6AU6	.40	25L6GT	.39
6AV6	.37	25Z6GT	.38
6AX4	.55	32L7GT	.98
6B8	.85	35W4	.37
6B8G	.53	35Y4	.45
6BA6	.40	35Z3	.43
6BE6	.37	35Z5GT	.48
6BZ7	.89	45Z3	.42
6C5	.39	50B5	.40
6CB6	.45	50C5	.44
6CD6	1.10	50L6GT	.62
6D6	.69	55	.49
6F8G	.99	58	.58
6J6	.49	70L7GT	1.00
6N7	.98	76	.43
6SH7GT	.50		
6SL7GT	.49		
6U7G	.45		
6U8	.59		

TRANSMITTING AND SPECIAL PURPOSE

Type No.	Price
OA3/VR75	$ .99
OA4G	.65
OB3/VR90	.95
OC3/VR105	.98
OD3/VR150	.89
1B22	1.80
1B23	8.70
1B24	8.89
1B26	2.19
1B27	10.50
1B29	2.90
1B32	1.90
1B35	7.85
1B42	15.90
1B63A	49.00
1C21	1.29
1D21	3.80
2C34	.59
2V39A	29.95
2C40	6.95
2C43	15.95
2C44	.89
2C46	11.50
2C51	3.66
2D21	1.09

Type No.	Price	Type No.	Price	Type No.	Price	Type No.	Price	Type No.	Price	Type No.	Price
2E22	1.19	2K22	22.50	3C31	3.39	6K4	3.50	328A	6.50	714AY	17.50
2E30	2.30	2K23	10.95	3C33	9.40	12L8GT	1.30	350A	10.00	715A	4.95
2E31	1.25	2K25	28.19	3D21A	7.95	12SY7	1.10	350B	5.65	715B	6.50
2E43	1.29	2K28	27.40	3D22	13.50	15E	1.85	357A	14.50	715C	17.50
2J21A	15.50	2K29	22.50	3E29	10.95	15R	.89	371B	1.90	717A	.58
2J22	11.50	2K33	215.00	4X150A	34.50	FG17	3.80	388A	1.45	719A	4.10
2J26	26.95	2K39	130.00	4B26	6.50	24G	1.30	394A	4.95	721A	2.50
2J27	29.50	2K41	125.00	4C27	24.95	26A6	2.95	417A	12.50	723A/B	19.50
2J31	24.00	2K45	145.00	4C28	34.00	FG27A	8.10	434A	12.50	724A	3.50
2J32	28.50	2K50	340.00	4C35	22.50	35T	3.40	446A	2.40	724B	1.90
2J33	26.00	2K54	198.00	4E27	17.40	100TH	9.85	446B	3.40	725A	9.50
2J34	23.50	2K55	197.00	4J31	98.50	100TL	17.25	450TH	49.00	726A	9.50
2J36	98.00	2K56	175.00	4J38	98,50	203A	8.95	450TL	44.00	726B	43.00
2J37	12.50	2Y3G	1.99	4J52	195.00	204A	95.00	471A	2.70	726C	62.00
2J38	17.50	2X2	.39	5C22	37.50	211	2.21	529	24.00	730A	23.00
2J39	9.50	2X2A	1.15	5D21	14.50	221A	.49	530	9.50	800	2.95
2J40	34.00	3B22	2.40	5J29	11.50	242C	9.95	531	5.50	801A	.39
2J48	24.00	3B24	4.60	6AK5W	1.75	249C	4.50	532A	3.50	802	4.10
2J49	84.00	3B24W	7.11	6AR6	2.85	250TH	18.50	673	12.00	803	2.90
2J50	90.00	3B25	3.49	6AS6	1.75	250TL	17.50	700A	24.00	804	9.90
2J51	225.00	3B26	3.65	C6J	9.50	304TH	7.90	701A	6.90	805	2.90
2J55	83.00	3B28	5.95	6C21	23.90	304TL	7.50	703A	4.70	806	23.00
2J56	145.00	3C22	79.00	6D	2.65	307A	4.80	705A	1.50	808	2.50
2J61	44.00	3C23	7.29	6D4	2.65	316A	2.50	706AY	44.00	812	2.50
2J62	44.00	3C24	1.75	6J4	4.95	323B	6.51	707B	14.50	814	3.80
										815	3.90
										826	.89
										829	7.80
										829B	10.10
										830B	2.50
										832	7.50
										832A	9.90
										833A	39.00
										834	5.80

Type No.	Price	Type No.	Price
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837	1.40	1851	.180
838	4.80	2050	1.39
841	1.30	7193	.55
842	.60	8012	2.50
843	1.20	8013A	3.80
845	5.90	8014A	.79
849	28.95	8019	1.70
857B	151.10	8020	2.90
860	6.85	8025A	4.50
861	22.50		
864	.85		
865	1.20		
866A	1.45		
869B	65.00		
872A	3.10		
874	1.30		
878	3.50		
884	1.80		
885	1.40		
889RA	189.50		
954	.34		
955	.54		
956	.85		
957	.34		
958A	.65		
991	.60		
CK1005	.60		
1280	1.10		
1608	5.70		
1613	.82		
1616	1.95		
1619	.35		
1624	1.70		
1625	.29		
1626	.49		
1629	.44		
1630	1.10		
1631	1.40		
1632	.65		
1633	.89		
1634	1.10		
1641	.79		

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1N22	1.75
1N23	1.95
1N23A	2.70
1N23B	3.50
1N34	.65
1N35	1.95
1N43	1.95
1N45	1.80
1N47	3.95
1N48	.60
1N51	.49
1N54A	1.10
1N58A	1.65
1N60	.60
1N63	2.50
1N64	.57
1N69	.89

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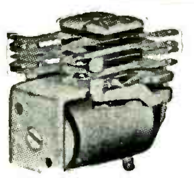

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ELAPSED TIME METER, 110 volt 60 cycle, registers to 9,999.9 and repeats, Cramer RT-2H, 3½" rd case $13.50
ELAPSED TIME METER, 200-240 Volts 60 cycle, to 9,999.9 hrs. and repeats, Cramer RT-3H 3" square case $13.50
DC MICROAMMETER, 0-50, Electrotech #350, AWS type MR34W050DCUA, 3½" case ..... $ 8.50
DCMA, 0-500, SC type IS-122, st #3F222, G.E. 2½" bl sc ..... $ 6.50
RF Amp, 0-3, for Navy XMTR, Weston 507, 2½" case, black scale $7.50
RF AMP, 0-8, SC type IS-89, GE DW-44, 2½" case, bl. sc. $6.50
DCMA 0-200, for TCS XMTR, Weston 506 .. $ 8.50
RF Amp, 0-3, for Navy XMTR, Weston 507, 2½" case, black scale ..... $ 7.50

Items Brand New and Guaranteed Net FOB warehouse. Send for additional listings, details.

AVONIC ASSOCIATES
124 Birchwood Road Paramus, N. J.
Ridgewood 6-6336

Quick ANSWERS to your business problems...

MISCELLANEOUS business problems are daily being solved quickly and easily by the use of the Searchlight Section of McGraw-Hill publications.

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When you want additional employees, want to buy or sell used or surplus new equipment, want additional products to manufacture, seek additional capital, or have other business wants—advertise them in the Searchlight Section for quick, profitable results!

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McGRAW-HILL PUBLISHING CO., INC.

330 West 42nd Street, New York 36, N. Y.

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- Food Engineering
- National Petroleum News
- Nucleonics
- Petroleum Processing
- Power
- Product Engineering
- Textile World
- Welding Engineer

NEW YORK'S RADIO TUBE EXCHANGE

TYPE	PRICE
OA2	$1.00
OA3	1.10
OB2	.99
OB3	1.10
OC3	.96
OD3	.89
C1B	2.95
1B21	1.50
1B22	1.50
1B23	6.95
1B24	12.00
1B26	1.75
1B27	12.50
1B32	2.95
1B38	35.00
1B50	23.00
1B51	7.50
1B56	35.00
1B60	35.00
1N21	1.25
1N21A	1.75
1N21B	2.75
1N21C	19.50
1N22	1.00
1N23	1.95
1N23A	2.75
1N23B	2.75
1N23C	7.50
1N25	4.50
1N26	6.75
1N27	3.50
1N34A	.79
1N43	2.25
2B4	1.25
2B22	1.75
2C34	.15
2C40	9.00
2C42	12.00
2C43	14.50
2C44	.60
2C46	7.50
2E22	2.25
2J21A	12.00
2J22	9.00
2J26	15.00
2J27	15.00

TYPE	PRICE
2J31	24.00
2J32	29.00
2J33	12.00
2J34	36.00
2J36	90.00
2J38	8.95
2J39	8.95
2J40	29.00
2J42	135.00
2J49	60.00
2J50	55.00

TYPE	PRICE
3C24	1.50
3C31	2.95
3DP1	7.50
3DP1A	10.00
3DP1A-52	10.00
3EP1	5.00
3E29	15.50
3FP7	5.00
3HP7	5.00
4A21	2.75
3GP1	5.00

TYPE	PRICE
5BP1	3.95
5BP2A	12.00
5BP4	3.95
5CP1	7.50
5CP7	6.95
5CP7A	14.00
5D21	18.00
5FP7	1.95
5JP1	27.50
5JP2	19.50
5JP4	27.50

TYPE	PRICE
203A	7.50
211	.95
217C	12.00
242C	10.00
244A	9.50
249C	4.25
250TH	19.95
250TL	12.00
274B	2.75
304TH	10.00
304TL	10.00

TYPE	PRICE
464A	7.50
471A	1.25
527	18.00
WL530	23.00
WL531	22.50
WL532	1.75
WL533	15.00
HK654	35.00
700A/D	10.00
701A	4.50
703A	3.95

TYPE	PRICE
802	3.95
803	5.95
805	4.95
807	1.50
808	1.95
809	2.95
810	10.50
811A	3.75
812A	3.95
813	13.75
814	3.75

TERRIFIC SLASHES in PRICE up to 70% from PREVIOUS LOW PRICES

TYPE	PRICE
2J55	150.00
2J56	110.00
2J61	35.00
2J62	35.00
2K22	15.00
2K23	15.00
2K25	27.50
2K26	68.00
2K28	35.00
2K29	35.00
2K33A	95.00
2K39	140.00
2K41	135.00
2K45	80.00
2K50	275.00
2K54	125.00
2K55	125.00
2K56	72.00
3AP1A	10.00
3BP1	7.20
3B24	4.50
3B25	5.50
3B26	5.00
3B28	8.00
EL3C	5.50
3C22	99.00

TYPE	PRICE
4B26	5.40
4C27	22.50
4C28	35.00
4E27	16.00
4J25	150.00
4J26	150.00
4J27	150.00
4J28	150.00
4K29	150.00
5J30	150.00
4J31	150.00
4J32	150.00
4J33	150.00
4J34	100.00
4J35	150.00
4J36	150.00
4J37	150.00
4J38	150.00
4J39	150.00
4J40	150.00
4J41	150.00
4J42	190.00
4J51	190.00
4J52	225.00
4J53	225.00
C5B	250.00

TYPE	PRICE
C6A	11.00
C6J	7.50
7BP7	5.00
7DP4	9.00
12AP4	50.00
12DP7	24.00
LM15	225.00
15E	1.75
15R	.75
NE16	.59
20-4	.75
KY21A	8.25
RX21	8.00
HK24G	1.50
25T	2.95
45 Special	.35
RK39	2.75
HF50	1.75
VT52	.35
HK54	4.50
RK72	1.00
RK73	1.00
FG95	19.95
100TH	7.95
FG105	20.00
122A	1.75

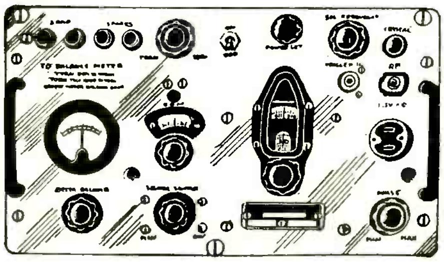
TYPE	PRICE
307A	3.50
310A	4.50
310B	4.95
311A	6.50
312A	3.50
323A	15.00
327A	3.75
328A	6.75
350A	10.00
350B	5.95
352A	3.00
HK354C	15.00
357A	15.00
368AS	4.95
371B	1.50
385A	4.50
388A	1.80
393A	7.50
394A	3.95
MX408U	.50
417A	15.00
434A	15.00
446A	1.95
446B	3.95
450TL	45.00
450TH	52.50

TYPE	PRICE
704A	1.95
705A	1.75
706AY/FY	25.00
707A	9.75
707B	15.00
714AY	18.00
715A	4.50
715B	9.00
715C	22.50
717A	1.50
718AY/EY	30.00
719A	22.50
720AY/GY	150.00
721A	3.50
722A	3.50
723A/B	18.00
724A	1.95
724B	2.25
725A	9.00
726A	18.00
726B	45.00
726C	45.00
728AY/GY	15.00
730A	22.50
750TL	120.00
801A	.90

TYPE	PRICE
815	6.25
816	1.45
829	11.00
829A	12.00
829B	15.00
830B	2.00
832A	9.95
833A	45.00
834	7.50
836	3.95
837	2.75
838	5.95
849	35.00
860	3.50
861	25.00
866A	1.50
869B	67.50
869BX	50.00
872A	3.50
878	1.50
879	.50
880	250.00
884	1.50
885	1.50
914A	75.00
931A	5.00

TYPE	PRICE
954	.35
955	.50
956	.75
957	.25
958A	.60
959	2.25
E114A	.25
1280	.95
1500T	135.00
HK1554	75.00
1603	5.00
1612	1.50
1613	1.25
1616	1.25
1619	.45
1622	1.50
1624	1.75
1625	.35
1626	.25
1851	1.80
2000T	150.00
2050	1.80
2051	1.00
Various 5000 and 6000 series of new production	
8012	2.00
8012A	2.50
8013	3.00
8013A	3.50
8019	1.75
8020	1.80
8025	3.75
PD8365	96.00
9001	1.25
9002	.90
9003	1.25
9004	.35
9005	2.75
9006	.25

Thousands of other tubes



NEW TS-147 C/UP TEST SET
Hard-to-get X-Band SIGNAL GENERATOR
Now Available

Test Set TS 147 C/UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

NEW
MICROWAVE TEST EQUIPMENT
TS148/UP
SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

Other test equipment, used checked out, surplus

TSK1/SE K Band Spectrum Analyzer
TS3A/AP Frequency and power meter S Band
RF4A/AP Phantom Target S Band
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS33/AP X Band Power and Frequency Meter
TS34/AP Western Electric Synchroscope
T35/AP X Band Signal Generator
TS36/AP X Band Power Meter
1-96A Signal Generator
TS45 X Band Signal Generator
TS47/APR 40-400 MC Signal Generator
TS59/AP Frequency Meter 400-1000MC
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP S Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS270 S Band Echo Box
TS174/AP Signal Generator
TS175/AP Signal Generator
TS226 Power Meter
TS239A-TS239C Synchroscope
TF890/1 X Band Spectrum Analyzer
834 General Radio Frequency Meter

SURPLUS EQUIPMENT

APA10 Oscilloscope and panoramic receiver
APA38 Panoramic Receiver
APS 3 and APS 4 Radar
APR4 Receiver and Tuning Units
APR5A Microwave Receiver
APT2-APT5 Radar Jamming Transmitter

MINIMUM ORDER 25 Dollars

YOU CAN REACH US ON TWX NY1-3235

Cables: TELSERUP

SPECIAL
Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

Large quantities of quartz crystals mounted and unmounted.
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80.
Large quantity of Polystyrene beaded coaxial Cable.

LIBERTY ELECTRONICS, INC.
135 LIBERTY STREET
NEW YORK 6, N. Y.
Phone WOrth 4-8262

INDEX SEARCHLIGHT

APRIL, 1954

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

APRIL, 1954

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

COMPASS COMMUNICATIONS CO.

A Division of COMPASS ELECTRONICS CORP.

A WELL-INTEGRATED ORGANIZATION WITH FACILITIES AND TRAINED PERSONNEL FOR—

- DESIGN, MODIFICATION, PRODUCTION, AND TESTING OF COMMUNICATIONS AND RADAR EQUIPMENT
- SUPPLY AND DISTRIBUTION OF ALL TYPES OF EQUIPMENT AND TUBES

WE MAINTAIN OUR OWN FULLY EQUIPPED TESTING LABORATORY TO TEST AND GUARANTEE ANYTHING WE SELL

THIS MONTH'S SPECIAL OFFERS

TS-69/AP FREQUENCY METER, Range 340-1,000 mcs. Uses 0-200 microammeter; Excellent **$75.00**

SN—RADAR—10 cm—Compact, light and portable, ranges of 5 and 20 miles. Uses 5CPI scope. Operation is from 115 volts, 60 cycle, but we can supply converter for dc operation. **$850.00** ea

ANTENNA ASSEMBLY—Reflector is a lightweight parabolic cylinder, Ass'y has both manual and motor drive. Ideal unit for labs, classroom demonstration, smal craft, etc. **$99.50** ea

APR-4—38—4000 mcs. precision receiver, complete w/5 tuning units. Operates on 115/1/60 .... **$1700.00** ea

MAG—10cm. remarkable link radar, portable, operated from 6 volt battery, uses folding antenna and tripod. A pair at **$1750.00**

APS-3—3 cm—Airborne radar for search and homing, 5-in. scope. 10 brand new sets at **$750.00** ea

APQ-13—Very late model airborne radar set, complete and new. One only at **$2,950.00**

SCR-545—Complete radar set, less vehicle, antenna and power plant, pretty fair condition, sold as-is at **$1,375.00**

MOTOR GENERATORS CONVERTERS • INVERTERS DYNAMOTORS

We Have One of the Largest Stocks of Electrical Conversion Equipment in the East, including All Types of Rotating Machinery and a Variety of DC and AC Magnetic Starters and Controllers from 100 Watts to 100 Kilowatts

MOTOR GENERATOR, in 115 vac, out 220-250 vdc, @ ½ KVA **$65.00**

ESCO ROTARY CONVERTERS—Mounted in Steel Drip-Proof Boxes—Type R-1-41. Filtered **Input** 110 volts, 2.5 amps, 3600 rpm. **Output** 110/1/60 @ 1.8 amps, 200 watts **$45.00**

ESCO MOTOR GENERATORS—Dual unit (a) **Input** 32 v dc @ 8 amp. **Output** 110/1/60 @ 1.5 amps, 165 va 150w, 1800 rpm. (b) **Input** 32 volts dc @ 16 amps. **Output** 260 volts, 1500 cycles @ 4 amps. Rating 1.05 kva, 3,000 rpm. Filtered. These two units are mtd. together on bed plate, complete with control panel containing switch & 0-50 v dc meter. **$32.50** ea. part.

MOTOR - GENERATOR - ALTERNATOR—Mfgr.—Quality Electric Co. Ltd. **Input** 115/1/60 ac @ 22.5 amps, 1800 rpm. **Outputs:** #1.500/1000 v dc. 0.25/0.3 amp., 0.125/0.3 kw. #2 150 v dc, 0.667 amp., 0.1 kw. #3. 115 v ac 0.87 amp., 3000 cycles, 0.1 kva. PF-1. **$245.00**

ESCO CONVERTER—Input 110 volts dc. **output** 110 volts ac @ 1.2 amps. Brand new. **$45.00**

ALLIS CHALMERS CONVERTER 110 volts dc to 110 volts ac @ 1.25 kva output **$165.00**

PINCOR ROTARY CONVERTER — Input 110 volts dc. **Output** 220/1/60, 0.300 kva: .90 pf; 3000 rpm; cont. duty; 40°C. Filtered for Radio use **$60.00**

CONTINENTAL MOTOR-GENERATOR — 350 watts. Type CC-21991—Wt. 148 lbs. **Input** 115 volts dc @ 5.7 amps, 0.625 hp. **Output** 115 volts ac, 1 ph., 60 cycles @ 3.04 amps, 1800 rpm, 0.85 pf, 40°C temp. rise, sep, excited. Filtered **$95.00**

WESTINGHOUSE ELECTRIC GENERATOR — 10 KVA—AC. **Output** 115/1/60 @ 108.5 amps: .80 pf: 50°C; cont. duty 1800 fpm, sep. excited, 125 dc. DC generator **Output** 125 volts dc @ 8 amps. This generator is mounted on bed plate with room for motor mounting. It can be driven by any mechanically coupled motor, dc or ac or other drive **$459.00**

MOTOR GENERATOR 800-1D — Input 24-28 volts dc. **Output** 115 v. 800 cycles at 10.5 amps. Small and compact **$29.50**

M-209—Holtzer-Cabot—Filtered. **Input** 115/1/60. **Output** 115 volts, 3ϕ, 233 cycles; at 0.4 amps and **24 volts dc** at 6.5 amps. 3500 rpm **$125.00**

MG-149—Holtzer-Cabot Inverter **$49.50**

2J1F1 SELSYN—115-57.5v. 400 cycles **$4.45**

SF, 5G—SYNCHRO—115 v, 60 cycles **$30.00**

POWER UNIT TYPE 23—Rotary transformer, filtered. **Input** 24 vdc. **Output** 6.3 volts at 2 amps and 200 volts at 30 ma **$19.50**

And, of course, PE-73, PE-94, PE-98, DM-25, -28, -32, -33, etc.

SPECIAL PURPOSE and TRANSMITTING TUBES

This Is A Sample Listing • Write for Other Items & Unlisted Prices

Tube #	Selling Price
O1A	write
OC3	$1.60
OD3	1.50
C1A	6.00
C1B	7.00
C5B	2.95
C6A	write
C6F	12.50
C6J	write
10Y	.90
VR-92	.49
1B22	3.95
1B23	10.00
1B24	write
1N23B	2.50
2B22	4.95
2B26	3.75
2C40	18.00
2C44	1.20
2C43	25.00
2D21	1.70
2D29	
2E22	3.75
2J21	17.50
2J22	17.50
2J26	27.50
2J27	27.50
2J31	27.50
2J32	27.50
2J33	35.00
2J34	write
2J36	100.00
2J38	49.50
2J39	49.50
2J42	75.00
2J49	65.00
2J50	75.00
2J55	62.50

Tube #	Selling Price
2J56	145.00
2J61	55.00
2J62	55.00
2K22	write
2K25	26.00
2K26	100.00
2K29	35.00
2K36	write
2K45	100.00
2K54	150.00
2K55	100.00
3B24	5.40
3B27	10.00
3B28	5.00
3C31	5.75
3E29	14.00
4C27	25.00
4C28	35.00
4D32	22.50
4E27	17.50
4J25	175.00
4J26	175.00
4J28	175.00

Tube #	Selling Price
4J29	175.00
4J30	write
4J31	175.00
4J33	190.00
4J34	195.00
4J42	225.00
4J51	300.00
4J52	285.00
5J23	write
5J26	125.00
5J29	write
6C21	29.50
100TH	9.00
204A	60.00
211	1.00
250TH	30.00
250TL	30.00
304TH	9.75
304TL	9.75
307A	5.00
339A	35.00
371B	2.50
388A	2.75

Tube #	Selling Price
415GL	37.50
446A	2.00
446B	3.75
450TH	45.00
450TL	45.00
464A	9.50
705A	3.25
706A-GY	45.00
707B	12.50
715B	17.50
717A	1.50
720	write
720DY	90.00
721A	3.75
723A/B	25.00
724B	6.50
725A	write
730A	45.00
803	7.00
807	1.65
813	9.00
829A	12.00
832A	10.00

Tube #	Selling Price
833A	39.50
836	3.95
837	1.45
843	.50
849	27.50
851	45.00
860	5.00
861	25.00
865	1.25
872A	3.85
874	1.50
889R	195.00
891R	210.00
892	150.00
892R	250.00
2X2879	1.05
1616	2.75
1619	.75
1624	2.00
1625	.65
1626	.75
1629	.65
1636	1.50
1642	3.50
2050	2.00
5611	100.00
8012	4.25
8014A	55.00
8020	3.50
8025	7.00
9001	1.20
9002	1.00
9003	1.20
9004	.50
9005	1.90
9005	1.90
9006	.50

APPLY 15% REDUCTION TO ALL TUBE PRICES. WE WERE TOO LATE TO CHANGE THIS COPY.

All Tubes Guaranteed • All Prices Are FOB Our Warehouse and Subject To Change Without Notice

OUR EXPORT DEPARTMENT AVAILABLE FOR SPECIAL SERVICE TO OVERSEAS CUSTOMERS

393 GREENWICH STREET **NEW YORK 13, N. Y.**
All phones: **BEEKMAN 4-6509** *Cable Address:* **COMPRADIO, N. Y.**

INDEX TO ADVERTISERS

Want more information? Use post card on last page.

•

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. HILTY, Mgr.

This index is published as a convenience to the readers. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibility for errors or omissions.

electronics READER SERVICE

FOR ADVERTISEMENTS IN THIS ISSUE ONLY

For additional information on any advertisement

READERS MUST DESIGNATE PAGE NUMBER and ADVERTISER'S NAME

This free service is designed to provide readers with a simple method of obtaining more detailed information on products or services advertised in ELECTRONICS. The two business reply postcards below (perforated for easy tear-out) are for your use and must be completely filled out according to the sample shown on the right and the instructions given below under "HOW TO ORDER". Each individual request is separated and sent to the manufacturer concerned. The information asked for is essential so that manufacturers can promptly and correctly address their replies to your request.

Please note sample with correct fill-in on the right.

Request for "Ad" Information, Page No. 156
Advertiser E. Warwick, Inc.
Your Name Henry Wriothesley
Title Electronic Engineer
Company Kings' Company, Inc.
Co. Address 161 Avon St., Stratford, N.J. E-8

HOW TO ORDER

Please read these instructions carefully. They provide a simple method which, if followed, will bring you the information you desire.

1. There are two business reply postcards on the right. Each one divided in four parts, thus providing space for eight individual requests.

2. Each request must be made separately and the required information must be completely given for each one. This is important, for these cards are cut apart and sent to manufacturers. Therefore, each one must have ALL the necessary mailing and addressing information.

3. This service applies only to the advertisements that appear in this issue. It does not apply to any part of the editorial content.

4. Please print as neatly as possible.

5. Use ink, as pencil is apt to smudge with handling.

6. Tear out complete postcard, even if all four portions are not used. Drop in the mail—no postage required.

PLEASE NOTE:

In the event this copy of ELECTRONICS is passed along to other members of your company, please leave this sheet in for their convenience. This assures everyone in your plant the opportunity to fill in their requests. When the round is completed, cards can then be detached.

GIVE ALL REQUIRED INFORMATION FOR EACH REQUEST YOU MAKE

THESE CARDS VOID AFTER APRIL 30

Request for "Ad" Information, Page No. ....
Advertiser ....
Your Name ....
Title ....
Company ....
....
Co. Address ....
.... E-4-4

Request for "Ad" Information, Page No. ....
Advertiser ....
Your Name ....
Title ....
Company ....
....
Co. Address ....
.... E-4-4

Request for "Ad" Information, Page No. ....
Advertiser ....
Your Name ....
Title ....
Company ....
....
Co. Address ....
.... E-4-4

Request for "Ad" Information, Page No. ....
Advertiser ....
Your Name ....
Title ....
Company ....
....
Co. Address ....
.... E-4-4

Request for "Ad" Information, Page No. ....
Advertiser ....
Your Name ....
Title ....
Company ....
....
Co. Address ....
.... E-4-4

Request for "Ad" Information, Page No. ....
Advertiser ....
Your Name ....
Title ....
Company ....
....
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An electronics service designed FOR THE CONVENIENCE of READERS and MANUFACTURERS

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ELECTRONICS fundamental policy has always been to supply its readers with all the pertinent and timely industry news. The ELECTRONICS Reader Service supplements this policy by offering the reader an easy and effective means of obtaining complete, up-to-the minute data on equipment, components, materials, instrumentation and allied products and, of maintaining at his fingertips comprehensive, practicable information on products and services in the industry.

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In every issue of ELECTRONICS there's complete coverage of the month by month development of manufacturers products. Some of these items will be of particular interest to specific design and plant engineers, buyers, executives and others of our readers. They will want to make further inquiry concerning the products advertised. ELECTRONICS Reader Service makes it easy for them to obtain in readily accessible and usable form the information they desire.

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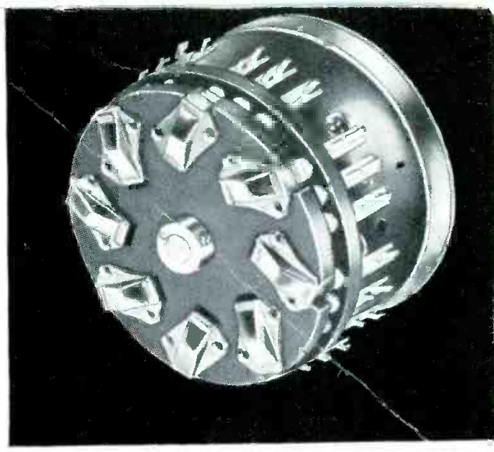

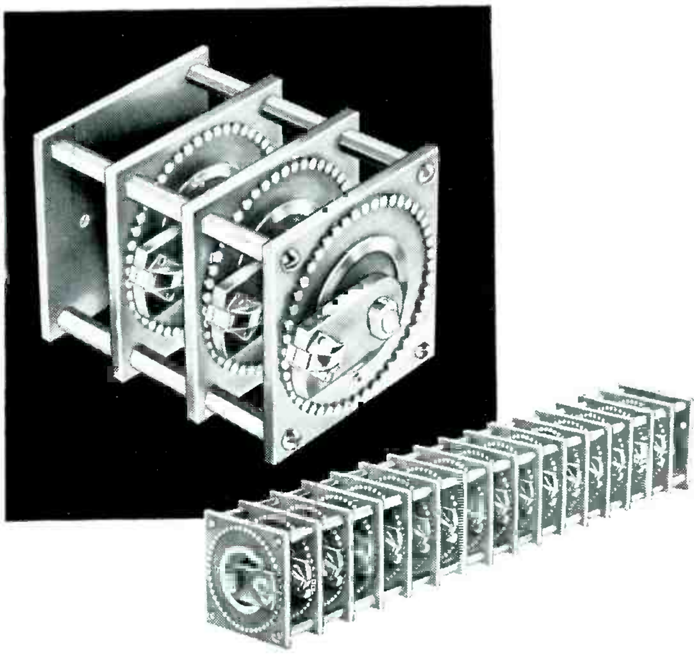

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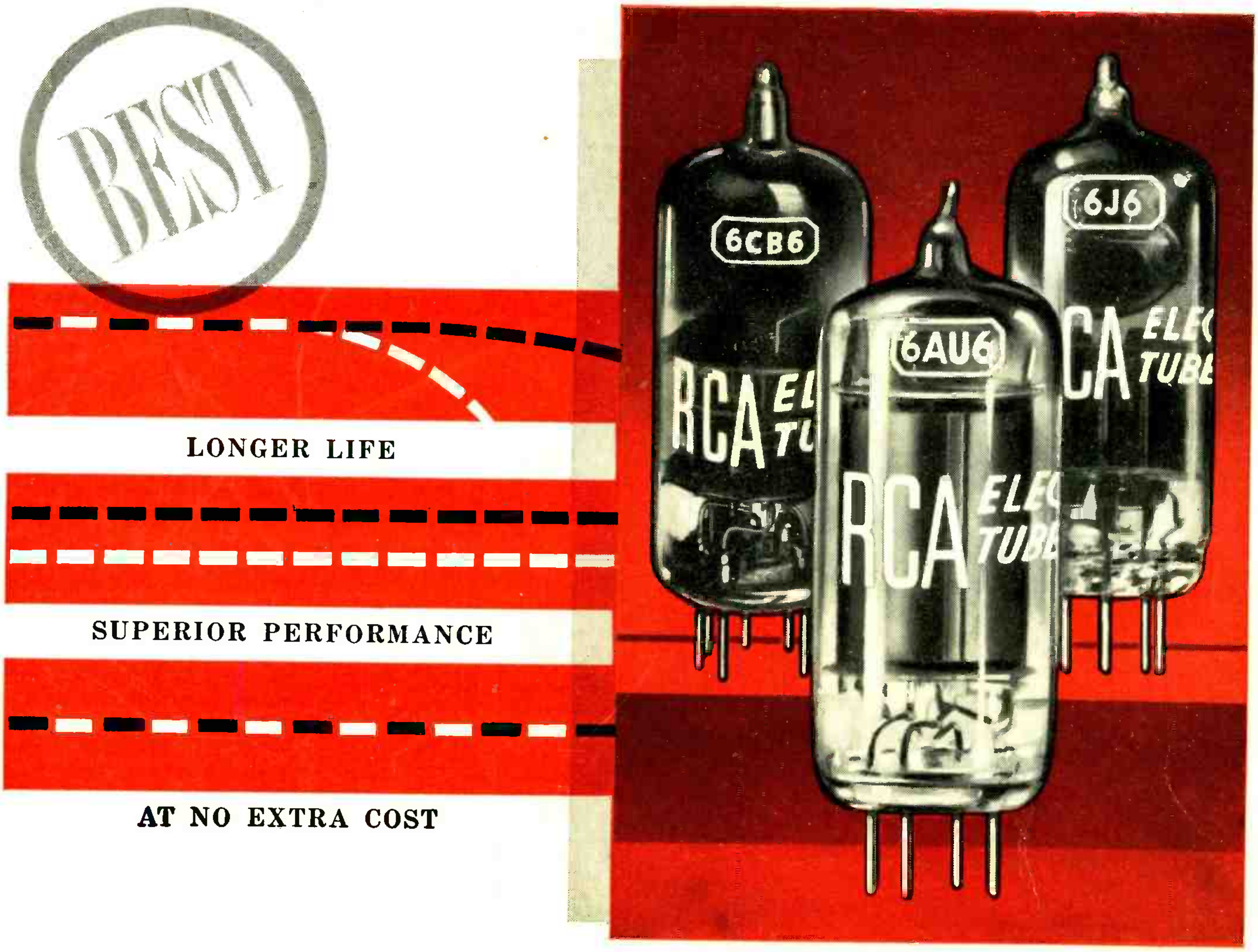

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