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JOHN I. SHEETZ
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SPRAY-TESTING MARINE RADAR—Operating small-boat radar in salt spray booth as one of final tests at Waltham, Mass. plant of Raytheon Manufacturing Co. (see p 184) .... *COVER*

JULY, 1954 ELECTRONICS Vol. 27, No. 7

Member ABC and ABP

Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. Publication Office, 99-129 North Broadway, Albany 1, N. Y.

Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y. Donald C. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Executive Vice-President, Publication Division; Ralph B. Smith, Vice-President and Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.

Subscriptions: Address correspondence to Electronics—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address. Subscriptions are solicited only from persons engaged in theory, research, design, production, maintenance and use of electronic and industrial control components, parts and end products. Position and company connection must be indicated on subscription orders.

Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $2.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries and the Philippines, $15.00 a year; $25.00 for two years. All other countries $20.00 a year; $30.00 for two years. Entered as second class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A. Copyright 1954 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; McGraw-Hill House, London, E.C. 4; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3, Ga.; 1111 Wilshire Blvd., Los Angeles 17; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

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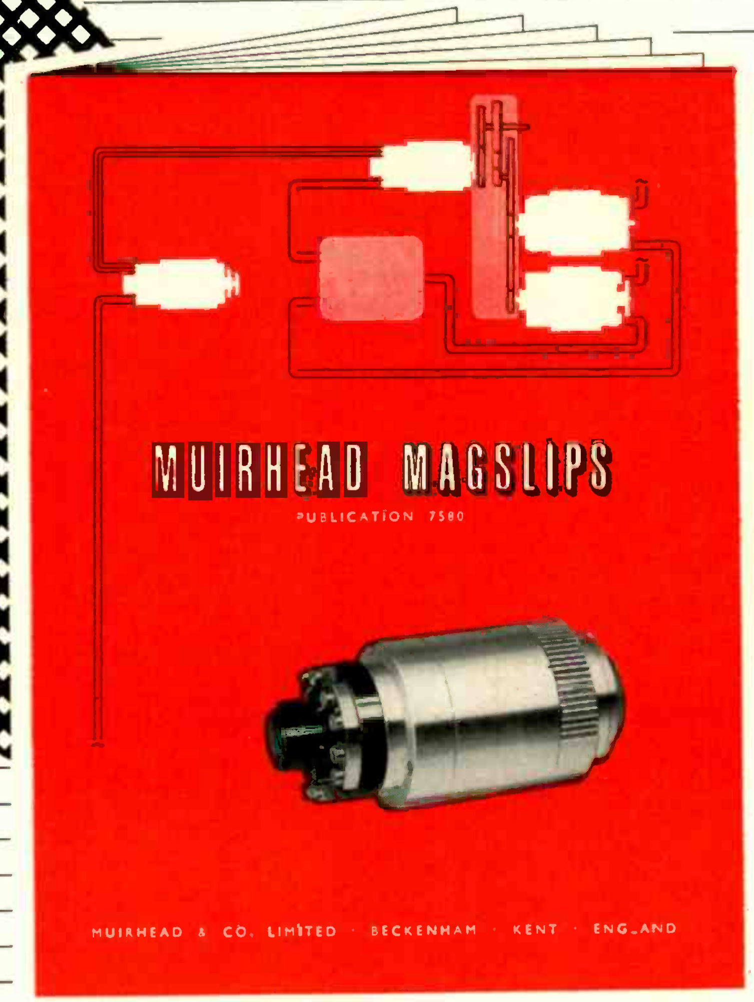

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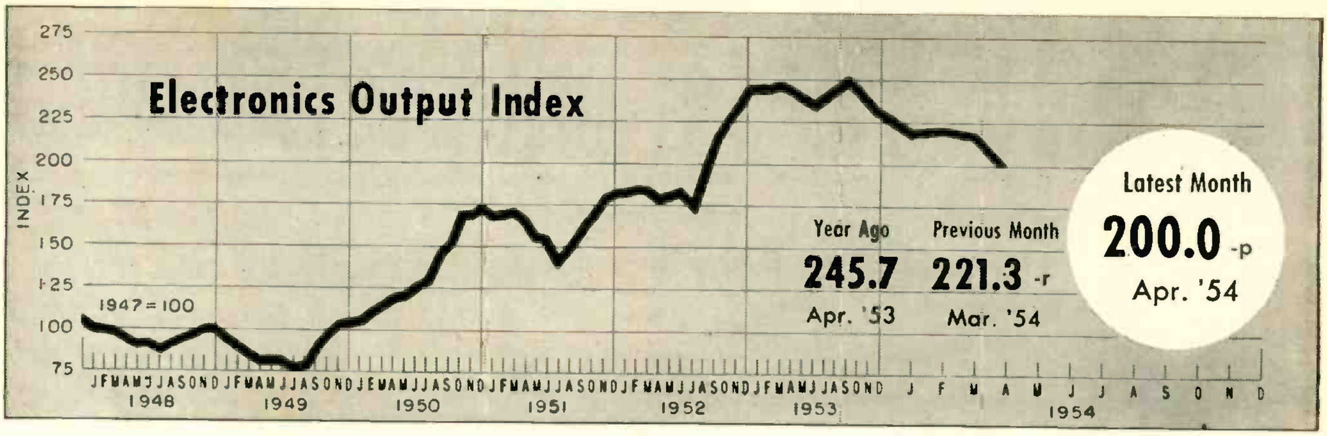
MAKERS OF HIGH GRADE PRECISION ELECTRICAL INSTRUMENTS



FIGURES OF THE MONTH

RECEIVER PRODUCTION
(Source: RETMA)

	Year Ago	Previous Month	Latest Month
	Apr. '53	Mar. '54	Apr. '54
Television sets, total	567,878	599,606	457,608
With UHF	......	124,855	112,833
Radio sets, total	1,158,936	940,352	745,235
With FM	40,178	19,693	14,008
Home sets	286,974	244,110	165,232
Clock Radios	187,394	119,863	73,590
Portable sets	201,476	206,130	175,424
Auto sets	483,092	370,249	330,989

RECEIVER SALES
(Source: RETMA)

	Apr. '53	Mar. '54	Apr. '54
Television sets, units	319,721	512,861	371,720
Radio sets (except auto)	412,802	486,034	427,911

RECEIVING TUBE SALES
(Source: RETMA)

	Apr. '53	Mar. '54	Apr. '54
Receiv. tubes, total units	41,342,599	29,063,484	29,640,942
Receiv. tubes, value	$27,720,635	$22,130,627	$21,697,489
Pic. tubes, total units	907,076	759,468	727,655
Picture tubes, value	$21,657,266	$15,904,687	$14,994,779

SEMICONDUCTOR SALES
(Source: RETMA)

	Apr. '53	Mar. '54	Apr. '54
Germanium Diodes / Silicon Diodes	2,450,015	1,061,010	994,280

INDUSTRIAL TUBE SALES
(Source: NEMA)

	Quarterly Figures		
	Year Ago	Previous Quarter	Latest Quarter
	1st '53	4th '53	1st '54
Vacuum (non-receiving)	$10,400,000	$9,467,331	$8,971,335
Gas or vapor	$3,300,000	$4,854,222	$4,589,239
Phototubes	$700,000	$405,000	$405,000*
Magnetrons and velocity modulation tubes	$10,500,000	$13,073,095	$16,135,274
Gaps and T/R boxes	$1,700,000	$1,707,730	$1,517,426

*4th quarter 1953

TV AUDIENCE
(Source: NBC Research Dept.)

	Year Ago	Previous Month	Latest Month
	Apr. '53	Mar. '54	Apr. '54
TV Homes, total	23,256,000	......	29,495,000

BROADCAST STATIONS
Source: (FCC)

	May '53	Apr. '54	May '54
TV Stations on Air	189	387	397
TV Stns CPs—not on air	266	190	176
TV Stns—Applications	611	52	45
AM Stations on Air	2,445	2,563	2,575
AM Stns CPs—not on air	130	112	111
AM Stns—Applications	244	158	158
FM Stations on Air	591	552	549
FM Stns CPs—not on air	20	16	18
FM Stns—Applications	9	4	5

COMMUNICATION AUTHORIZATIONS
Source: (FCC)

	Apr. '53	Mar. '54	Apr. '54
Aeronautical	38,887	43,324	42,998
Marine	39,745	44,598	45,132
Police, fire, etc.	12,956	15,065	15,241
Industrial	16,515	20,599	21,029
Land Transportation	5,769	6,758	6,829
Amateur	110,884	118,750	120,581
Citizens Radio	2,074	5,612	5,664
Disaster	189	259	271
Experimental	432	544	550
Common carrier	1,144	1,534	1,549

EMPLOYMENT AND PAYROLLS
(Source: Bur. Labor Statistics)

	Mar. '53	Feb. '54	Mar. '54
Prod. workers, comm. equip.	418,300	364,400-r	362,300
Av. wkly. earnings, comm.	$66.67	$67.89-r	$67.55
Av. wkly. earnings, radio	$64.24	$67.09-r	$66.76
Av. wkly. hours, comm.	40.9	39.7 -r	39.5
Av. wkly. hours, radio	40.4	39.7 -r	39.5

STOCK PRICE AVERAGES
(Source: Standard and Poor's)

	May '53	Apr. '54	May '54
Radio—TV & Electronics	295.3	304.0	305.3
Radio Broadcasters	287.3	309.5	322.1

p—provisional; r—revised

FIGURES OF THE YEAR

	1953 Total	TOTALS FOR FIRST FOUR MONTHS 1953	1954	Percent Change
Television set production	7,214,787	2,827,821	1,904,718	—32.6
Radio set production	13,368,556	4,993,720	3,326,800	—33.4
Television set sales	6,375,279	2,100,620	2,152,515	+ 2.5
Radio set sales (except auto)	7,064,485	1,851,673	1,487,247	—19.7
Receiving tube sales	437,091,555	163,401,335	106,026,920	—35.1
Cathode-ray tube sales	7,582,835	3,705,997	2,690,519	—27.4

INDUSTRY REPORT

electronics—July • 1954

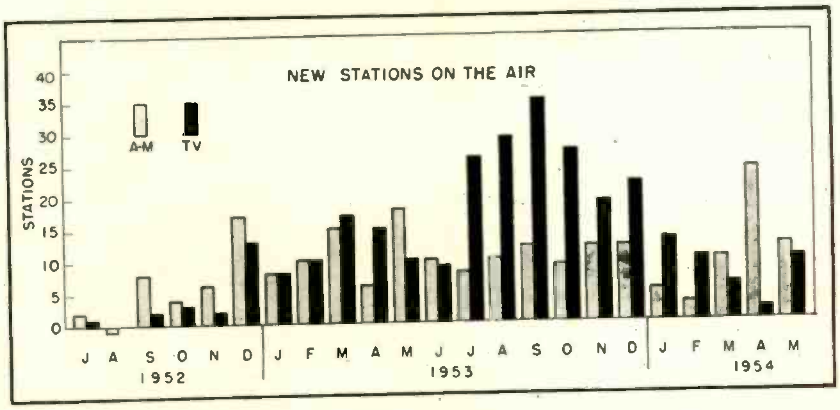
Government Market Is Bigger Than It Seems

FINDING OUT who buys what and where in the federal government has buffaloed a good number of electronic manufacturers who want to sell to the U. S. government. A step toward eliminating this problem has been made by the Small Business Administration which recently published a U. S. Government Purchasing Directory. It lists in detail the supplies and services bought by the military and civilian departments of the federal government, the addresses of their purchasing offices and the necessary procedures for selling them.

▶ **Markets**—The government uses nearly every type of electronic equipment and all types of departments and bureaus buy electronic equipment. For example, there are six military and four different government civilian offices that buy home-type tv receivers. They range from the U. S. Weather Bureau to Army and Air Force post exchanges. There are 16 civilian offices that purchase resistors, ranging from the Bureau of Census to the Bureau of Land Management, and 10 military offices.

▶ **Navy**—Just how big a customer a government department may be is indicated by the operations of just one Navy department, the Electronic Supply Office.

It controls an inventory of 216,000 different line items with a total value of $350 million. During fiscal year 1953, ESO spent $21 million dollars for maintenance repair parts, including tubes. The principal portion of these were from northern Illinois and southeast Wisconsin.



TELEVISION starters decline; new a-m stations increase, as . . .

Business Booms in A-M Radio

Station building climbs as old-timers revamp studio and transmitting equipment

DON'T sell a-m short—a maxim heard even during the post-freeze boom in television station building, points the way to increasing profits in the broadcast equipment business this year.

▶ **New Stations**—As the chart indicates, a-m radio was good from the transmitting equipment point of view even during the big tv boom in late 1953. Now, with that boom apparently tapering off, the a-m market is climbing even higher. In the past 10 months, 114 new a-m authorizations were issued.

▶ **New Equipment**—Remote control of a-m transmitters, recently authorized by the FCC, accounts for much business. Manufacturers report that 300 packaged units have been sold. Many new a-m transmitters have built-in provision for remote operation.

Next feature for transmitters may be remote control of directional antennas. This is being done now in Canada but is not yet authorized by the FCC for U. S. broadcasters. Remote control manufacturers are working up packages with d-a provisions.

A paper presented to the NARTB convention in Chicago described tape sequencing equipment installed by a Honolulu radio station. Such gear may take over some of the functions of the announcer-disk jockey as well as those of the engineer.

▶ **Replacement**—The market for equipment to replace outmoded gear is one that equipment salesmen are aggressively exploring. Many broadcasters are using transmitters 12 to 15 years old and older. In many cases, parts are not easily obtained. Older rigs often use tubes much less efficient than those developed in recent years. Thus, replacement may prove cheaper than repair. One manufacturer reports three orders for 50-kw plants.

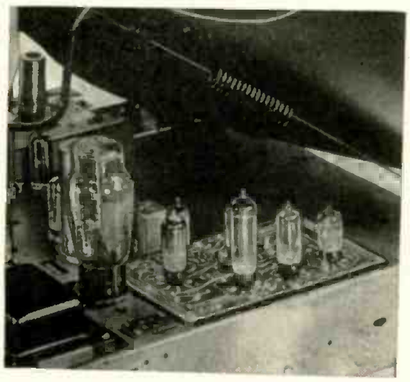
The studio equipment market is also good. Broadcasters are finding a second or third console, additional remote pickup equipment or auxiliary tape-handling gear essential to their operations.

Scientific Apparatus Business Increases

GROWING output of scientific instruments and laboratory apparatus, much of which is electronic, is seen in the large increase in employment in the field. According to the Bureau of Labor Statistics, employees in the laboratory, scientific and engineering instrument field increased from 39,000 in 1951 to 49,000 in 1952 and reached a total of 54,000 in 1953.

► **Breakdown**—Indication of how important the various products are saleswise in total scientific instrument sales is indicated by the following figures: In 1953 total sales in the field reached $212.3 million. Of this total $131.9 million was accounted for by laboratory apparatus, $13.3 million by optical and $67.1 million by industrial instruments. Significantly, during 1953, the largest percentage sales increase over the previous year's sales was registered by industrial instruments with a 8.6-percent increase in shipments.

Printed Circuit Bows in TV Line



This section of a 21-inch Admiral tv set uses 4½ by 7-inch printed circuit which incorporates six tubes and one-third of normally-exposed wiring. After components are assembled to the photo-etched copper plate it is dipped in a solder pot at 500 degrees F for three to five seconds

INVENTORS Reynolds and Leies watch their solar generator, at right, enclosed in a plastic shield while . . .

Sunkissed Crystal Turns Motor

LATEST SOLAR power plant, developed at Wright Air Development Center, Dayton, Ohio, uses a yellow cadmium sulfide crystal to change sunlight into electricity. The experimental model uses a crystal about the size of a lump of sugar. Later developments are expected to pare the crystal wafer-thin.

► **Getting the Juice**—Attached to opposite sides of the slab are electrodes to which wires connect. A silver electrode is the positive terminal; the negative terminal is indium. The whole unit is known as a barrier-layer cell. Light, striking the crystal-electrode interface, produces a direct-current electrical potential.

► **How Much Power**—In the pilot model, a one-eighth square inch area produces a third of a volt. Later models are expected to increase the voltage six to eight times. Doubling or tripling the area will increase power by the same factor. According to the inventors a wafer-thin slab of crystal four by fifteen feet built into the roof of a house will supply enough current to operate all lights, stove, refrigerator and other appliances 24 hours a day.

Electronics Covers The Weather

Radar is being used more extensively and computers may soon enter the picture

U. S. WEATHER BUREAU has 22 radar units in operation in the country and present plans call for use of additional installations for approximately 15 more locations within the next 12 months.

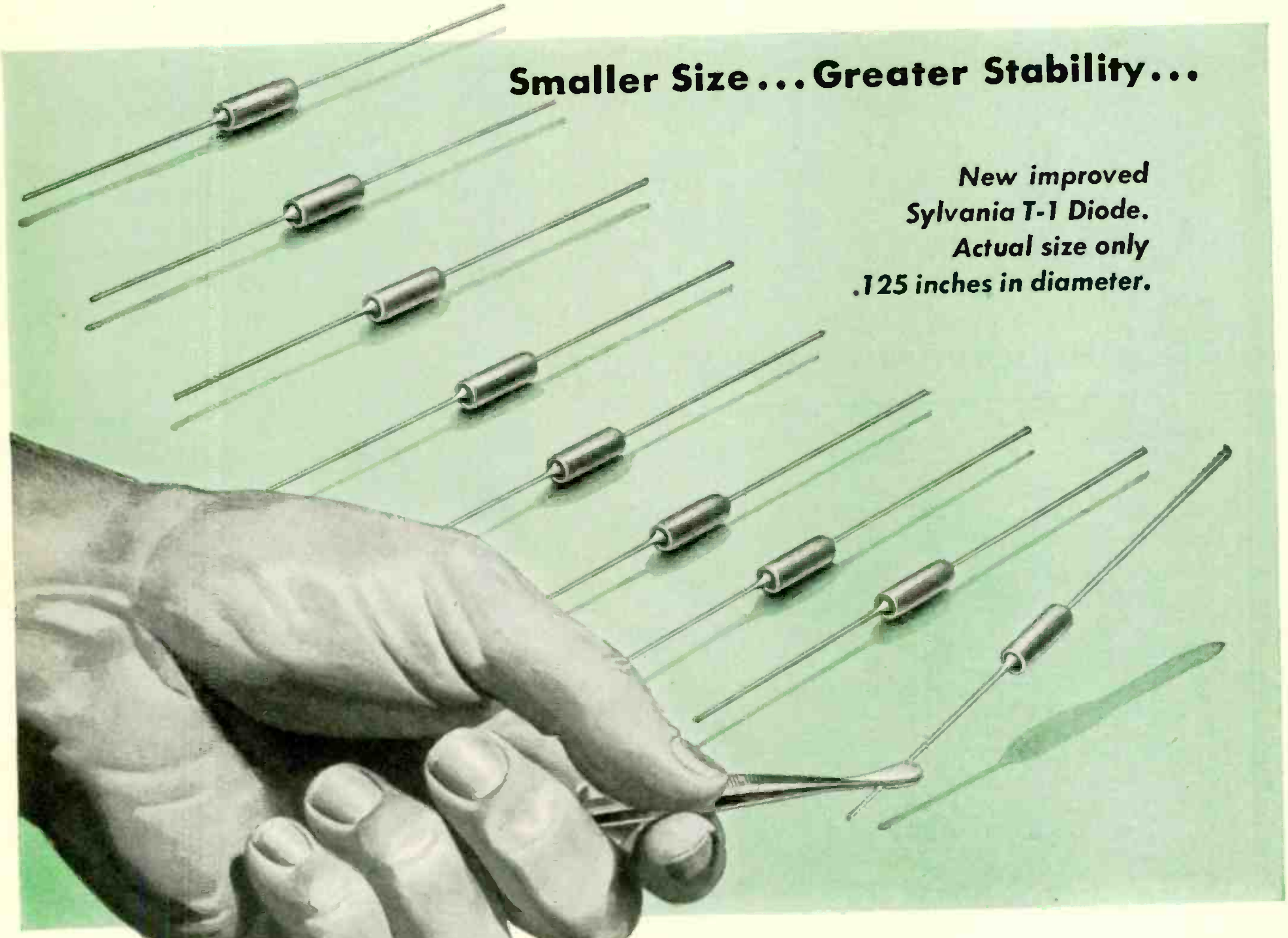
► **Network**—Largest number of units in operation at present are in Texas where a tornado picket line of radars is being set up to give an almost complete picture of weather in the state. By the first of July, about 14 radar stations in as many cities across Texas and extending into Louisiana will be in operation. Cities in Oklahoma and in Louisiana may join the network.

Most of the stations in Texas have been set up on a cooperative basis between the individual cities involved and the U. S. Weather

(Continued on page 8)

Sylvania Offers You . . .

A NEW COMPACT DIODE LINE



In keeping with today's trend toward miniaturization in set and circuit designs, Sylvania offers a complete quality line of compact crystal diodes with improved stability.

These new components measure only .125 inches in diameter . . . require only 1/6th the space of former units. At the same time, due to advanced manufacturing techniques and Sylvania's new automatic precision equipment, they provide far higher performance records.

With these tiny diodes, you can be assured of more uniform characteristics and closer tolerance limits . . . even on large quantity orders.

This new T-1 Series also has recently passed MIL-E-1B moisture-resistance tests. Now available in capacities for every need. For full details write to Dept. 4E-1607, Sylvania today!

Another reason why it pays to specify Sylvania!

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Bureau. The Bureau supplies the gear, maintains it and supervises the network. The cities pay about $10,000 to have the gear modified and installed.

▶ **Equipment**—Models used for the tornado belt warning system are mainly APS 2 surplus radars that were turned over to the Weather Bureau by the Navy. An APS 13 is in use in New York City. The surplus gear is converted for weather use and equipped with six-foot antenna dishes. With latest modifications a range of 200 miles is possible. The Bureau has a staff of 35 electronic technicians who service the gear.

Successful use of radar in weather work has prompted some electronic manufacturers to size up the field as a possible market for specially designed sets. One company is already designing radars specifically for locating storm centers.

▶ **Brains**—Electronic computers may also see service in U. S. weather operations. It is reported that the U. S. Weather Bureau, the Air Force and the Navy will start operating an electronic computer for weather predictions on a trial basis beginning in July.

This has been done for some time in Sweden with BESC, Binary Electronic Sequence Computer. Use of the instrument is planned for this summer to make 48-hour weather forecasts on a routine basis. In operating BESC, wind information, for example, is fed into the computer which figures, by prescribed formulas, the winds for each of 48 consecutive hours into the future.

It takes about 10 hours to gather and feed the information into the computer for a 24-hour forecast. The computer, however, does the necessary 2.7 million calculations in less than 30 minutes.

Top Management Salary Survey

Company	Capacity	Salary	Bonus	Pension	Total 1953	Total 1952
Bendix	Pres	$84,233	$39,500	$7,844	$131,577	$177,441
	V-P	60,400	29,250		89,650	91,500
CBS	Pres	235,780		12,335	248,115	165,855
	Chm	100,000		16,526	116,526	118,524
	Dir	240,627			240,627	211,126
DuMont	Pres	103,675			103,675	98,664
	V-P					25,192
Total payments to all officers and directors					184,791	160,397
Emerson	Pres	60,008	25,000	12,054	97,062	72,523
	Treas. & Secy	39,936	20,000	5,934	65,870	46,177
	Ex. V-P	31,980	15,000	3,298	50,278	50,524
Total payments to all officers and directors					427,991	376,964
GE	Pres	214,991			214,991	202,524
	Chm	147,519			147,519	140,028
	Ex. V-P	125,017			125,017	
Magnavox	Total payments to all officers and directors				359,135	290,305
Motorola	Pres	82,500			82,500	82,500
	Ex. V-P	55,000			55,000	55,000
	V-P, Dir. Eng.	55,000			55,000	55,000
Total payments to all officers and directors					648,133	533.132
Olympic	Pres	33,099			33,099	32,100
	V-P Sales	65,600			65,600	29,349
	Res. & Dev. Dir	31,100			31,100	31.100
Total payments to all officers and directors					228,030	183,299
Philco	Pres	75,000	99,000	27,768	201,768	187,827
	Ex V-P	60,000	80,000	22,342	162,342	150,831
	Chm	50,000		7,978	57,978	56,918
Total payments to all officers and directors					1.9 million	1.7 million
RCA	Chm	200,000			200,000	200,251
	Pres	165,000			165,000	165,251
Sentinel	Pres	25,000		1.388	26,388	39.297
	V-P	17,500	22,500	5,063	45,063	33.598
Total payments to all officers and directors					109,398	100,080
Westinghouse	Pres	203.250			203,250	203,250
	Ex. V-P	125,000			125.000	125,000

ELECTRONIC manufacturers, like other companies with securities listed on stock exchanges, are required to file reports and proxy statements with the Securities and Exchange Commission.

In the reports, firms list the payments made to officers who receive more than $30,000 a year. The SEC defines an officer as a president, vice-president, treasurer, comptroller, or any person who performs functions corresponding to those performed by such officers.

▶ **Changes**—Figures for the companies sampled indicate that, in general, officer payrolls for radio and tv manufacturers increased substantially in 1953. However, for a number of firms, payments to top officers remained at 1952 levels. In some cases, where payments decreased, stock-sharing plans have been substituted. In companies where total payments to all officers and directors were higher in 1953 than in 1952 despite no increases for top officers, enlarged staffs or increased salaries for lower-echelon officers may have accounted for the change.

For the twelve set makers covered, payment increases to top officers listed averaged $19,000 from 1952 to 1953. The scale of increases was wide, however, ranging from $1,000 to $82,000 for any individual.

(Continued on page 10)

only Sprague makes them all!

YOU CAN CHOOSE FROM 5 DIFFERENT STYLES OF TANTALEX* CAPACITORS

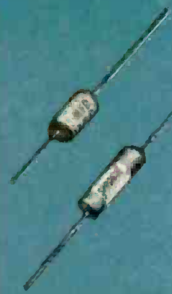
Looking for tantalum electrolytic capacitors? You'll save time and trouble by checking Sprague's complete selection *first*. Sprague makes more types of tantalum capacitors than *any other manufacturer.*

Sprague Tantalex capacitors provide maximum capacitance in minimum space . . . exhibit no shelf aging under long testing periods . . . have extremely low leakage current. And most important, they give unusually *stable* performance, because they're made with tantalum, the most stable of all anodic film-forming materials.

There's a complete range of sizes and ratings available in Tantalex capacitors . . . from the ultra-miniature 10 mf, 4 volt unit in a case only ⅛" in diameter by 5/16" long . . to the 7 mf, 630 volt unit in a case 1⅛" in diameter by 2 19/32" long. As for case styles, Sprague makes them all, from tiny tubular and cup units to the large cylindrical types.

For complete details relating to your miniaturization or high temperature problems, write Sprague Electric Co., 35 Marshall St., North Adams, Mass.

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



NEW! TYPE 101D for low-cost transistor circuitry

Especially useful for filter, coupling, and bypass applications in transistor electronics, these foil type miniature Tantalex capacitors were intended for use in hearing aids, pocket radios, and similar uses. Operating temperature range is —20 to +65°C. Request Engineering Bulletin 353.

NEW! TYPE 102D for −55°C to +85°C operation for military use

Here are tubular capacitors hermetically sealed in cases of silver plated copper. Intended for applications from 3 to 150 vdc, their small capacitance drop-off at extremely low temperatures, extremely low leakage current, and low power factor are of particular interest. Request Engineering Bulletin 351.

NEW! TYPE 103D ultra-miniature capacitors for transistor circuitry

Only ⅛" in diameter, and from 5/16" to ½" in length, these are the smallest electrolytics made. Providing relatively large values of capacitance in the very minimum of space in bypass, coupling, and filter applications, they are ideally suited for transistor hearing aids and military amplifiers in which small size is all-important.
Request Engineering Bulletin 352.

NEW! TYPE 104D miniature "cup" capacitor for military use

These low-voltage units consist of a sintered porous tantalum anode housed in a miniature silver thimble, which serves as both cathode and container for the electrolyte. Volume is less than 1/10 cubic inch; operating temperature range —55 to +85°C, and up to 100°C with a voltage derating of 15%. Request Engineering Bulletin 354.

TYPE 100D for −55 to +125°C operation for military use

These hermetically sealed capacitors are available in voltage ratings up to 630 volts at 85°C or 560 volts at 125°C. They are of the sintered porous tantalum anode type, with internal construction to withstand high g shock, severe vibration, and thermal cycling. Request Engineering Bulletin 350A.

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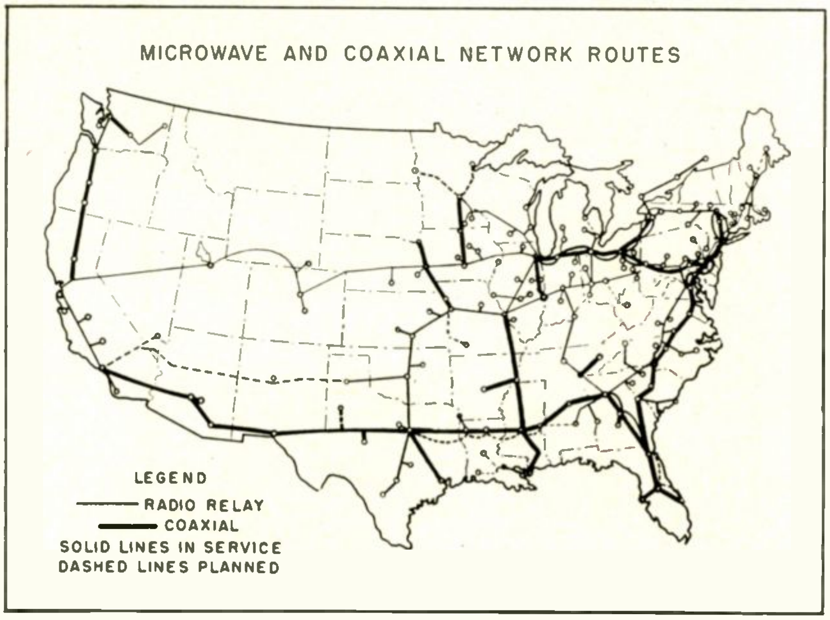


Television Network Facilities

More than 54,000 channel miles of coaxial cable and radio-relay facilities provide 300 stations in 191 cities in the United States with network television. Distances between microwave towers average about 30 miles, depending on topography. A relay system has a capacicty of 12 channels, six in each direction. Each channel can carry one television program

Model Business Goes Electronic

THE MANUFACTURE of transmitters and receivers designed for control of model planes is a small but growing segment of the electronics business. Many are companies wholly devoted to producing for the hobby field, but some have been supplying guidance equipment for Armed Forces small target drones.

At present, radio controlled models are operated on three major frequencies: 465 mc and 27.255 mc under the FCC Citizens Radio Service, and the 50 to 54 mc band. The latter requires an amateur operators license.

Equipment designed for operation at 465 mc is critical, complex and expensive. In addition, FCC rulings require that 465-mc transmitters be type-approved and sealed to prevent tampering.

Airlines Consider Radar Eye

Lightweight radar for commercial airlines permits crew to see weather and obstructions 150 miles ahead

AIRBORNE RADAR that sees storms, indicates obstructions and weighs less than a passenger makes sense to operators of commercial airlines. They have been watching development of a lightweight equipment known to the military as APS-42. Bendix Radio has recently demonstrated a modified civilian version known as the RDR-1. Two operators, so far, like it enough to use it.

Pan American-Grace Airways has authorized installation of the new radar eye in its fleet of DC-7's. Pan American World Airways will try one out in a DC-6.

▶ **What It Shows**—Operating on so-called X-band (3.2 centimeters) the radar is sensitive to obstacles the size of raindrops. It can spot a one-mile hole between two storms at twenty miles. On the ppi screen, the heaviest rainfall appears as a black spot surrounded by a white fringe of lesser precipitation.

Besides giving a view 240 degrees wide 150 miles ahead, the radar can be tilted up or down 15 degrees to search for higher aircraft or to map the ground. Circular lines on the scope indicate distance from the center, which represents the position of the plane.

▶ **Payload Reduction**—For what it does, the little radar costs only 136 pounds of payload. It comprises an antenna scanner mounted in the nose, a control unit and two indicator scopes in the cockpit, a synchronizer with power supply and transmitter-receiver both of which are mounted in the radio rack.

Equipment Makers Push Color Sales

Broadcasters ready plants for network feed, plan local films and slides

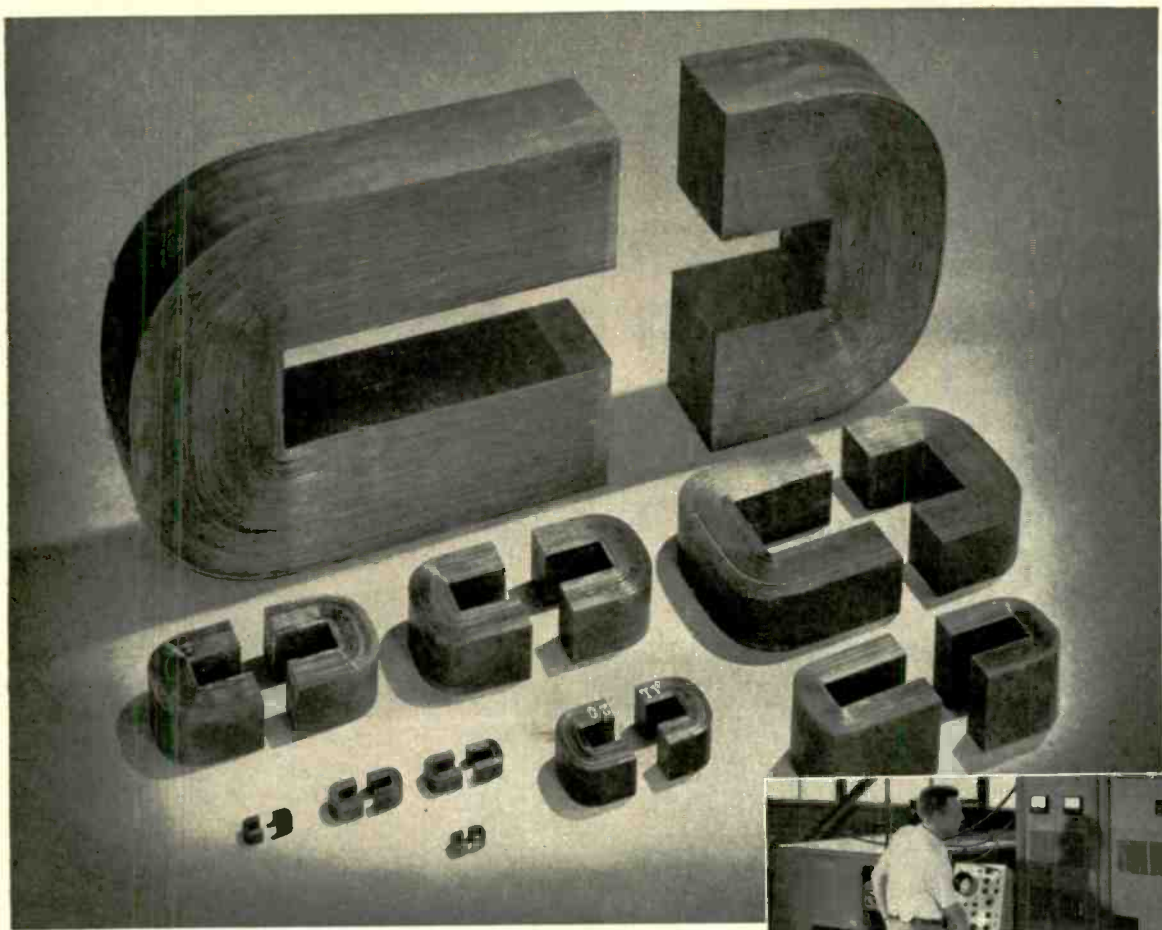
COLOR television is here, insofar as New York and Los Angeles viewers are concerned. Metropolitan dailies now list colorcasts on their television program pages. These are live shows originating at network key stations.

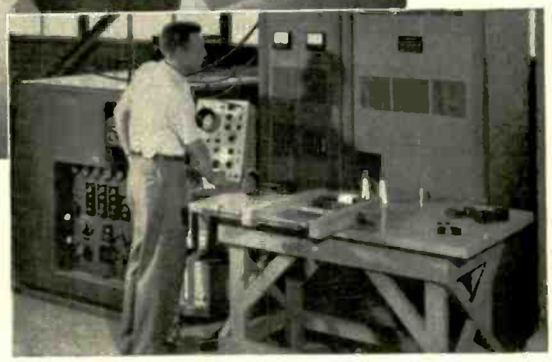
Color will come to the rest of the country by way of network feed and locally originated films and slides. At present 42 stations in 29 cities are equipped to handle network color. By the year's end 130 stations in 96 cities should be so equipped.

▶ **Equipment**—It will cost the station owner between $50,000 and $100,000 to convert his plant to color. This includes special test equipment, stabilizing amplifiers, transmitter modifications where required and film and slide equipment.

Du Mont, Philco, RCA and GE

(Continued on page 12)





Arnold Pulse Transformer Cores are individually tested under actual pulse conditions

W&D 5238

WRITE for your COPIES

"MAGNETIC MATERIALS CATALOG"

General information on all Arnold magnetic materials: permanent magnets, tape-wound and powder cores, types "C" and "E" cut cores, etc.

"ARNOLD SILECTRON CORES"

52 pages of valuable data covering a complete range of core shapes, sizes, tape gauges, etc.

ADDRESS DEPT. E

The inset photograph above illustrates a special Arnold advantage: a 10-megawatt pulse-testing installation which enables us to test-prove pulse cores to an extent unequalled elsewhere in the industry.

For example, Arnold 1 mil Silectron "C" cores—supplied with a guaranteed minimum pulse permeability of 300—are tested at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gausses. The 2 mil cores, with a guaranteed minimum pulse permeability of 600, receive standard tests at 2 microseconds, 400 pulses per second, at a peak flux density of 10,000 gausses.

The test equipment has a variable range which may enable us to make special tests duplicating the actual operating conditions of the transformer. The pulser permits tests at .05, .25, 2.0 and 10.0 microsecond pulse duration, at repetition rates varying anywhere from 50 to 1000 pulses per second.

This is just another of Arnold's facilities for better service on magnetic materials of all description. ● Let us supply *your* requirements.

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

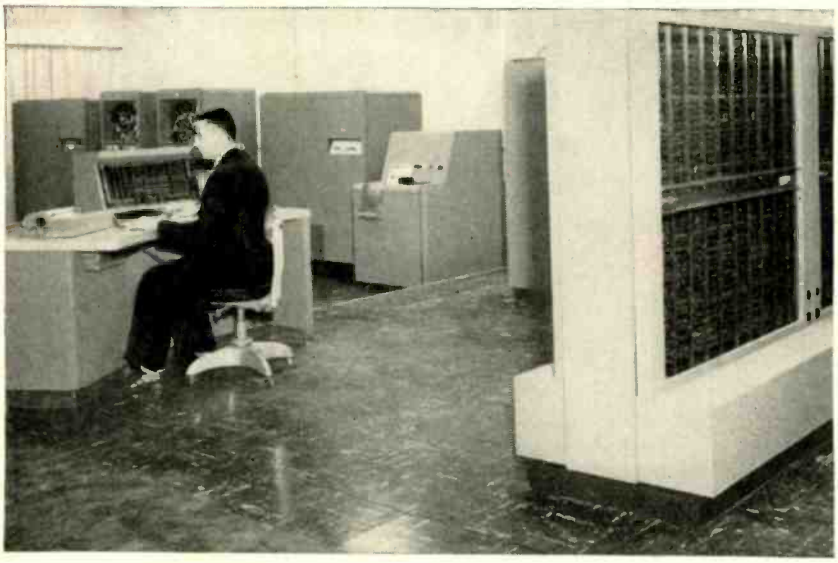
General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

are all offering film and slide originating equipment. The GE unit utilizes the CBS-developed Chromacoder. The RCA equipment uses three Vidicon cameras. The Philco scanner can handle both 16 and 35-mm film. Du Mont, Philco and GE use the flying-spot principle.

Computer to Reduce Payroll Work



Unitized computer is made up of arithmetic and logical units, input and output equipment and memory units as required by specific application

A COMPUTER designed for business use in accounting, payroll and inventory work has added another area to the growing fields of computer application. Insurance companies, banks and other businesses handling statistics and accounts on a large scale are expected to be the major markets for the new unit.

Scheduled for production in January 1955, the IBM model 702 computer will be leased at a figure in the neighborhood of $25,000 per month. The 702 uses magnetic tape or punch cards for programming and has an electrostatic memory consisting of 70 cathode-ray storage tubes. Magnetic-tape storage units provide additional memory space if required. Output can be in the form of punch cards at the rate of 100 per minute.

Use of the computer in a typical payroll operation reduces the number of steps from 302 in customary accounting methods to 28. In this example cost of the work would be reduced from $4,000 to $1,935.

▶ **Computers in Use**—IBM estimates that the number of their earlier model computers now in use or on order is in excess of 5,500. Most of the four models that have been produced are being used in scientific and engineering research.

Reminder To Reader

If this issue of ELECTRONICS has come to your home or to the place at which you work, you are reading it only because you, or someone in your behalf whose name is on our circulation records, has paid a subscription-price for ELECTRONICS' service to you as a reader.

The payment underwrote a judgment that ELECTRONICS would help you in your work.

It placed ELECTRONICS under a contract to do that.

Renewal of such a contract, on the original terms at the end of the subscription period, is wholly a reader-decision that ELECTRONICS has not failed.

The publisher of ELECTRONICS believes that the controlling interest of the reader demands and deserves that he hold this kind of a contract, which can be provided only under the principle of voluntarily renewable paid-subscription service.

H. W. MATEER
PUBLISHER

Anne Track Speeds Messages

Multichannel radio link combines compact equipment with eventual dollar savings

NEW FIELD RADIO equipment developed by Bell Labs is now coming off Western Electric production lines in quantity. With a nearly pronounceable military designation AN/TRC-24, it is customarily referred to as Anne Track Twenty-Four. Its purpose is to provide multichannel radio communication linking positions up to 25 or 30 miles apart.

Cascading equipments in multilink fashion provides moderately long-distance telephony. Alternatively, one or more links can be interposed between sections of a comparable wire carrier system using spiral-four cable.

In the transmitter and receiver, frequency modulation is used at carrier frequencies over the range 100 to 400 mc. The equipment accommodates a signal band from 250 to 68,000 cycles.

▶ **The Economics**—It is difficult to compare this new equipment with that used in World War II because there was nothing exactly like it. The nearest approach was many times as bulky and several times as expensive. Since the requirements of all military groups was represented by the Signal Corps in guid-

(Continued on page 14)

ing the development, other services will employ the equipment, making for greater potential speed of all armed forces and reducing costs through standardization.

Broadcasters Attend Biggest Confab

NARTB membership turns out in force to get low-down on colorcasting

MORE than 2,500 broadcasters representing every state in the union, Hawaii, Alaska, Canada, Mexico, Cuba and other points jammed Chicago's Palmer House in May as the National Association of Radio and Television Broadcasters held their 32nd annual conclave.

Present were six of the seven FCC commissioners including Rosel Hyde, acting chairman. More than 100 exhibitors maintained displays. Station equipment on the main exhibit floor was valued at more than $4 million. About a third of the exhibitors were manufacturers or distributors of studio and transmitting equipment. The remainder were station reps, film and record companies and publications.

▶ **Technical Session**—Concurrent with the management conference was the 8th annual engineering conference. The 26 technical papers presented constituted a broadcast engineer's short course in color television. Color likewise was much in evidence on the exhibit floor with four companies showing film scanners, two live shows in progress and assorted items of color test equipment spread about.

Other equipment on display included a 50-kw a-m transmitter and 50-kw vhf television rigs, microwave relay links readied for color and uhf transmitters ranging from 1 kw upwards.

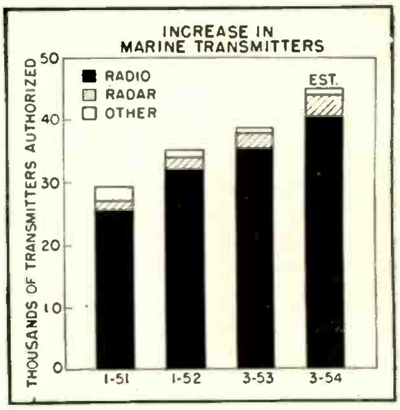
▶ **Business**—Underlying theme of the convention, however, was the uhf problem. Other subjects of interest included remote operation of a-m stations, ways to make profits from f-m and opposition to threatened advertising bans.

RADAR is adapted to a bridge-ducking tug as . . .

Waterborne Equipment Sales Rise

Radio and radar volume increased substantially last year as shippers took to the air

AMOUNT of electronic equipment used in the marine service has increased steadily thoroughout the past three years. As is shown in the chart, radio transmitters for two-way communication between coast stations and ships along with radar equipment have accounted for over 95 percent of unit sales to the field. Remaining sales have nearly all been for land or fixed station transmitters.



▶ **Market**—Under the Communications Act all cargo vessels of 1,600 or more gross tons and all passenger vessels navigated in the open sea are required to carry radiotelegraph installations unless exempted by the FCC under certain conditions. International regulations require that cargo vessels between 500 and 1,600 gross tons on international voyages be equipped with either radiotelegraph or radiotelephone. Regulations also require lifeboats of specified type ships to carry automatic transmitter-receiver units. A large number of vessels on the Great Lakes are also equipped with radiotelephone installations.

▶ **Companies**—Mackay has reported that complete radio and electronic equipment was being supplied for a fleet of 22 new tankers and that similar equipment was installed aboard many vessels for the U. S. government. The company's portable lifeboat set was ordered for 600 ships during 1953. Sixty new ships were equipped during the year with complete radio stations and over 200 more were converted to international standards and work was done on 300 rental contract ships.

Radiomarine Corporation has re-

(Continued on page 16)

for control of

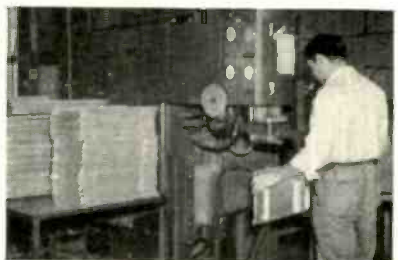
SHOCK and VIBRATION

BARRY B MOUNT

They're YOUR designers - but WE pay them.

You don't have shock and vibration problems every day — but when you *do*, you want them solved promptly. So you want the practical experience of men who've been spending *all* their time in this highly specialized engineering — men who have most likely met and successfully answered questions just like the ones that are bothering you. These men are Barry engineers — ready and able to analyze *your* shock and vibration problems, backed by a laboratory staffed and equipped to *prove* their solutions, and served by model shops geared to produce *your* prototypes whenever you need them.

You'll save time, money, and trouble by using our design and prototype service. Write today for Bulletin DP-54 "This is Barry".



PRODUCTION FACILITIES include such modern equipment as this 100 KVA spot welder, accurately timed for welding aluminum.

LAB-TESTING the performance of Barrymounts protecting delicate electronic equipment.

THE **BARRY** CORP.

707 PLEASANT STREET
WATERTOWN 72, MASS.

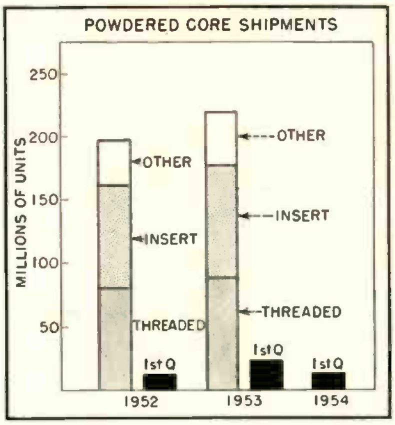
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES ported a 57-percent increase in sales in 1953 over 1952 volume. Repeat orders for specialized electronic units helped swell sales to the armed forces and other government procurement agencies to more than twice the volume of the previous year. Some of the increases in the firm's sales were due to diversification, however, and some new products made by the division were not in the marine field.

Installations of radar were made by the firm on more than 100 ships operating on the Great Lakes and a similar number that sail on other inland waterways. About 34,500 marine service calls were answered in 1953 by the firm.

Raytheon reports that about 2,100 commercial ships are equipped with its radar. Approximately 35 percent of the firm's commercial product sales were to the marine field in 1953. The same percentage is expected for 1954.

Radar is being actively adapted and sold in the tug-boat field. Recent adaptation of Raytheon radar equipment has transmitter and receiver built entirely within the antenna housing so that the tug can lower her mast and retract her wheelhouse seven feet to duck under low bridges. No rigid waveguide is used in the installation.

Powdered Iron Cores Gain Sales



Shipments to the industry have risen steadily and applications are increasing

IMPORTANCE powdered iron cores have gained in the electronics business was pointed up at the recent tenth annual meeting of the Metal Powder Association.

Sessions concerning electronic cores were held for a full day in which manufacturers of receivers, cores, coils and coil forms discussed the product.

A program of standardization was adopted to bring about reduced costs of the components to set manufacturers. According to the association, the return of a buyer's market has emphasized and heightened the need for standardization.

▶ **Market**—The sales field that the electronics industry represents to core makers is indicated in the chart. Over 217.5 million cores of all types were shipped for use in electronic equipment last year compared to approximately 197 million in 1952. Insert cores, those in which a metal insert is molded or cemented in one or both ends of the core, comprised the largest shipments in both 1952 and 1953 with 81.8 million units and 89.0 million units shipped respectively. Such cores are used to adjust an inductor to a fixed frequency.

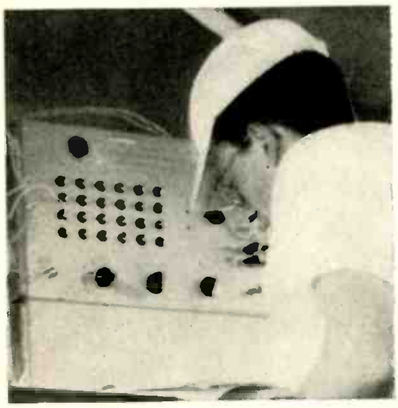
Threaded cores were next largest in use with shipments for electronics use totalling 79.3 million units in 1952 and 87.1 million units in 1953. The remaining core shipments in 1953 were made of 11.7 million tuning cores which is a side or end molded iron core for continuous permeability tuning with an insert cemented or molded into it; 8.0 million of the coil form which is an iron core formed with wire leads at both ends (for peaking coils), and 21.5 million of the special and miscellaneous types of cores.

▶ **Sales**—For the first quarter of this year, iron core shipments to the electronics industry have been below the first quarter of 1953 mainly because of lower radio and tv production. Military use of the cores has dropped off and comprised only 10 percent of the total cores shipped for electronics in the first quarter.

In the first quarter of 1953 they accounted for 12 percent of shipments and in 1952's first three months, 29 percent was for military electronics. For the full year of 1953, the military took 9 percent of shipments compared to 21 percent for all of 1952.

▶ **Future**—Despite lower production in the first quarter of this year, core manufacturers expect increasing business. They feel that although the industry is in a buyer's market for the first time since the war, the utilization of metal powders will continue to grow despite and perhaps because of an increase in general business competition.

Electronics Gages Sports Car Speed



Auto speeds in hundredths of a mile per hour were checked at the National Sports Car Races by Naval Ordnance Laboratory engineers through use of two pickup units, exactly 100 feet apart, consisting of 450-mm lenses with phototubes in the focal planes and a Potter megacycle frequency-time counter shown above

Advisory Board Points Up Nickel Conservation

Tight nickel supplies and possible increased demands color supply picture

DESPITE recent reports that 10 percent more nickel would be available for civilian uses because of lighter military requirements, the government is still concerned about the supply picture for the metal. A recent report by the Material Ad-

(Continued on page 18)

Announcing G-R's NEW Unit Pulser

Pulse Durations: 0.2 to 60,000 μs
Repetition Rates: 0 to 100 kc
Rise Time: .05 μs

Type 1217-A Unit Pulser $225
shown with plug-in **Type 1203-A Unit Power Supply $40**

Pulse-modulated UHF signal sent through tv-convertor, into tv-set antenna-input, and through tv-set to screen — overall transient response from front to end determined quickly and easily — convertor and receiver manufacturers may in this way effectively determine ability of their products to pass uhf signals, under simulated operating conditions.

The Type 1217-A Unit Pulser is the first *laboratory-quality* pulse generator to be made commercially available at *moderate cost*. Its wide range of pulse durations and repetition rates, stability, high output voltage and variable amplitude control make this instrument a highly versatile piece of equipment for every industrial and college laboratory.

The GR Unit Pulser . . . *Small* . . . *Compact* . . . *Economical*

Provides square waves from 10 cycles to 100 kc for checking Overall Audio-Amplifier Transient Response.

For TV-Receiver Testing — a Unit Pulser locked to the receiver line frequency produces a visual response directly on the picture tube in checking operation of video detector and amplifier.

Invaluable in Educational Laboratory and Demonstration Class — an Oscilloscope and Unit Pulser may be used in student experiments to illustrate ability of linear, passive networks to pass pulses of varying durations and repetition rates.

Useful in Telemetering, Computing and Nuclear Research and Development — Pulser produces clean pulses controllable over wide ranges — combination of two Pulsers produces a flexible phasing system and source of delayed pulses or gates adjustable with time.

The Type 1000-P7 Balanced Modulator Is A Unique New Device Which Permits Full 100% Amplitude Modulation Of Carriers From 60 to 2300 Mc — Modulating Signal May Be Any Frequency Over 0 to 20-Mc Band.

Where good rise time characteristics and negligible incidental f-m *are essential*, these instruments are highly recommended.

With the Unit Pulser and this Modulator, signal generators may be pulse modulated over extremely wide ranges. The two instruments make a highly useful combination for pulse work . . . such as testing of television broadcast and receiving equipment . . . and measurements on radar, omni-range and DME, and telemetering apparatus.

Write for the recently published VHF-UHF Bulletin which gives specifications and technical details for the new Unit Pulser, the Balanced Modulator, and G-R's completely integrated line of high-frequency equipment.

Since 1915 — GR — Manufacturers of Electronic Apparatus for Science and Industry

GENERAL RADIO Company
275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.
90 West Street NEW YORK 6 920 S. Michigan Ave. CHICAGO 5 1000 N. Seward St. LOS ANGELES 38

Admittance Meters ☆ Amplifiers ☆ Coaxial Elements ☆ Distortion Meters ☆ Frequency Measuring Apparatus ☆ Frequency Standards ☆ Impedance Bridges ☆ Light Meters Megohmmeters ☆ Modulation Meters ☆ Polariscopes Precision Capacitors ☆ Oscillators ☆ U-H-F Measuring Equipment ☆ Parts & Accessories ☆ Signal Generators Wave Analyzers ☆ Variacs ☆ TV & Broadcast Monitors Pulse Generators ☆ R-L-C Decades ☆ R-L-C Standards ☆ Unit Instruments ☆ Sound & Vibration Meters ☆ Stroboscopes ☆ Null Detectors ☆ Motor Controls ☆ Wave Filters ☆ V-T Voltmeters visory Board of the National Academy of Sciences to the Defense Department recommended additional research on conservation means.

▶ **Recommendations** — The Board listed several possible ways to conserve nickel in the manufacture of communications equipment. They are:

Substitution of 10-percent nickel silver for 12-percent nickel silver in parts other than springs. Substitution of zinc-plated steel for nickel silver. Substitution of chromium stainless steels (AISI 400 series) for nickel chromium stainless steel types (AISI 300 series). Further substitution of silicon steel for high nickel alloys in armatures and cores. Further reduction in the thickness of nickel plating under ceramic coatings. Complete elimination of nickel plating in such applications by substitution of special enameling steels.

▶ **Manufacturers**—Despite the supply problem, some electronic manufacturers report that they have felt no actual shortage of the metal. However they admit that nickel is tight. A few feel that if set production had not slumped off this year, a shortage might have developed.

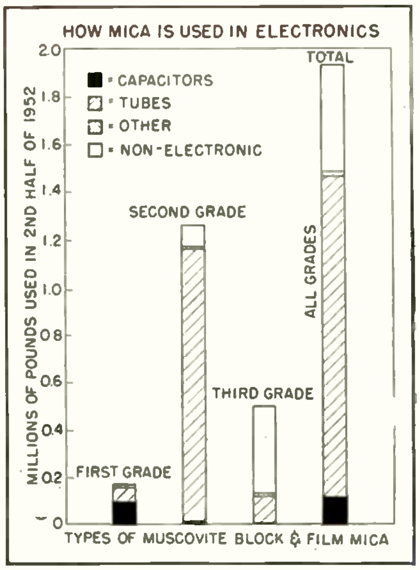
Nickel manufacturers see no overall shortage despite reports. They term the present situation spotty and say there is no shortage for rolled nickel but that in plating there are some shortages. They feel that the future is important and that the world situation and its effect on government and military nickel policies could change the supply situation overnight.

▶ **Consumption**—Over 200 million pounds of nickel are consumed in the U. S. annually. About 45 percent of the total is utilized in stainless and engineering alloy steels.

The electron tube industry uses about 3.5 million pounds annually, close to 300,000 pounds a month. In 1952 it was estimated by RETMA that the amount of nickel used in radio-tv set production was approximately 2.5 million pounds and that with conservation methods and lower production a 65-percent saving of nickel could be made.

Mica Fabricators Study Sales

The industry is a volume user of natural mica; synthetic mica enters the picture



ABOUT 19,000 tons of natural mica of all types are imported annually into the U. S.

According to the Bureau of Mines, about 3.8 million pounds of this block mica are suitable for electronic applications. India is our main source for mica of this type. It is estimated that approximately 50 percent of the high grade mica used in the U. S. comes from India, 45 percent from Brazil and only 5 percent from the U. S. But the beginning of commercial production of synthetic mica this year in the U. S. may change the mica import picture in the future. So far only small crystals have been produced but it is hoped that larger crystals will be forthcoming within two years.

▶ **Consumption**—Nearly 70 percent of the mica suitable for electronics is used in electron tubes, 6.4 percent is used in capacitors, 0.6 percent in other electronic applications and 23.0 percent in nonelectronic products such as flatirons, toasters, gage glass and telephones.

With the cooperation of the Mica Fabricators Association, the Bureau of Mines estimates that receiving tubes used 1.3 million pounds in the second half of 1952 while transmitting and radar tubes used 17,739 pounds. All other tubes used 20,374 pounds.

In receiving tubes, stained or second grade mica accounted for 1.1 million pounds of the total used. Transmitting and radar tubes also used more stained or a total of 14,859 pounds. Only for tubes of other types was first grade mica used to a greater extent, with a total consumption of 12,190 pounds. Capacitor manufacturers used mostly first and second quality film mica during the period.

Mica fabricators for the electronics industry enjoyed a good year in 1953 when nearly 4.0 million pounds of mica were used by manufacturers in the field.

Financial Roundup

VARIED profit picture was indicated in the financial statements reported in the past month by firms in the electronics field. Here are the net profits for 17 companies for monthly periods indicated in fiscal 1954 and 1953:

Company	Net Profit 1954	Net Profit 1953
Admiral 3m	$ 1,504,044	$ 3,056,878
Am. Cable & Radio 3m	476,106	238,799
Bendix Av. 6m	6,359,188	4,721,962
CBS 3m	2,866,365	2,338,148
Cornell-Dubilier 6m	847,953	895,204
T. A. Edison 3m	289,907	260,543
Electronic Eng 3m	18,153	
Emerson Radio 6m	947,515	1,768,694
General Inst. 12m	926,903	1,275,864
IT&T 3m	2,323,343	2,207,457
Magnavox 9m	2,030,912	2,051,578
Minn. Mining & Mfg. 3m	5,354,866	4,354,859
Philco 3m	2,438,000	3,401,000
Standard Coil 3m	406,306	1,737,045
Tung Sol 3m	450,304	552,318
Westinghouse 3m	26,286,000	16,858,000
Weston Inst. 3m	350,788	255,939

▶ **Securities**—Triad Transformer of Venice, Calif. filed with SEC covering 20,000 shares of common stock (par $5) to be offered at $10 per share. Proceeds are to be used to reduce bank loans and for working capital.

Tape Recording Corp. filed with SEC covering 15,000 shares of noncumulative preferred stock to be first offered at par ($1 per share) to common stockholders on basis of one preferred for each four shares of common. Net proceeds will be added to working capital.

Control Engineering of Norwood,

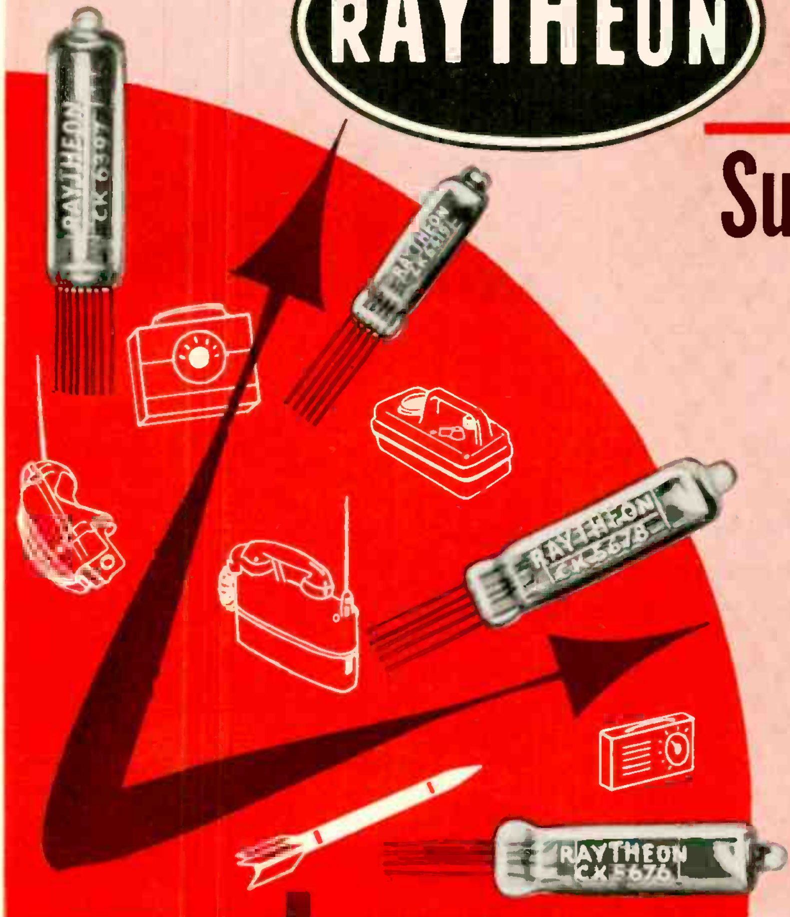
(Continued on page 20)

TAKE JUST ONE MINUTE

RAYTHEON

to consider
the advantages of

Filamentary Subminiature Tubes



There are many applications where filamentary subminiatures meet your requirements better than the familiar heater-cathode types. RAYTHEON Filamentary Subminiature Tubes have the dependability, life and performance required for critical applications:

Low Operating Power — total input as little as 6.5 milliwatts

Small Size — as small as 0.06 cubic inches

Negligible Heat To Dissipate

Rugged — up to 500G shock — standard fatigue vibration

Reliable Filaments — tests indicate only one failure per 500,000 on-off cycles

Quick Heating — well under a second

Low Microphonics — Raytheon CK512AX and CK6419 are extraordinary in this respect

Long Life — combined test data on all types show 58,000 hours of dependable performance for each failure

High Efficiency — mutual conductance (micromhos) as much as 4 times greater per watt of filament power as per watt of heater power in comparable heater-cathode tubes

Here are characteristics of a few representative types of Raytheon Filamentary Subminiatures. Complete data on all types are available on request.

TYPE	DESCRIPTION	Length (Inches)	Diameter (Inches)	FILAMENT VOLTS	FILAMENT MA	PLATE VOLTS	SCREEN VOLTS	GRID VOLTS	PLATE MA	SCREEN MA	MUT. COND. UMHOS	VOLTAGE GAIN	PLATE RESIST. MEG.
1AD4	RF Pentode	1.50	.300–.400	1.25	100	45	45	Rg=2meg.	2.8	0.8	2000		0.5
1AG5	Diode-Pentode	1.50	.285–.385	1.25	30	45	45	Rg=5meg.	0.8	0.25	350		0.26
CK512AX	Ampl.-Pentode	1.25	.285–.385	0.625	20	22.5	22.5	-0.625	0.125	0.04	160	37	1.25
CK5676/6050	UHF Triode	1.50	.300–.400	1.25	120	135		-5.0	4.0		1600		
CK5678	RF Pentode	1.515	.300–.400	1.25	50	45	45	Rg=5meg.	0.8	0.22	820		1.2
CK6088	AF-RF Pentode	1.50	.285–.385	1.25	20	45	45	-1.25	0.65	0.15	625	†10.5	0.7
CK6092	AF Pentode	1.50	.285–.385	1.25	50	45	45	-4.5	1.4	0.4	600	†25	
CK6286	UHF Triode	1.50	.285–.385	1.25	125	67.5		-2.0	6.0		2100		
CK6397	RF Pwr. Pentode	1.60	0.40	1.25	120	125	125	-7.5	7.0	1.1	1800		
CK6418	AF Pentode	1.25	.235–.290	1.25	10	22.5	22.5	-1.2	0.24	0.06	300	†2.2	0.42
CK6419	Ampl. Pentode	1.25	.235–.290	0.625	10	15	15	-0.625	0.0046	0.002	17	27	12

†Power output — milliwatts

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass.

For Application Information Call: Boston, Bigelow 4-7500 ● Chicago, NAtional 2-2770 ● New York, WHitehall 3-4980 ● Los Angeles, Richmond 7-4321

RAYTHEON MAKES ALL THESE:

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

Mass. offered an issue of $300,000 6% subordinated convertible debentures due April 1, 1964 at 100 percent. Net proceeds are to be used for general corporate purposes, including additional working capital largely for the promotion of commercial and industrial use of the firm's present instruments and for the development of new products and markets.

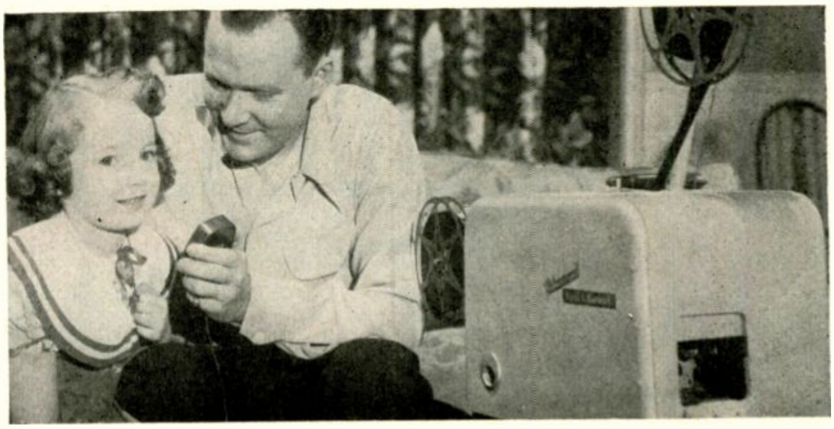
Daystrom is requesting holders of capital stock of Weston Instrument to submit tenders for the purchase by Daystrom of up to 55,000 shares of the capital stock of Weston at a price of $25 per share.

Hoffman Radio registered with SEC covering 130,000 shares of its common stock, 50 cents par. Net proceeds are to be added to working capital. The firm intends to build a new $1.5 million plant in El Monte, Calif.

Firms Alive to Tube Replacement Business

SMALL manufacturers seeking a piece of the lucrative tube replacement market have concentrated on specialty items. For example, fringe-area televiewing and large-screen sets seem to have created a special market for souped-up versions of the type 5U4 low-voltage rectifier. An additional output of 20 to 40 volts often makes it attractive to replace the conventional rectifier with one drawing a third more filament current. Some bigger companies have their own higher-current tubes, too, with special construction and new type numbers.

▶ **One Answer**—One manufacturer's approach to a competitive situation is a complete redesign of several popular tubes found in many television sets. General Electric is now offering its new, interchangeable versions of the 5U4, 6BQ6 and 6SN7. The line will also include 25BQ6, 1B3 and 5Y3. Mechanical improvements claimed for various new tubes are bottom-stem bases, higher melting-point solder and different glass envelopes. On the electrical side, maximum plate voltage for the new 6SN7, for instance, is 200 volts above the old rating—500 volts.



MAGNETIC striping gives excellent results on 16-mm film as . . .

Home Movies Sound Off On Tape

System using tape recorder and silent projector may replace magnetic striping on film

SOUND with home movies has been the goal of practically all 8-mm and 16-mm amateur enthusiasts. Introduction of magnetic striping on the side of movie film attracted much interest, but the method requires adding a magnetic sound head on the projector and separate processing of film for applying striping.

Normal expansion and contraction of film with temperature and humidity tended to crack off the striping. Laminated striping cured this.

▶ **Market Figures**—There are some 3,000,000 movie makers in this country, of which about 600,000 use 16-mm film and 2,400,000 use 8-mm film. Magnetic striping is considered satisfactory only for the 16-mm enthusiasts, because there is not enough room on 8-mm film to get sufficient powder for adequate fidelity.

▶ **New Technique**—An electronic control system being patented by E. Anthony of Long Island, permits use of a standard two-track magnetic tape recorder with any movie projector to achieve synchronized sound. Ordinary tape and ordinary film are used, with no extra processing whatsoever. Synchronization is always accurate to the spacing between adjacent sprocket holes. The simple attachments required on the recorder and projector can be put on in a few minutes and connected to the electronic control chassis. Installed cost of control unit and accessories is expected to be about $100.

The user feeds sound to the recorder while watching the projected film. Control signals are recorded automatically on the other track of the tape, for insuring correct projector speed during playback. For lip synchronization with sounds recorded during filming, as required for many industrial films and for catching baby's first words, a pickup device can be added to the camera in some cases.

▶ **Striping Systems**—Lowest-priced 16-mm magnetic recording projector in the Bell & Howell line retails at approximately $700. With this, amateurs can add sound to movies for 3½ cents a film foot, the cost of striping magnetic material on the film edge.

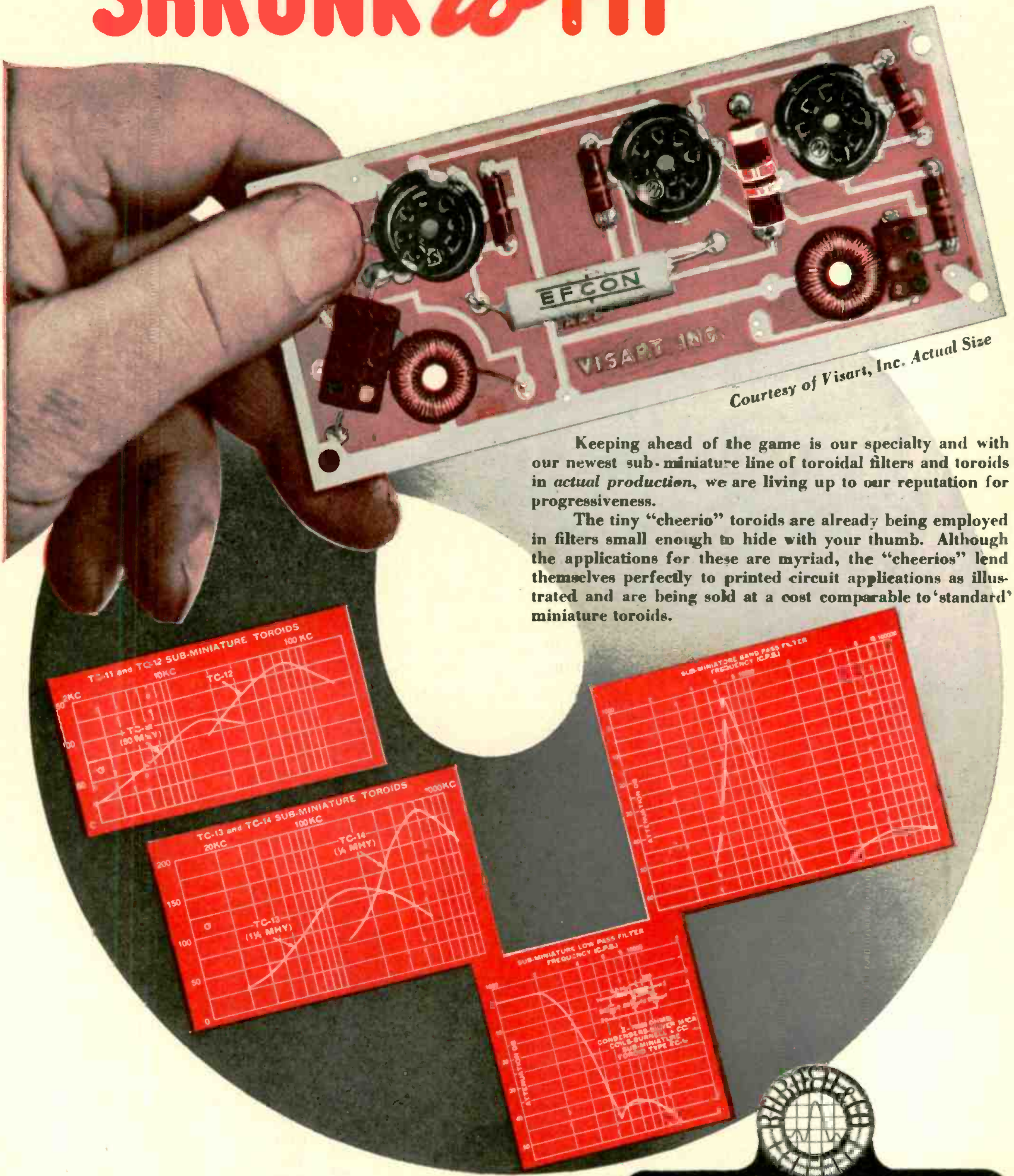
Ampro makes an 8-mm silent projector designed to take magnetic sound track when and if it becomes inexpensive enough to interest the 8-mm enthusiasts. Cost of converting this for sound has not yet been determined. Ampro also makes 16-mm optical-magnetic sound projectors starting at $720.

Victor Animatograph provides a magnetic sound attachment retailing at about $200 for its 16-mm

(Continued on page 22)

Burnell TOROIDS and FILTERS

"SHRUNK *to* FIT"



Courtesy of Visart, Inc. Actual Size

Keeping ahead of the game is our specialty and with our newest sub-miniature line of toroidal filters and toroids in *actual production*, we are living up to our reputation for progressiveness.

The tiny "cheerio" toroids are already being employed in filters small enough to hide with your thumb. Although the applications for these are myriad, the "cheerios" lend themselves perfectly to printed circuit applications as illustrated and are being sold at a cost comparable to 'standard' miniature toroids.

Write for new and enlarged 16 page catalog 102A

Exclusive Manufacturers of Communications Network Components

Burnell & Co., Inc.
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projectors. The magnetic head is rated for at least 1,000 hours of use.

Magnetic laminate tape with a thermoplastic adhesive for bonding to film either before or after processing is made by Minnesota Mining. Costs are competitive with liquid striping, being about 2½ cents a foot for 16-mm film and $1.75 per 50 feet of 8-mm film at one processor (Calvin Co., Kansas City, Mo.). Longer life for magnetic heads is claimed when using the laminate, because the liquid tends to leave ridges at each edge that virtually saw into the head.

Striping equipment is available in a number of foreign countries. Pyral, of Paris, has added an electromagnetic thickness-measuring device for control of the thickness of the stripe while it is being applied.

In Germany, striping is done on 16-mm film for television recording and on 8-mm film for amateur use.

Eight Nation TV Network Begins

Britain, Belgium, Denmark, France, West Germany, Holland, Italy, Switzerland linked

WORLD-WIDE television network moved a step closer in June when tv viewers in eight European countries were able to tune in on the same programs simultaneously. A total of 18 programs will be exchanged during the four-week hookup. Estimates of the viewing audience for the first telecast ranged from 8 million to 20 million people.

▶ **Equipment**—The "Eurovision" network covers about 4,000 miles and utilizes 44 transmitters and more than 80 relay stations. Equipment used is largely British although each country involved has equipment of its own make in operation. U. S. equipment is represented mainly in cathode-ray tubes. It is estimated that $5 million in British equipment is in use.

▶ **How**—Many technical problems involved in converting the various standards used in the countries were solved when the coronation went out from London last year to France, Belgium, Holland, Western Germany and Berlin. However, that telecast was one-way only. On the present network two-way tv is possible over a large part of the network.

Converters are located in Breda, Holland, Paris and Dover to make the standards conversions necessary for the country involved. For example, for converting from French to British standards, an 819-line picture is displayed on a specially coated c-r tube and the scanning lines are broadened to eliminate line structure. The picture is then re-televised by a 405-line system camera.

▶ **Sales**—Foreign tv manufacturers as well as those in the U. S. are hoping that the international tv experiment will hypo sales of both sets and equipment in the countries involved. Manufacturers see a wide market, particularly for microwave equipment, for interstation links. The London radio show next fall is expected to emphasize the British electronics industry's ability to meet export demand for tv cameras, studio equipment, film scanners and outside broadcast units.

▶ **Future**—The present experimental network may become permanent. The nucleus of a permanent European network has been laid in the connections between Belgium, France and the Netherlands. Switzerland has established permanent links with Germany and Italy.

Phosphor Makers Face Good Business

Cathode-ray tubes represent a substantial market for the chemical coatings

TUBE manufacturers buy about 30,000 pounds of phosphor every month in picture-tube production, about 360,000 pounds a year. In dollars, this represents phosphor sales of $4.7 million annually. Each 21-inch tv picture tube needs about 8½ grams of phosphor, about 32 cents worth.

▶ **Uses**—Virtually all tv picture tubes contain the P4 phosphor with a blue-white phosphorescent color. Others of the most commonly used phosphors are: P1 for general oscilloscope use; P7, P12 and P14 for radar and sonar; P11 for photographic applications and P15 for flying-spot scanners.

A new phosphor, P23, has come on the scene for picture tubes but is not yet in widespread use. Developed by U. S. Radium Corp., it has persistence characteristics similar to those of P4 but the color is less blue.

▶ **Companies**—Ten manufacturers make phosphors for c-r tubes. Three of the leading producers are du Pont, Sylvania and U. S. Radium. Sylvania is apparently the only tube manufacturer in the phosphor business at the present time. Other cathode-ray tube manufacturers have attempted to move into the field of selling to outside companies but have not been successful. However, nearly all c-r tube manufacturers maintain phosphor laboratories that are working for better tv screens.

▶ **Color**—So far, color television has had little effect on the phosphor business. Volume is still small even though a color tube may use three times as much phosphor as black-and-white tv.

The present method of applying the dots is a three-step process in which the full face of the tube is coated three separate times with blue, red and green phosphors. The

(Continued on page 24)

excess phosphor that is etched away to form the dots cannot be saved because of impurities it has picked up. Phosphor makers believe that improved methods of applying the phosphors may enable tube makers to use no more of it than is presently used for black-and-white tv.

Until that time comes, however, phosphor makers will enjoy tripled volume for every color tube produced. At present levels, color phosphor prices range from $12 to $27 per pound compared to $13.25 for white. As volume increases, phosphor makers expect color phosphors to decrease in price.

MEETINGS

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. 6–7: First Annual National Conference, IRE Professional Group on Nuclear Science, Sherman Hotel, Chicago, Ill.

OCT. 13–17: 1954 Annual Convention, Audio Engineering Society, Hotel New Yorker, New York, N. Y.

OCT. 14–17: Andio Fair, Hotel New Yorker, New York, N. Y.

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

OCT. 27–30: Thirtieth Annual Convention, National Association of Educational Broadcasters, Hotel Biltmore, New York, N. Y.

NOV. 4–5: East Coast Conference on Airborne and Navigational Electronics, IRE, Sheraton-Belvedere Hotel, Baltimore, Md.

NOV. 9: First International Automation Exposition, 242nd Coast Artillery Armory, New York, N. Y.

NOV. 10–11: Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago, Ill.

NOV. 12–13: National Symposium on Quality Control Methods In Electronics, IRE and American Society for Quality Control, Hotel Statler, New York, N. Y.

NOV. 18–19: Sixth Annual Electronics Conference, Kansas City IRE, Hotel President, Kansas City, Mo.

JAN. 12–15, 1955: World Symposium on Applied Solar Energy, Stanford Research Institute, Westward Ho Hotel, Phoenix, Ariz.

JUNE 29–JULY 3: International Conference on Semiconductors, Netherlands Physical Society and UNESCO, Amsterdam, Netherlands.

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. 10–13: Associated Police Communication Officers National Conference, William Penn Hotel, Pittsburgh, Pa.

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. 1: Fifth Annual Meeting of the IRE Professional Group On Vehicular Communications, Rice Hotel, Houston, Texas.

RETMA Organizes Automation Group

SUB-COMMITTEE to promote "standards for components for use in printed circuit assemblies compatible with automation requirements and with particular emphasis on revising existing types of components", was set up by RETMA at its Chicago meeting.

Membership is open to members and non-members of RETMA who are: Users of printed wiring or printed circuit assemblies; Producers of automatic electronic assembly equipment; Manufacturers of components but only through the chairman or a designated representative of their respective RETMA committee.

The first meeting of the group is scheduled for August 3 in New York City under the chairmanship of H. L. Shortt of Technograph Printed Electronics.

Industry Shorts

▶ **Retail** sales of tv receivers (see p 4) during the first four months of this year reached the highest volume on RETMA records, kept since 1951. April retail tv sales were also the highest recorded for the month.

▶ **End** of 1954 will see network color tv available in areas covering 95 percent of the tv homes in the country, according to NBC.

▶ **Analog computer** center to be put into operation about July 1 at Princeton, N. J. by Electronic Associates, Inc. will provide analytical service on rental basis for industry and the military leading towards automation and improved design of industrial products.

▶ **Tightening** its requirements for amateur and commercial operators, FCC proposes to make ineligible members of Communist-dominated groups, consider the moral character of former Communists and convicted criminals and provide for submission of fingerprints.

▶ **BBC** has purchased two superturnstiles antennas for increased tv coverage for Scotland and Ireland.

▶ **Eight-Ounce** uhf power tetrode with 600-w plate dissipation has been developed by RCA for airborne radio transmitters.

▶ **Prediction** that more than 10 million color tv sets will be in use in U. S. homes by1959 was made by E. W. Engtrom of RCA.

▶ **First** leg of a 1,000-mile submarine cable communication system that follows the route of the Air Force missile test range in the Caribbean (ELECTRONICS, p. 8, Feb. 1954) has been completed by Western Electric. Sixteen carrier telephone repeater stations along the route provide amplification facilities for signals transmitted over the system's 12 channels.

MICROWAVE SIGNAL GENERATORS

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

with Polarad single dial operation

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

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

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

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

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

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

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

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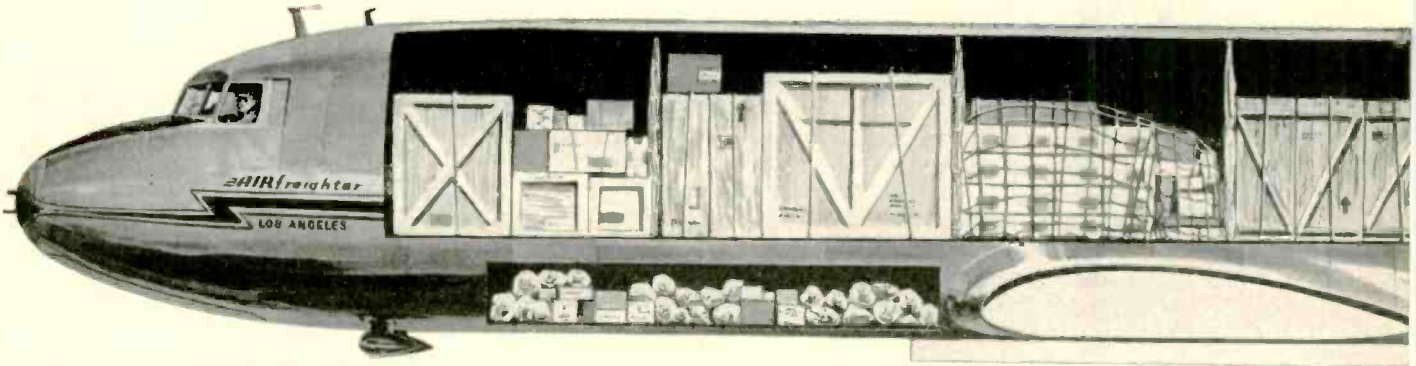
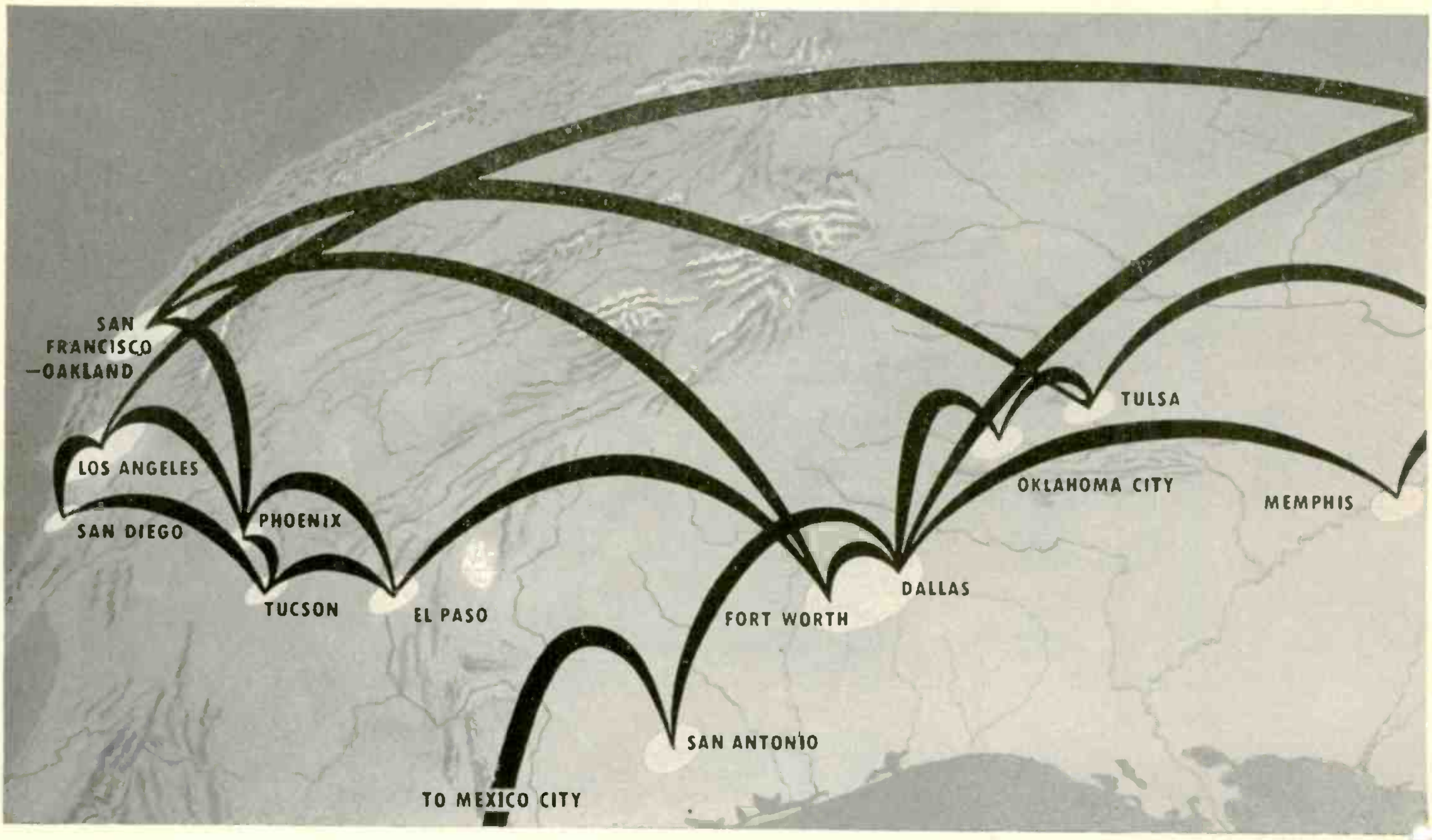
American Airlines has the greatest capacity in the
—more planes carrying freight to more places





Capacity, of course, is one measure of a carrier's ability to deliver the goods. That's why it's important for you to know American Airlines has the greatest cargo capacity in the airfreight field.

But, equally important, when it comes to specifying a carrier, is the availability of that space—having it where and when it can best serve you. Here again, American leads all others.

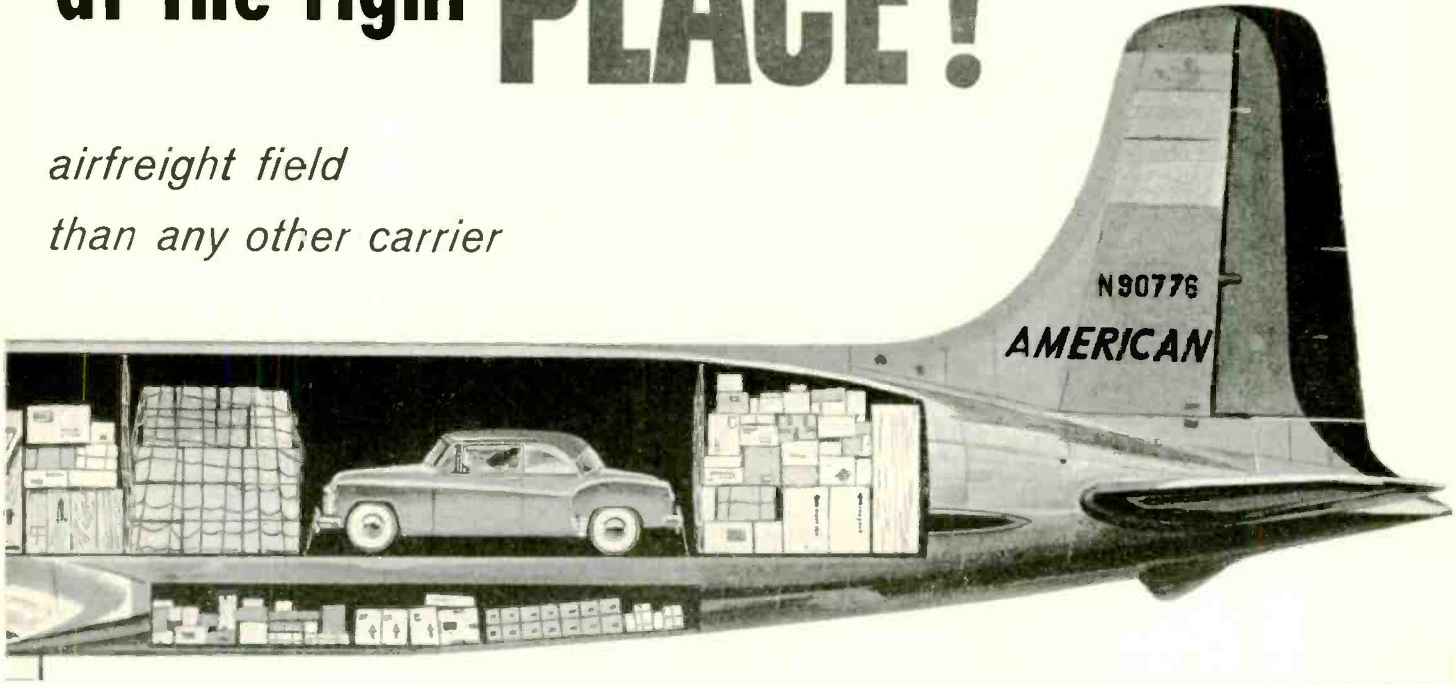
• While providing fast and frequent service to seventy-seven key cities throughout the Country, *only American serves two-thirds of the top thirty retail markets—all twenty-three of the leading industrial states.*

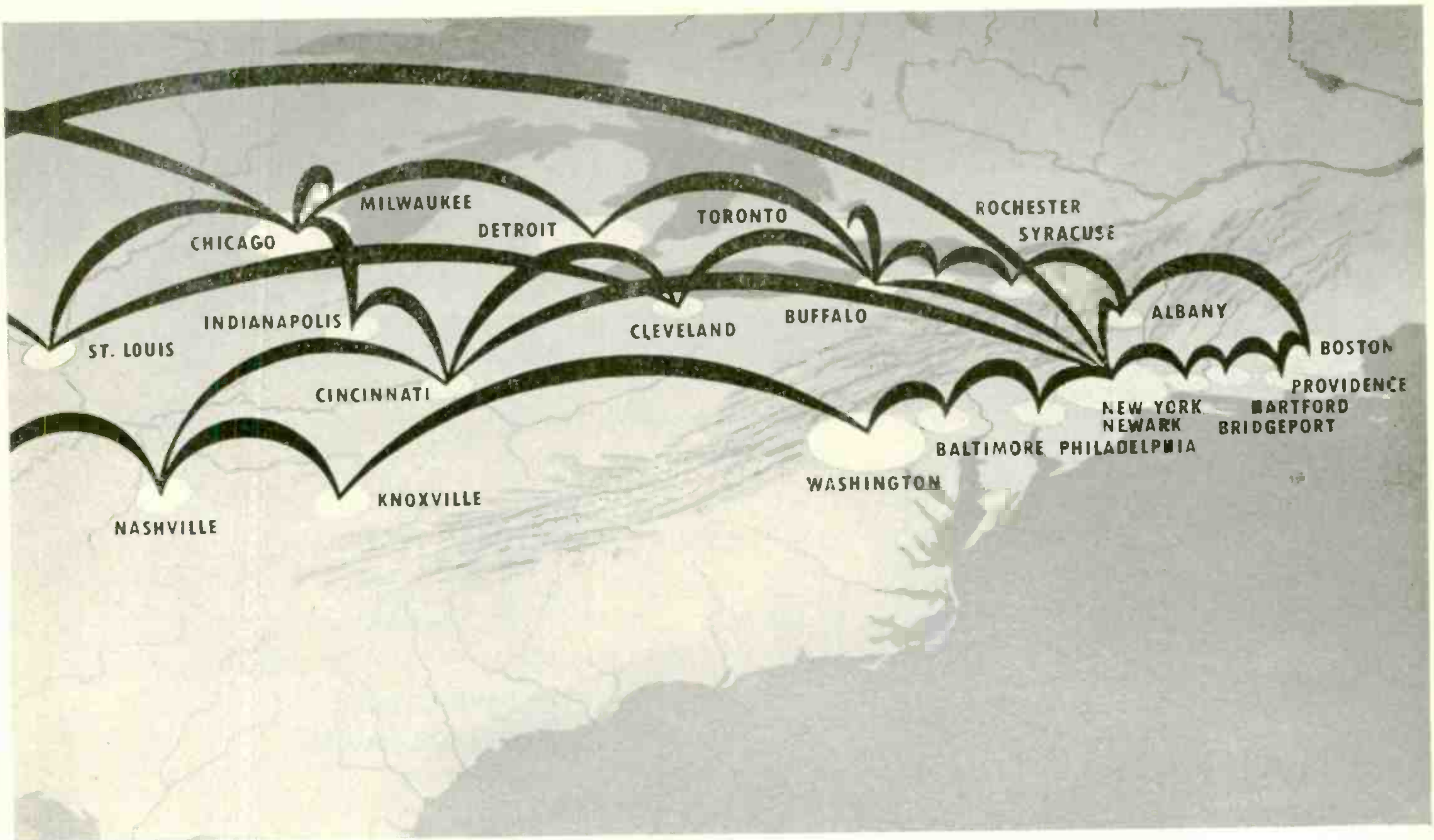
Add this to American's superiority in expe-

at the right PLACE!

airfreight field

than any other carrier





rience and handling facilities and you'll readily see why American Airlines is best qualified to handle your shipments, while helping solve your distribution problems. For complete information, write or wire collect to: American Airlines, Cargo Sales Division, 100 Park Avenue, New York 17, New York.

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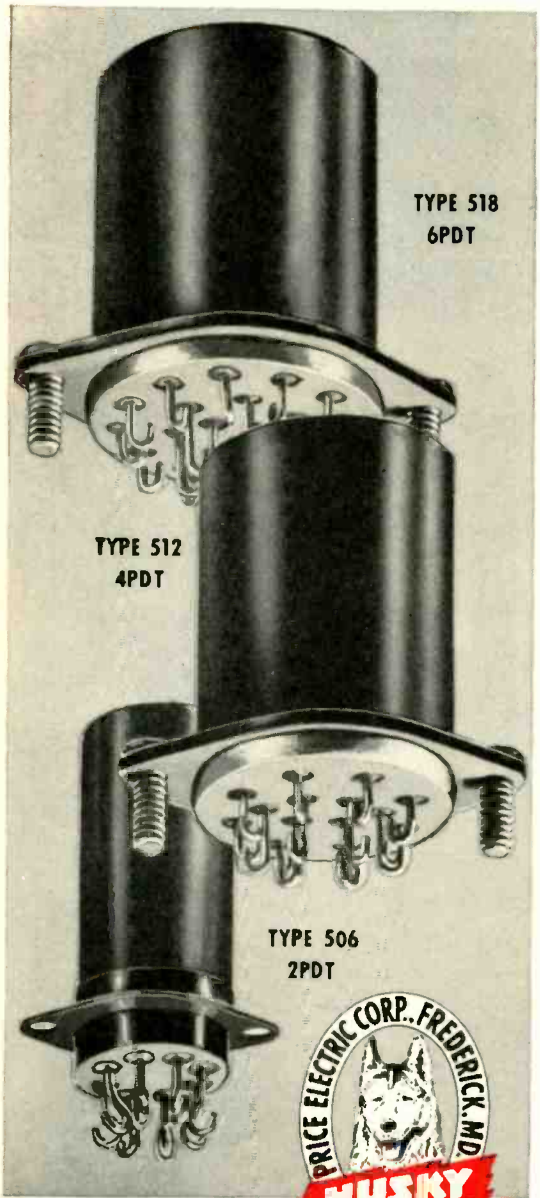
NOW A NEW HUSKY

MINIATURE RELAY

that really takes SHOCK and VIBRATION!



The new *Husky* "500" miniature relay will withstand over 50 G's Operating Shock and 250 G's Mechanical Shock. Vibration, 30 G's up to 2000 c.p.s. Available with the following pole combinations: 6PDT (Type 518), 4PDT (Type 512) and 2PDT (Type 506).

FEATURES

COIL RATING .... 26.5 V. DC
CONTACT RATING .... 2 AMPS, 24 V. DC Non-inductive
ALTITUDE .... Up to 85,000 feet

DIMENSIONS

TYPE	OVERALL LENGTH	DIAMETER	MOUNTING CENTERS
506	1 21/32"	5/8"	7/8"
512	1 23/32"	1 3/64"	1 13/32"
518	1 23/32"	1 3/16"	1 9/16"

TEMPERATURE RATINGS (ALL TYPES)

CLASS A .... —55C to +85C
CLASS B .... —65C to +125C
CLASS C .... —65C to +200C

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Please send complete data on Type 500 miniature relays and relay reference file.

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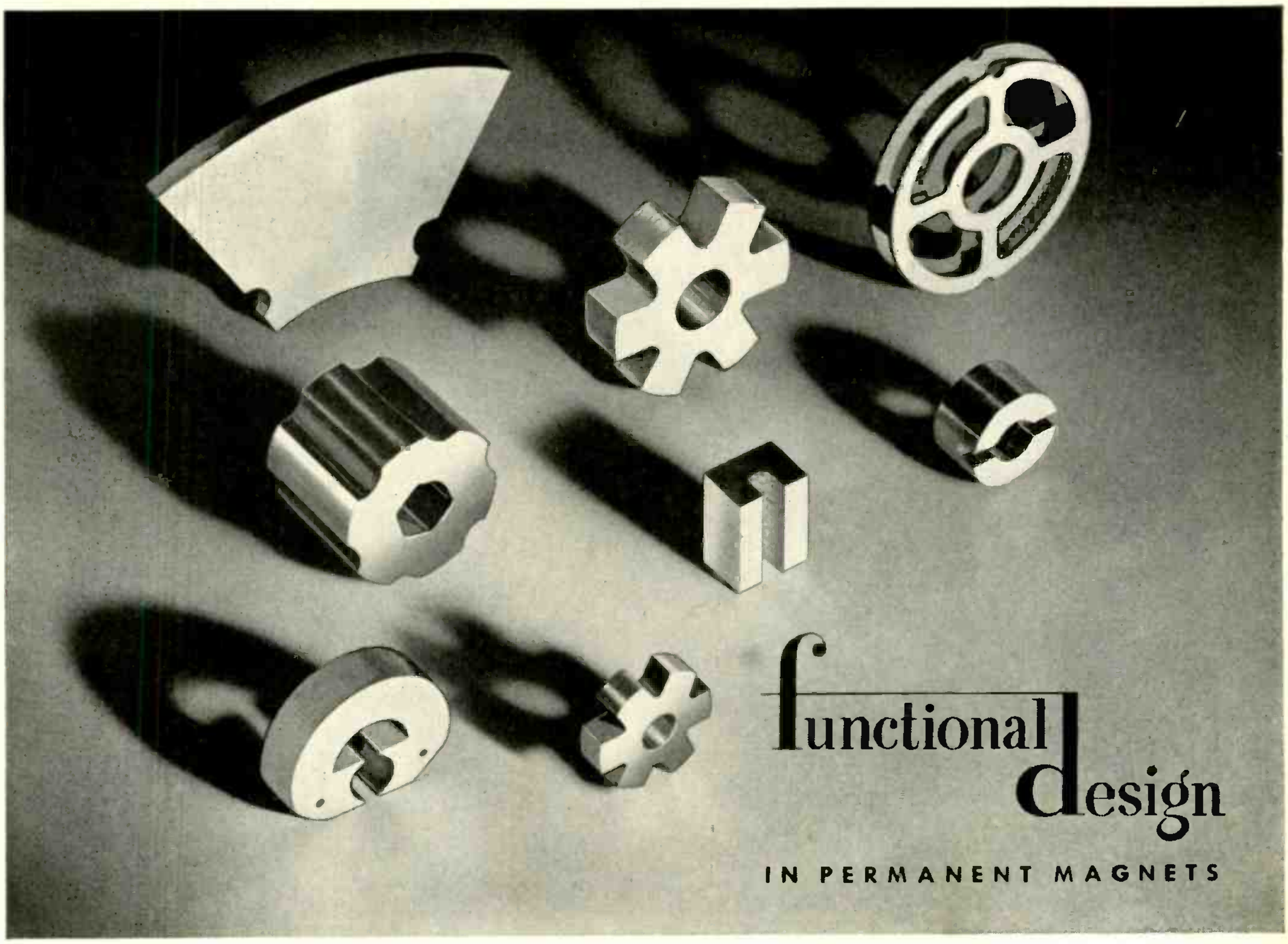
ONE IN A SERIES: discussing the importance of selecting the proper permanent magnet to use in your product



Why SOUND, FUNCTIONAL MAGNET DESIGN

guarantees superior product performance

Magnets must be "tailored" to your product . . . tailored in size, shape, and the material used . . . if greatest efficiency, at the lowest possible cost, is to be expected.

The magnet assemblies shown above are typical of such "tailoring." Those used in test meters, for example, are designed specifically to maintain a magnetic field of uniform high energy, so necessary to the precise operation of such meters. Others—for holding applications—are designed so that their magnetic circuits provide the greatest possible tractive power. In applications where the magnet acts on moving parts of an assembly, still different designs may be required.

Our engineers—specialists in permanent magnet design and application—welcome the opportunity to assist you with your designs. For their recommendations—without cost or obligation—write us today. Or return the coupon below for a free copy of the helpful article, "Selecting the Proper Permanent Magnet Material for Your Product."

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GERMANIUM DIODE INTERCHANGEABILITY CHART

Type & Mfr.	G-E Replace-ment	Minimum Forward Cur. @ +1V. (MA)	Peak Inverse Voltage (Volts)	Cont. Reverse Voltage (Volts)	Maximum Reverse Cur. (μa) @ −50V.	Maximum Reverse Cur. (μa) Other	Remarks
1A (TP)	None	60	5			100 @ −5V. 250 @ −15V.	Gold bonded diode
1B (TP)	None	30	15			100 @ −5V. 250 @ −15V.	Gold bonded diode
1C (TP)	None	30	15			100 @ −5V. 250 @ −15V.	Gold bonded diode
1D (TP)	G6		15 15				60% Rect. Eff. @ 100 Mc
1E (TP)	G7C		5 5				75% Rect. Eff. @ 100 Mc
1F (TP)	G7G		5 5				60% Rect. Eff. @ 100 Mc
1N34 (S,K,RR)	1N48	5.0 4.0	75 85	60 70	800 833	50 @ −10V.	
1N34A (S,A,RCA,RR,NU)	1N52	5.0 4.0	85	60 70	500 150	30 @ −10V.	
1N35 (S,K,Hy,RR)	G8A	7.5 4.0	75 85	50 70	150	10 @ −10V.	Matched pairs See Note 1
1N38 (S,K,RR,Hy)	1N70	3.0 3.0	120 125	100 100	300	6 @ −3V. 625 @ −100V. 25 @ −10V.	
1N38A (S,A,NU,Hy,RR)	1N63	4.0 4.0	125	100 100	50	6 @ −3V. 500 @ −100V.	
1N39A (Hy)	None	3.0	225	200		200 @ −100V. 800 @ −200V.	
1N39 (S,K)	1N75	1.5 2.5	225 125	200 100	50	200 @ −100V. 800 @ −200V.	
1N40 (S)	1N73	12.75 @ +1.5V. 15.0 @ +1.7V.	75 75	25		40 @ −10V. 50 @ −10V.	Quad, See Note 2 Quad, See Note 3
1N41 (S)	None						
1N42 (S)	1N73	12.75 @ +1.5V. 15.0 @ +1.7V.	120 75	50		6 @ −3V. 625 @ −100V. 50 @ −10V.	Quad, See Note 2 Quad, See Note 3
1N43 (WE)	1N69	5.0 5.0	60 75	60	850 850	20 @ −5V. 50 @ −10V.	
1N44 (WE)	1N70	3.0 3.0	115 125	100	1000 300	25 @ −10V.	
1N45 (WE)	1N65	3.0 2.5	75 85	70	410 200		
1N46 (WE)	1N48	3.0 4.0	60 85	70	1500 833		
1N47 (WE)	1N70	3.0 3.0	115 125	100	410 300	4 @ −3V. 25 @ −10V.	
1N48 (GE)		4.0	85	70	833		
1N51 (GE)		2.5	50	40	1667		
1N52 (GE)		4.0	85	70	150		
1N53 (M)	None						Silicon microwave diode
1N54 (S,K,Hy,RR)	1N69	5.0 5.0	75 75	35 60	850	10 @ −10V. 50 @ −10V.	
1N54A (S,A,NU,R,Hy,RR)	1N52	5.0 4.0	75 85	50 70	100 150	7 @ −10V.	
1N55 (S,K,RR,Hy)	1N75	3.0 2.5	170 125	150 100	50	300 @ −100V. 800 @ −150V.	
1N55A (NU,S,RR,Hy,RCA)	1N63	4.0 4.0	170 125	150 100	50	500 @ −150V.	
1N55B (H)	1N63	5.0 4.0	190 125	150 100	50	500 @ −150V.	
1N56 (S,K,Hy)	1N69	15.0 5.0	50 75	40 60	850	300 @ −30V. 50 @ −10V.	
1N56A (S,R,Hy,RCA)	1N69	15.0 5.0	50 75	40 60	850	300 @ −30V. 50 @ −10V.	
1N57 (S,K)	1N52	4.0 4.0	90 85	80 70	150	500 @ −75V.	
1N58 (S,K,RR,Hy)	1N63	4.0 4.0	120 125	100 100	50	800 @ −100V.	
1N58A (S,A,NU,RR,Hy,RCA)	1N63	4.0 4.0	120 125	100 100	50	600 @ −100V.	
1N60 (S,K,RR)	1N64	.05 @ +0.25V.	30 20	25		25 @ −1.3V.	See Note 4 See Note 5
1N61 (K)	1N63	5.0 4.0	140 125	130 100	50	300 @ −100V. 700 @ −125V.	
1N63 (GE)		4.0	125	100	50		
1N64 (GE)		.05 @ +0.25V.	20			25 @ −1.3V.	See Note 5
1N65 (GE)		2.5	85	70	200		
1N66 (R)	1N69	5.0 5.0	70 75	60 60	800 850	50 @ −10V. 50 @ −10V.	
1N67 (R)	1N63	4.0 4.0	100 125	80 100	50 50	5 @ −5V.	
1N67A (H)	1N63	4.0 4.0	100 125	80 100	50 50	5 @ −5V.	

Type & Mfr.	G-E Replace-ment	Minimum Forward Cur. @ +1V. (MA)	Peak Inverse Voltage (Volts)	Cont. Reverse Voltage (Volts)	Maximum Reverse Cur. (μa) @ −50V.	Maximum Reverse Cur. (μa) Other	Remarks
1N37A (N)	None	3.0	40	36		.06 @ −20V.	Silicon junc. diode
1N138A (N)	None	5.0	20	18		.01 @ −10V.	Silicon junc. diode
1N139 (GE)		20.0	50	40	1500		Gold bonded diode
1N140 (GE)		40.0	85	70	300		Gold bonded diode
1N141 (GE)		20.0	85	70	50		Gold bonded diode
1N142 (GE)		5.0	125	100		100 @ −100V.	Gold bonded diode
1N143 (GE)		40.0	125	100		100 @ −100V.	Gold bonded diode
1N147 (L)	G7A	10.0 @ 0.75V. 0.8 @ +0.5V.	2 5			800 @ −0.5V	UHF mixer See Note 6
1N148 (Hy)	G7E	0.26 @ 0.25V. 0.8 @ +0.5V.	20 5	15		350 @ −10V. 800 @ −0.5V.	Harmonic generator diode
1N150 (M)	None						Silicon microwave diode
1N151 (GE)		1570 @ +0.7V.	100	30		2400 @ −100V.	
1N152 (GE)		1570 @ +0.7V.	200	65		1900 @ −200V.	
1N153 (GE)		1570 @ +0.7V.	300	100		1200 @ −300V.	
1N155 (S)	None						Silicon microwave crystal
1N155A (S)	None						Silicon microwave crystal
1N158 (GE)		1570 @ +1.4V.	380	185		800 @ −380V.	
1N160 (M)	None						Silicon microwave diode
1N175 (NU)	None	20.0		200	50	200 @ −200V.	Small-area diode
1N191 (H)	None	5.0		90	125 (55° C.)	25 @ −10V. (55° C.)	Computer type
1N192 (H)	None	5.0		70	250 (55° C.)	50 @ −10V. (55° C.)	Computer type
1N193 (S)	None	1.0 @ +2.0V.		40 (150° C.)		50 @ −40V.	Silicon whisker diode
1N194 (S)	None	1.5 @ +2.0V.		40 (150° C.)		60 @ −40V.	Silicon whisker diode
1N195 (S)	None	2.0 @ +2.0V.		40 (150° C.)		80 @ −40V.	Silicon whisker diode
1N196 (S)	None	1.0 @ +2.0V.		40 (150° C.)		40 @ −40V.	Silicon whisker diode
600 (T)	1N81	3.0 3.0	30 50	40		1 @ −1V. 8 @ −10V. 10 @ −10V.	Silicon Junction diode
601 (T)	None	3.0	50			.01 @ −1V. .04 @ −40V.	Silicon Junction diode
CG2-E (BTH)	None	1.0	150		2.5		
CG5-E (BTH)	None	2.8	40			0.2 @ −10V.	
CG6-E (BTH)	1N65	2.0 2.5	70 85	70	200	50 @ −10V	
CG8-C (BTH)	None	4.0	15			1.5 @ −3V. 2.0 @ −10V.	
CG10-E (BTH)	1N65	2.0 2.5	100 85	70	250 200	50 @ −10V.	
CG12-E (BTH)	1N64	3.0 .05 @ +0.25V.	25 20			400 @ −10V. 25 @ −1.3V.	
CK705 (R)							Same as 1N66
CK705A (R)	1N69	5.0 5.0	70 75	60 60	800 850	10 @ −10V. 50 @ −10V.	
CK705-P (R)	1N69	5.0 5.0	70 75	60 60	800 850	50 @ −10V. 50 @ −10V.	
CK706-P (R)	1N64	0.05 @ +0.25V.	50 20	40		200 @ −10V. 25 @ −1.3V.	See Note 5
CK706 (R)	1N64	.05 @ +0.25V.	50 20	40		200 @ −10V. 25 @ −1.3V.	See Note 7 See Note 5
CK707 (R)	1N52	3.5 4.0	100 85	80 70	100 150	10 @ −5V.	
CK707-P (R)	1N52	3.5 4.0	100 85	80 70	100 150	10 @ −5V.	
CK708 (R)							Same as 1N68
CK708-P (R)	1N75	3.0 2.5	120 125	100 100	50	625 @ −100V.	
CK709 (R)	1N73	15.0 @ +1.7V.	75			50 @ −10V.	Quad, See Note 8 Quad, See Note 3
CK710 (R)	G7A	3 @ +0.5V.	10	5		200 @ −.6V.	See Note 9 See Note 6
CK711 (R)	1N73	15 @ +1.7V.	75	80	30	50 @ −10V.	Quad, See Note 10 Quad, See Note 3
CK712 (R)	1N75	2.0 2.5	225 125	200 100	50	800 @ −200V.	
CK713 (R)	1N52	21 @ +2.0V. 4.0	75 85	75 70	150	250 @ −40V.	
CK713A (R)	1N52	21.0 @ +2.0V. 4.0	85 85	70 70	150	250 @ −40V.	
CK713A-P (R)	1N52	21.0 @ +2.0V. 4.0	85 85	70 70	150	250 @ −40V.	
CK715 (R)	G7E	0.8 @ +.5V.	5	40		800 @ −.5V.	Frequency Mult. Frequency Mult.
CK715-P (R)	G7E	0.8 @ +0.5V.	5	40		800 @ −0.5V.	Frequency Mult. Frequency Mult.

1N67P (R)	1N63	4.0 4 0	100 125	80 100	50 50	5 @ 5V.	
1N68A (H)	1N75	3 0 2 5	130 125	100 100	50	625 @ − 100V.	
1N68 (R)	1N75	3 0 2 5	120 125	100 100	50	625 @ − 100V.	
1N69 (GE)		5.0	75	60	850	50 @ − 10V.	JAN type
1N70 (GE)		3.0	125	100	300	25 @ − 10V.	JAN type
1N71 (S,Hy)	None						Quad
1N72 (GE)		0.8 @ +.5V.	5			800 @ − 5V.	See Note 6
1N73 (GE)		15.0 @ +1.7V.	75			50 @ − 10V.	Quad. See Note 3
1N74 (GE)		15.0 @ +1.8V.	75			50 @ − 10V.	Quad. See Note 3
1N75 (GE)		2 5	125	100	50		
1N76							Silicon diode
1N77	None						Photo diode
1N78 (M)	None						Silicon diode
1N79 (S)	None						Silicon diode
1N81 (GE)		3.0	50	40		10 @ 10V	JAN type
1N82 (S,Hy)	G7A	0.8 @ +.5V.				800 @ − 5V	UHF Mixer See Note 6
1N82A (S)	G7A	0.8 @ +0.5V.		5		800 @ − 0 5V	Silicon UHF Mixer diode. See Note 6
1N86 (A)	1N48	4.0 4 0	85 85	70 70	833 833	50 @ − 10V.	
1N87 (A)	1N64	.05 @ +0.25V.	30 20	25		25 @ − 1.3V.	See Note 11 See Note 5
1N88 (A)	1N52	2.5 4.0	100 85	85 70	100 150		
1N89 (H)	1N52	3.5 4.0	100 85	80 70	100 150	8 @ − 5V.	
1N90 (H)	1N69	5 0 5.0	75 75	60 60	800 850	50 @ − 10V.	
1N91 (GE)		470 @ +0.5V.	100	30		2700 @ − 100V.	Diffused Junction Rectifiers
1N92 (GE)		310 @ +0.5V.	200	65		1900 @ − 200V.	
1N93 (GE)		250 @ +0.5V.	300	100		1200 @ − 300V.	
1N94 (GE)		1570 @ +0.7V.	380	185		800 @ − 380V.	
1N95 (H)		10 0 5.0	75 75	60 60	800 850	50 @ − 10V	
1N96 (H)	None	20 0	75	60	800		
1N97 (H)	None	10.0	100	80	100	8 @ − 5V	
1N98 (H)	None	20 0	100	80	100	8 @ − 5V.	
1N99 (H)	None	10.0	100	80	50	5 @ − 5V.	
1N100 (H)	None	20 0	100	80	50	5 @ − 5V.	
1N106 (NU)	None	20 0		300		70 @ − 100V 200 @ − 300V.	Gold bonded
1N107 (NU)	None	150 0		10		200 @ − 10V.	Gold bonded
1N108 (NU)	None	50.0		50		200 @ − 50V	Gold bonded
1N109 (Hy)	G7E	0.26 @ 0 25V 0 8 @ +0 5V	20 5	15		350 @ − 10V. 800 @ − 0.5V.	Harmonic generator diode
1N110 (RR)	G7A	0 8 @ + 5V				800 @ − .5V	See Note 12 See Note 6
1N111 (S,RR,Hy)	1N52	5.0 4 0	70 85	70	125 150	25 @ − 10V.	Computer type
1N112 (S,RR,Hy)	1N52	5 0 4 0	70 85	70	250 150	50 @ − 10V.	Computer type
1N113 (S,RR,Hy)	1N52	2.5 4 0	70 85	70	125 150	25 @ − 10V.	Computer type
1N114 (S,RR,Hy)	1N65	2 5 2 5	70 85	70	250 250	50 @ − 10V.	Computer type
1N115 (S,RR,Hy)	1N65	2 5 2 5	70 85	70	500 250	100 @ − 10V.	Computer type
1N116 (H)	1N52	5 0 4 0	75 85	60 70	100 150		
1N117 (H)	None	10 0	75	60	100		
1N118 (H)	None	20 0	75	60	100		
1N124 (L)	1N72	10 @ +0 75V. 0 8 @ +0 5V	2 5			800 @ − 0 5V.	UHF mixer See Note 6
1N124A (L)	1N72	10 @ +0 75V. 0 8 @ +0 5V				800 @ − 0.5V.	UHF mixer See Note 6
1N125 (Hy)	1N64	.05 @ +0 25V 05 @ +0 25V	30 20			25 @ − 1 3V 25 @ − 1 3V	See Note 5
1N126 (H)	1N69	5 0 5 0	75 75	60 60	850 850	50 @ − 10V. 50 @ − 10V.	JAN type JAN type
1N127 (H)	1N70	3 0 3 0	125 125	100 100	300 300	25 @ − 10V. 25 @ − 10V	JAN type JAN type
1N128 (H)	1N81	3 0 3 0	50 50	40 40		10 @ − 10V 10 @ − 10V	JAN type JAN type
1N133 (Hy)	G7A	3 0 @ +0 5V 0.8 @ +0 5V	6 5			300 @ − 0 6V 800 @ − 0 5V.	UHF mixer See Note 6
1N135 (Hy)	1N69	5 0 5 0	75 75	60	850 850	50 @ − 10V 50 @ − 10V	
CK731 (R)	1N72	0.8 @ +0.5V.	5			800 @ − 0.5V.	See Note 6
CK739 (R)	None	100 @ +0.8V.	60	50	20	2 @ − 10V.	Gold bonded diode
CK742 (R)	None	100 @ +1.0V.	125	100		5 @ − 10V. 20 @ − 100V.	Gold bonded diode
CV425 (BTH)	1N48	4.0 4 0	65 85	70	1000 833		
CV442 (BTH)	1N64	3.0 05 @ +0.25V.	25 20			1000 @ − 10V. 25 @ − 1.3V.	
CV448 (BTH)	1N52	3.0 4 0	80 85	70	100 150		
G1CA (IRC)	1N75	1.0 2.5	125 125	100	50 50		
G1HA (IRC)	1N65	1.0 2.5	85 85	70	500 250		
HS133 (Hy)	G7A	0.8 @ +0.5V.	5	5		800 @ − 0.5V.	UHF Silicon Mixer diode. See Note 6
NU34 (NU)	1N69	5.0 5.0	75 75	65 60	800 850	50 @ − 10V. 50 @ − 10V.	
NU38 (NU)	1N70	3.0 9 5	120 125	100 100	300	6 @ − 3V. 625 @ − 100V. 25 @ − 10V.	
NU39 (NU)	None	1.5	225	200		900 @ − 100V. 800 @ − 200V.	
NU58 (NU)	1N63	4.0 4.0	120 125	100 100	50	800 @ − 100V.	
S4 (TR)	None	1.0	50	40		1 @ − 10V.	Silicon diode
S5 (TR)	None	1 0	50	40		0.1 @ − 10V.	Silicon diode
S6 (TR)	None	4 0	22	20		0.5 @ − 5V.	Silicon diode
T1 (TR)	1N139	20.0 20.0	50 50	40 40	1500 1500		Gold bonded diode Gold bonded diode
T2 (TR)	1N140	40.0 40.0	85 85	70 70	300 300		Gold bonded diode Gold bonded diode
T3 (TR)	1N141	20.0 20.0	85 85	70 70	50 50		Gold bonded diode Gold bonded diode
T4 (TR)	1N142	5.0 5.0	125 125	100 100		100 @ − 100V. 100 @ − 100V.	Gold bonded diode Gold bonded diode
T5 (TR)	1N143	40.0 40.0	125 125	100 100		100 @ − 100V. 100 @ − 100V.	Gold bonded diode Gold bonded diode
TP34A (TP)	1N52	5.0 4.0	75 85	60 70	500 150	30 @ − 10V.	
TP38A (TP)	1N63	4.0 4.0	120 125	100	50	5 @ − 3V 500 @ − 100V.	
TP39 (TP)	None	1.5	225	200		200 @ − 100V. 800 @ − 200V.	
TP52 (TP)	1N52	4.0 4.0	85 85	70 70	150 150		
TP55 (TP)	1N75	3 0 2 5	170 125	150 100	50	300 @ − 100V. 800 @ − 150V	
TP55A (TP)	1N63	4 0 4 0	170 125	150 100	50	500 @ − 150V	
TP63 (TP)	1N63	4 0 4 0	125 125	100 100	50 50		
X-16 (TP)	G7E	0.8 @ +0.5V.	5			800 @ − 0 5V	Harmonic generator

Note 1: Forward resistances matched within 10% at + 1V.
Note 2: Four diodes in tube shell with forward resistances balanced within +2.5% at +1 5V. Forward resistances of each pair matched within 3 ohms.
Note 3: Four diodes in hermetically sealed tube shell. Forward resistances matched within 6.7 ohms for 1N73 and 13.4 ohms for 1N74 at 15 MA. Forward resistances of each pair matched within 2 ohms for 1N73 and 6.7 ohms for 1N74 at 15 Ma
Note 4: Tested with 1.8V. RMS input at 40 Mc, 70% modulated at 400 cycles. Minimum output is 1.8V. peak-to-peak across 4700 ohms shunted by 5 MMF.
Note 5: Tested with 0.1V. RMS, 44 Mc input to last I.F. grid. Minimum output is 100 ua through 3600 ohms shunted by 5 MMFD.
Note 6: Maximum conversion loss is 9.6 db measured at 900 Mc with 0.7 Mw L.O. level and d-c forward bias from a 0 25V., 250 ohm source.
Note 7: Tested with 0.1V. RMS, 50 Mc input to last I.F. grd. Minimum output is 330 ua through 5100 ohms shunted by 5 MMFD
Note 8: Four diodes in tube shell with forward resistances matched within 2.5%. At − 10V diodes are matched 2 5% or all have a resistance greater than 1.0 meg ohm.
Note 9: Typical noise temperature ratio of 2.
Note 10: Four diodes in tube shell. Each pair of diodes is shunted by 10,000 ohms center-tapped and the center tap of resistor and diodes connected by a microanimeter. With 0 to +3V. dc applied unbalance current limit is 5 MA
Note 11: Tested with 5V. peak input at 30 Mc. Output voltage across 3900 ohm load resistance must yield minimum rectification efficiency of 60%.
Note 12: Noise figure 12 db @ 750 Mc with 43.5 Mc I.F. circuit having 3 Mc noise bandwidth and 4 db noise figure.

*For additional information, contact General Electric Company, Electronics Park, Syracuse, New York, or your nearest G-E Tube Representative

For additional information, contact General Electric Company, Electronics Park Syracuse, New York, or your nearest G-E Representative.

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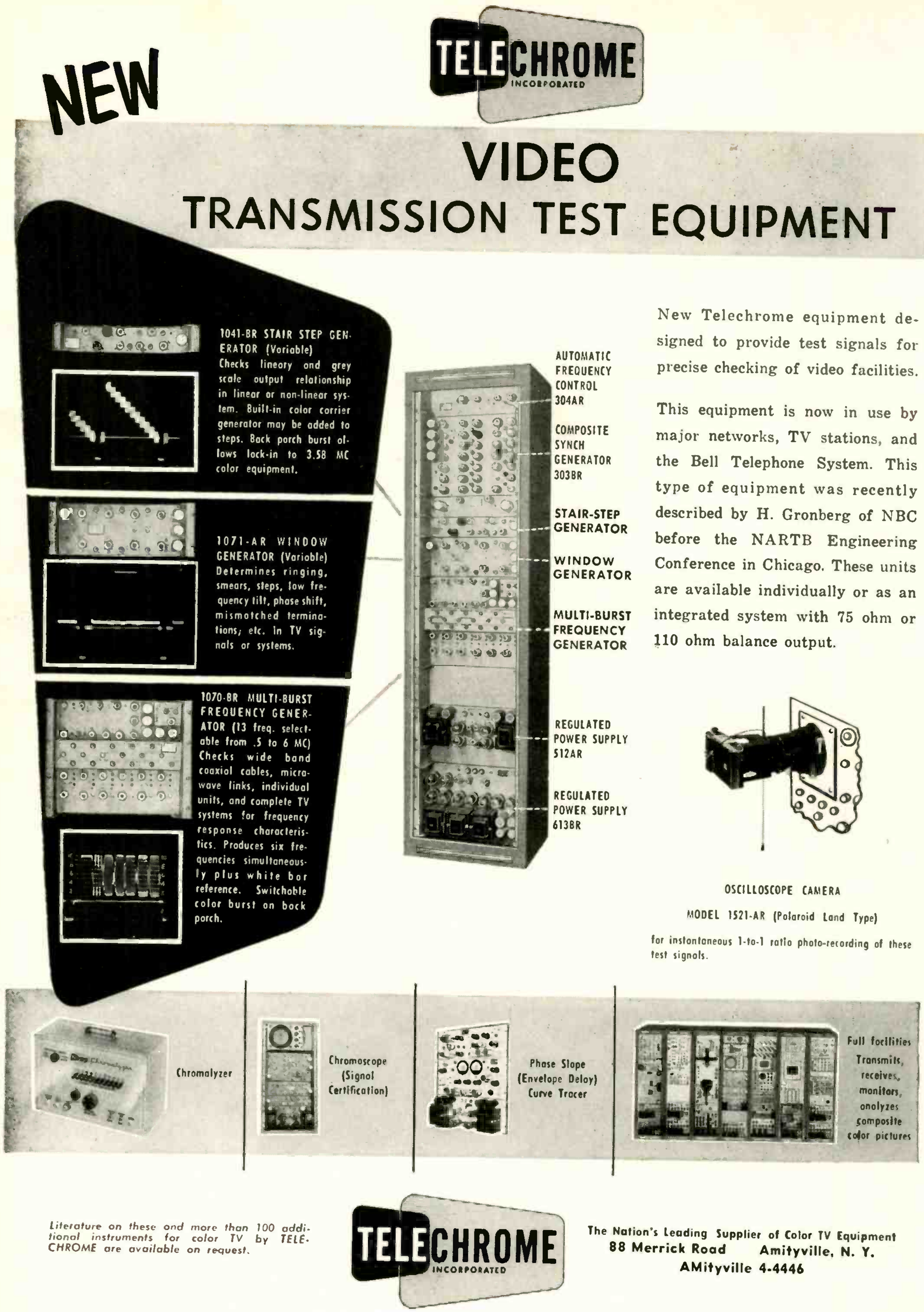
GE—General Electric
H—Hughes
Hy—Hytron
K—Kemptron
M—Microwave Associates
N—National Semi-conductor Products
NU—National Union
RR—Radio Receptor
R—Raytheon
RCA—RCA
S—Sylvania
T—Texas Instruments
TR—Transitron
TP—Transistor Products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1070-BR MULTI-BURST FREQUENCY GENERATOR (13 freq. selectable from .5 to 6 MC) Checks wide band coaxial cables, microwave links, individual units, and complete TV systems for frequency response characteristics. Produces six frequencies simultaneously plus white bar reference. Switchable color burst on back porch.
AUTOMATIC FREQUENCY CONTROL 304AR
COMPOSITE SYNCH GENERATOR 303BR
STAIR-STEP GENERATOR
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REGULATED POWER SUPPLY 613BR
New Telechrome equipment designed to provide test signals for precise checking of video facilities.
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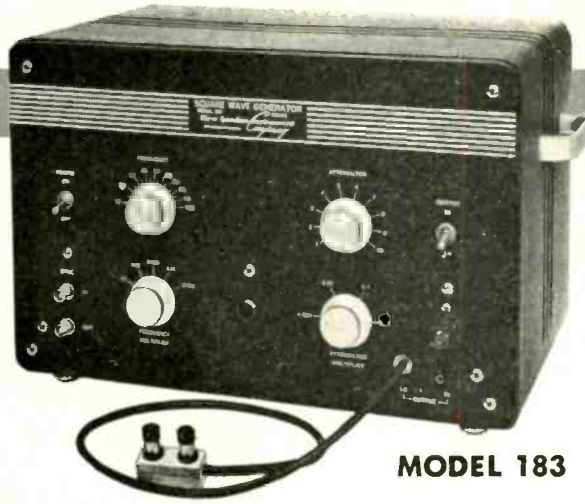

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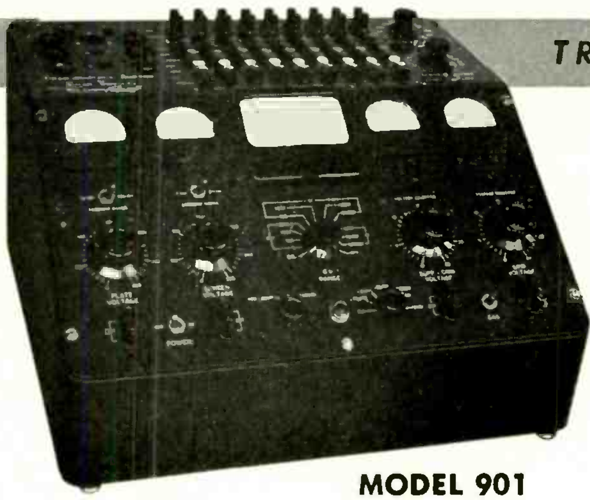
AND CIRCUIT SIMULATOR



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This direct-reading vacuum tube transconductance meter measures transconductance under all operating conditions. It also reproduces all kinds of static or dynamic tube characteristics.

It can be connected externally to components to simulate the circuitry in which the tube will operate. Simple push button switching applies the appropriate voltages to each tube element. Self-contained — no accessories required.

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60 db gain

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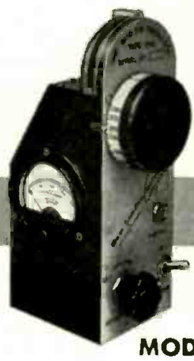

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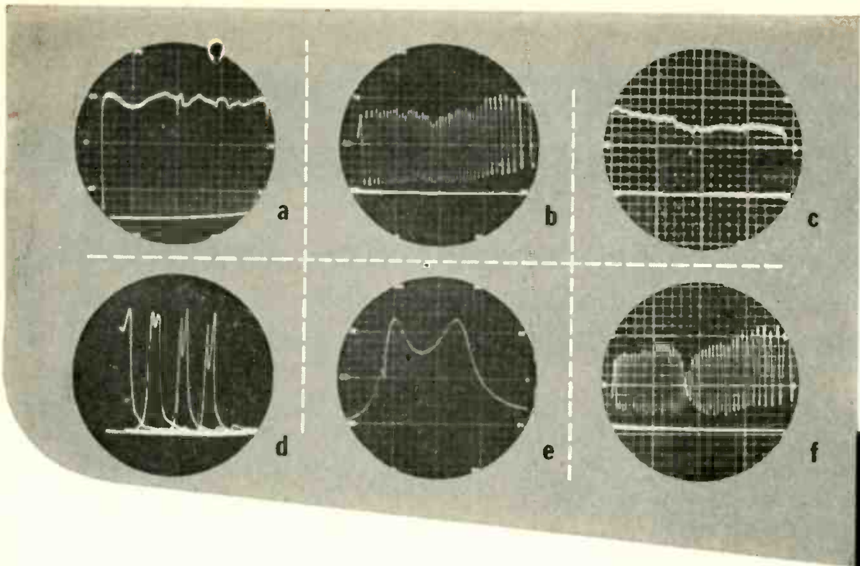

470 to 890 MC. CHARACTERISTICS TAKEN WITH 2144-02 GENERATOR

a) Detected output of sweep generator, showing marker at 650 mcs.

b) VSWR display of unterminated transmission line.

c) VSWR display of terminated transmission line.

d) Preselector responses of UHF tuner at channels 14, 20, 30 and 40.

e) Preselector response of tuner at channel 50, expanded on scope.

f) Input VSWR display of tuner at channel 50.

now sweep over 400 mc. at UHF without tuning

3 Stock models cover 225 to 420 mc. 470 to 890 mc. and 850 to 1275 mc. Special ranges on request.

New Kollsman TYPE 2144 Wide Range Sweep Generator

SPECIFICATIONS

Frequency Range	2144-01	225 to 420 mc.
	2144-02	470 to 890 mc.
	2144-03	850 to 1275 mc.
Minimum Power Output		10 milliwatts
Output Impedance		50 ohms
Maximum Source VSWR		1.25
Amplitude Linearity		± 1 db.
Marker Frequency Calibration		5 mc.
Marker Frequency Accuracy	2144-01	± 1 mc.
	2144-02	± 1.5 mc.
	2144-03	± 2 mc.
Sweep Rate		60 cycle
Tube Complement		6AF4, 6J6, OA2, 6X4
Primary Power		117 volts, 60 cycles, 60 watts

Also Available—Step Attenuator TYPE 2171-01

SPECIFICATIONS

Insertion Loss	Less than ½ db.
Attenuation Steps	0, 3, 6, 9, 12, 15, 20, 30, 40, 50, 60, 70, db.
Frequency Range	DC to 1000 mc.
Maximum VSWR	1.2
Other Attenuation Steps Available	

THE TYPE 2144 SWEEP GENERATOR SIMPLIFIES LABORATORY AND PRODUCTION MEASUREMENTS

- Instantaneous display of frequency response, impedance or VSWR over 400 mc. without test equipment adjustment.
- Simultaneous observation of desired and spurious receiver responses.
- Display antenna characteristics over entire operating band.

WITH THESE DESIRABLE FEATURES

- 50 ohm output.
- Low source VSWR and amplitude non linearity.
- Passive variable marker for stable, accurate frequency indication, with easily read dial.
- Oscilloscope horizontal sweep signal and base line retrace blanking.
- 60 cycle sweep rate for easy observation.
- Voltage regulation minimizes effect of line voltage variation.
- Uses only standard plug in tubes.

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General Ceramics ALUMINA CERAMIC*

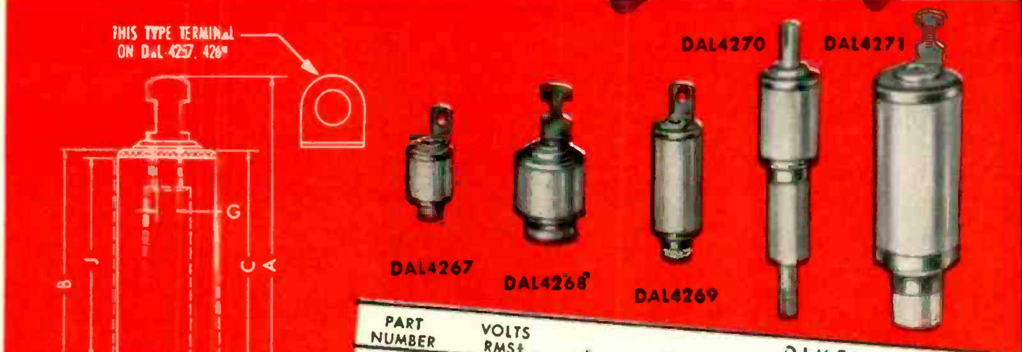
*Conforms to the requirements of Grade L-5A in accordance with JAN-1-10.

SOLDERSEAL HERMETIC TERMINALS

THE ITEMS SHOWN ARE STANDARD STOCK TERMINALS. DIMENSIONAL TOLERANCE, ±1½% BUT NOT LESS THAN ±.010"

featuring

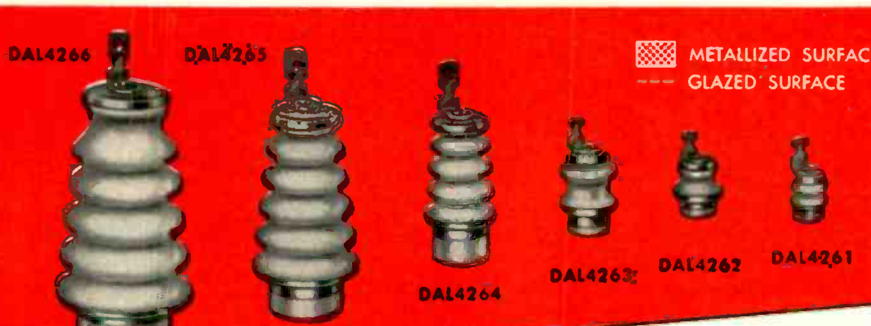
- High Mechanical Strength
- Resistance to Thermal Shock
- Fast, Easy Installation
- Permanent Hermetic Sealing

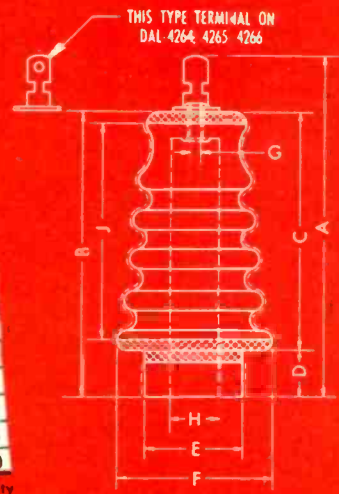


PART NUMBER	VOLTS RMS†	A	B	C	D	E	F	G	H	J
DAL4267	4000	.547	.375	.281	.093	.125	.234	.046	.084	.250
DAL4268	5000	.687	.422	.312	.109	.250	.359	.049	.171	.281
DAL4269	8000	.875	.687	.562	.125	.156	.250	.046	.093	.531
DAL4270*	10000	1.187	.937	.437	.500	.234	.312	-	-	.375
DAL4271	15000	1.531	1.250	.937	.312	.281	.413	.090	.187	.781

*Note: Part No. DAL4270 employs solid thru-stud slotted at each end.

METALLIZED SURFACE
--- GLAZED SURFACE





PART NUMBER	VOLTS RMS†	A	B	C	D	E	F	G	H	J
DAL4261	3000	.672	.391	.282	.109	.250	.312	.067	-	.171
DAL4262	4000	.750	.468	.312	.156	.312	.437	.067	-	.160
DAL4263	7000	.968	.687	.500	.187	.375	.500	.095	.156	.375
DAL4264	14000	1.343	1.250	.907	.343	.490	.625	.128	.250	.812
DAL4265	18000	2.218	1.750	1.407	.343	.656	.937	.118	.312	1.250
DAL4266	22000	2.655	2.187	1.844	.343	.812	1.187	.128	.375	1.643

†40% Relative Humidity

These terminals are made of glazed Alumina Ceramic. Lugs and eyelets are hot tinned brass and metallized areas are silver fired on ceramic, copper electroplated and tin fused for soft soldering. Immersion in 60/40 solder at 450°F for 1½ minutes for dip soldering will not injure the metallic coating. For complete information and quotations call, write or wire today.

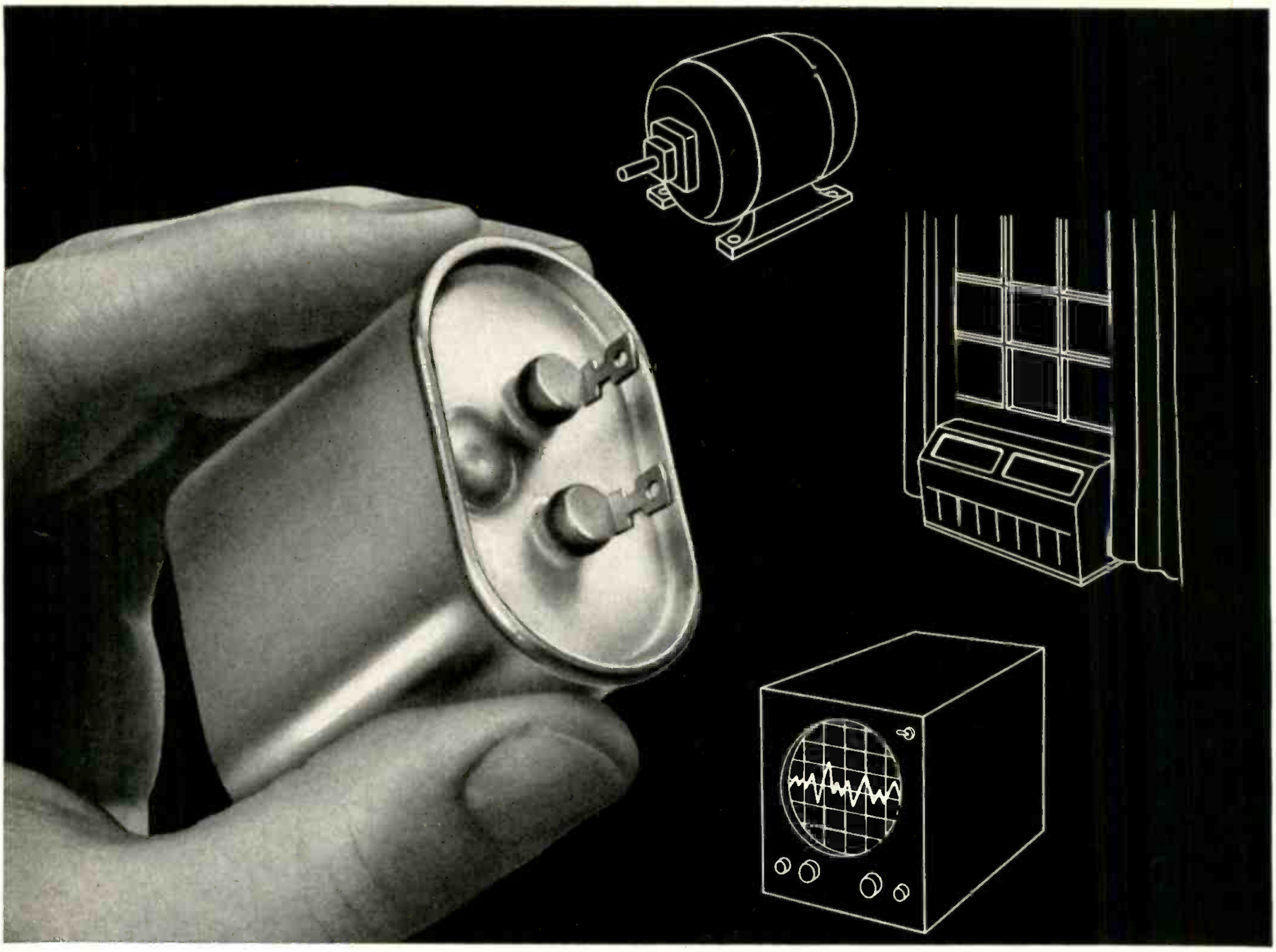
GENERAL CERAMICS · STEATITE CORPORATION · STEATITE INSULATORS

General CERAMICS CORPORATION

VALLEY 6-5100

GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, ALUMINA, ZIRCON, PORCELAIN, SOLDERSEAL TERMINALS, LIGHT DUTY REFRACTORIES, CHEMICAL STONEWARE, IMPERVIOUS GRAPHITE, FERRAMIC MAGNETIC CORES



Save space and weight in electronic equipment with versatile G-E drawn-oval capacitors

LONG RELIABILITY. G-E drawn-oval fixed paper-dielectric capacitors have been manufactured for fluorescent lamp ballasts and air-conditioning equipment for ten years. They also offer the important advantages of smaller size, lighter weight, and substantial cost reductions to the electronics industry. So, if you're using a fixed paper-dielectric capacitor in your electronic equipment consider the advantages offered by G-E drawn-ovals.

WIDE RANGE OF RATINGS. Ratings range from 1 to 15 uf at 600 to 1500 volts dc, or 330 to 660 volts ac. A wide choice of mounting arrangements makes G-E drawn-ovals ideally suited for quality electronic equipment, controls, and other applications where capacitors meeting the electrical and mechanical requirements of MIL-C-25A specifications (except for case dimensions and markings) are desirable.

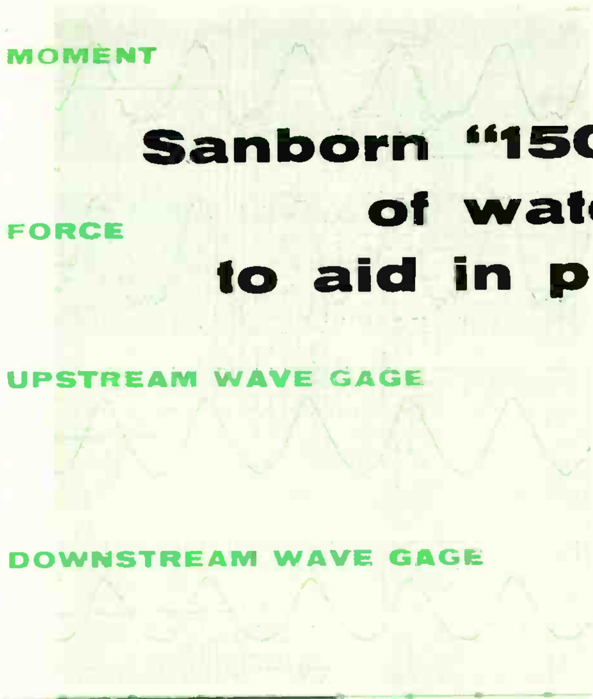
UP TO 20% COST REDUCTION. Prices range from 10 to 20% below those for similarly rated rectangular capacitors. Savings in size and weight amount to as much as 30% in some case styles. A double rolled seam attaches cover to drawn steel case, producing a lighter, yet stronger, capacitor.

CHOICE OF MOUNTINGS AND TERMINALS. Mounting versatility is provided by a choice of three bracket styles for upright, inverted, or side mounting to suit individual application requirements. Units are also available with either eyelet (pictured above), fork type, or quick-connect (solderless) terminals.

For more information on G-E drawn-oval capacitors, their ratings, dimensions, and prices, contact your G-E apparatus sales representative or write for Bulletin GEA-5777, to General Electric Co., Section 442-10, Schenectady 5, N. Y.

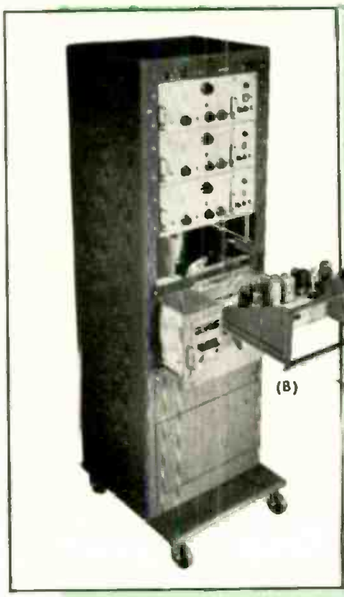
Progress Is Our Most Important Product

GENERAL ELECTRIC



Sanborn "150" records the effects of water wave forces to aid in pile structure design

By means of a Sanborn 150 Oscillographic Recording System equipped with four carrier type preamplifiers, engineers at the M.I.T. Hydrodynamics Laboratory are getting accurate pictures of simulated shallow water waves and their effect on dummy piles. The shape and length of precisely controlled waves in a 90 foot glass flume are plotted simultaneously with their moment and force on a suspended cylindrical pile. The excellent frequency response available with this method permits a sensitivity and accuracy not obtainable in previous model studies of this type.



Preamplifier (A) in position to plug into a driver amplifier with frame, combined with power supply and control panel (B) which is normally already in place in the basic cabinet assembly.

This is but one of MANY applications possible with Sanborn 150 Oscillographic Recording Systems

Virtually all electrical phenomena, within a frequency range of zero to 100 cps, can be accurately, permanently and graphically registered by Sanborn Oscillographic Recording Systems. This versatility of application is possible because of the *flexibility* of Sanborn 150 Series Recording Systems. A wide variety of quickly *interchangeable* preamplifiers, which plug in to *built-in* driver amplifiers (illustrated at left), are available for use with Series 150 Systems, to record such phenomena as: stress, strain, pressure, displacement, thickness, velocity, acceleration, current, voltage, temperature, torque, light, flow, force, load, position, rpm, radiation, tension, and power.

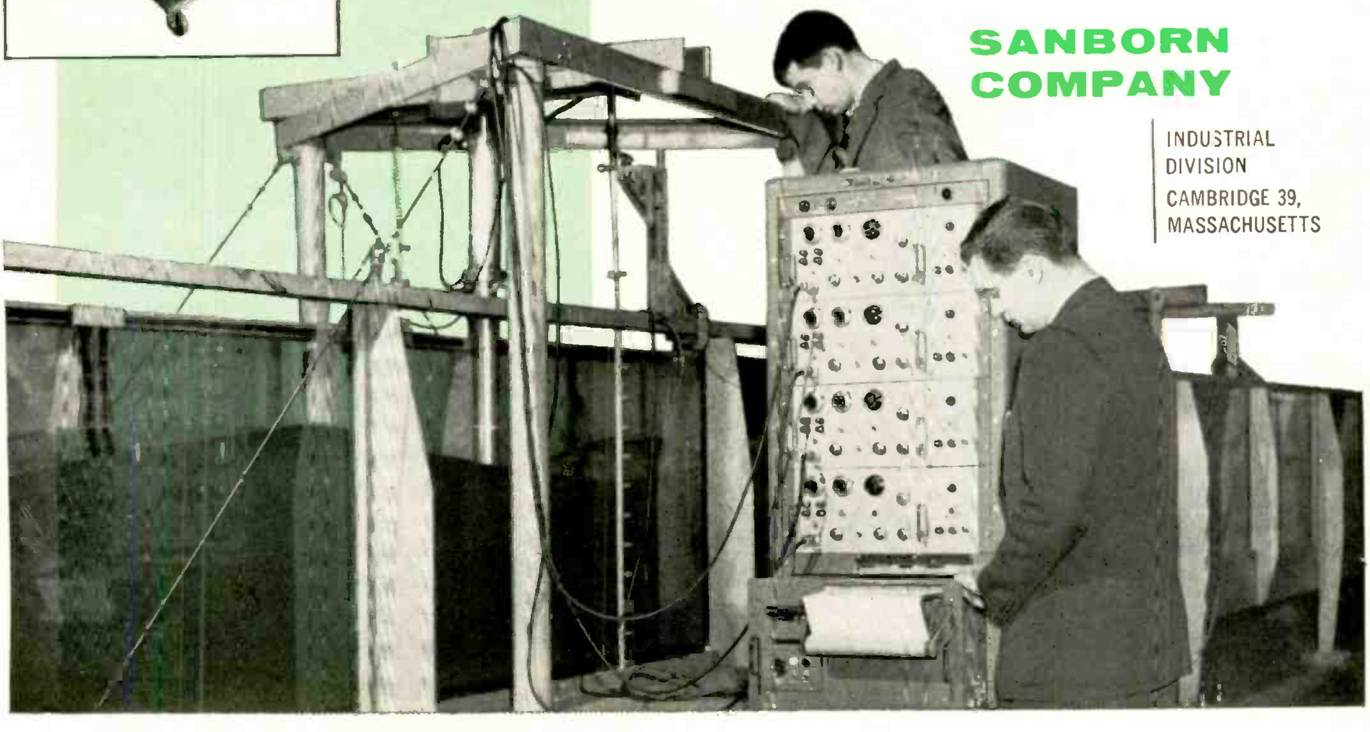
Add to this versatility the Sanborn features of inkless tracings in true rectangular coordinates, on plastic coated chart paper . . . high torque movement . . . time and code markers . . . numerous chart speeds.

Let Sanborn Answer YOUR Recording Requirements

For informative technical data on the basic 1, 2, and 4 channel Sanborn systems, and qualified counsel to help you select the correct Sanborn equipment for your requirements, write to

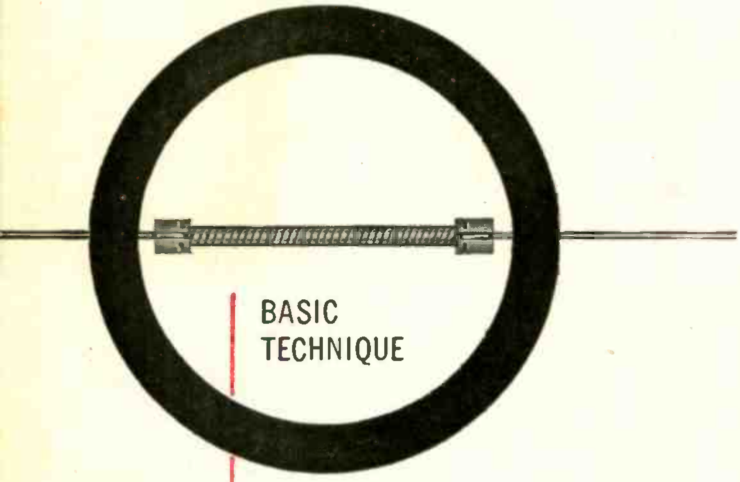
SANBORN COMPANY

INDUSTRIAL DIVISION
CAMBRIDGE 39, MASSACHUSETTS



Precision, high-speed winding equipment for IRC elements

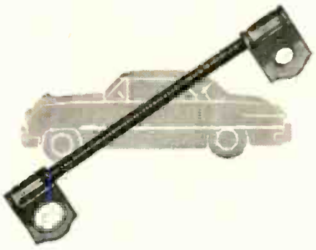
ONLY IRC WINDING SKILL OFFERS



BASIC TECHNIQUE

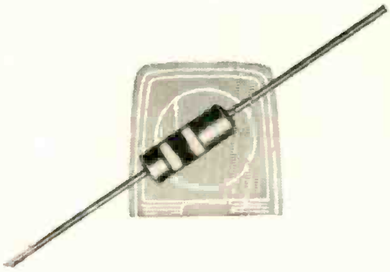
Wire element is uniformly and tightly wound on an insulated core. Axial leads or other terminations are secured to element by automatic machinery. Insulated housing may be used or omitted.

If you seek savings in component costs,
IRC's winding skill may serve your need.
IRC's mastery of winding wire elements
dates back more than 25 years. Today,
it provides a wide variety of unique units
that offer realistic possibilities for
savings. Cost-conscious IRC engineers
will glady analyze your requirements.



14c savings per car

Type AW Wire Wound resistors save automobile manufacturers an average of 14c per car. For quantity requirements, these low-cost windings can be made specially to suit individual designs. This adaptability has proved profitable to numerous appliance manufacturers.



low cost—low wattage

Type BW insulated wire wounds offer excellent stability in low ranges—at low prices. Leading instrument manufacturers attest to their superiority. ½, 1 and 2 watt sizes are equivalent to Jan types RU-3, RU-4 and RU-6.

50% savings

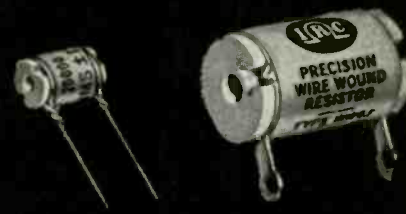
IRC Insulated Chokes offer savings up to 50% over ordinary types. Available in two sizes, they are fully protected against humidity, abrasion, assembly damage and danger of shorting to chassis. A favorite source of savings for TV and radio set manufacturers.

THESE SAVINGS

inexpensive solution

4-watt Insulated Power Wire Wounds with axial leads can save several cents over conventional power resistors. Inorganic core and high-temperature plastic housing allow safe operation up to 165° C. Widely used in toys, juke boxes and amusement devices.

NEW *specifications*



MIL-R-93A AMENDMENT 1

Government specifications for precision wire wound resistors have been revised. MIL-R-93A Amendment 1 is the new rigid standard.

IRC PRECISION WIRE WOUNDS

meet and beat these new specifications. They are equivalent to Mil types RB-15 through 19.

MAXIMUM STABILITY

Temperature cycling even beyond Mil requirements has only negligible effect. Send for new technical bulletin.

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

Wherever the Circuit Says

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

IRC

INTERNATIONAL RESISTANCE CO.
403 N. Broad St., Philadelphia 8, Pa.
In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send me technical data on: ☐ Precision Wire Wounds; ☐ Insulated Chokes; ☐ BW Resistors; ☐ 4-Watt Power Resistors

Name________________

Title________________

Company________________

Address________________

City____________ State________

F.M. DEVIATION DIRECTLY MEASURED

THE BESSEL ZERO or " Disappearing Carrier " method of measuring deviation requires complex monitoring equipment, an accurately known modulation frequency, and, finally, mathematical interpretation of results.

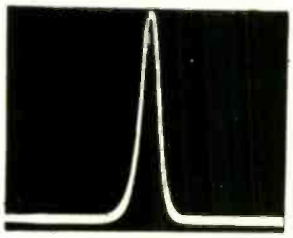
With the compact and easy-to-use Marconi Deviation Meter, the modulation frequency need not be known and deviation is directly read on a meter scale.

F. M. DEVIATION METER TYPE TF 934

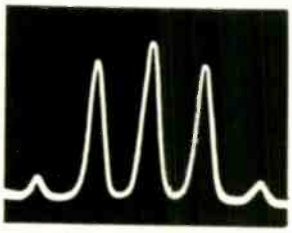
Carrier Frequency Range:	2.5 to 200 megacycles.
R.F. Input Level:	55 millivolts to 10 volts.
Deviation Measurement Ranges:	0 to ±5 kc, 0 to ±25 kc and 0 to ±75 kc.
Accuracy of Deviation Measurement:	±3% from full-scale to half-scale up to 12 kc and ±6% up to 15 kc.

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

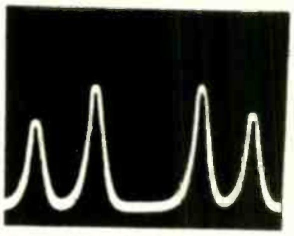
F.M. DEVIATION METER TF 934 · UNIVERSAL BRIDGE TF 868
FM/AM SIGNAL GENERATOR TF 995A · STANDARD SIGNAL GENERATOR TF 867
Also
VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS
WAVEMETERS · WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS



Unmodulated Carrier



Modulation Index 1.3



Modulation Index 2.4
The Carrier "Disappears"
BESSEL ZERO METHOD

MARCONI INSTRUMENTS

23-25 BEAVER STREET · NEW YORK 4

CANADA: CANADIAN MARCONI CO., MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL
ENGLAND: Head Office: MARCONI INSTRUMENTS LIMITED, ST. ALBANS, HERTFORDSHIRE
Managing Agents in Export: MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

TC40

C-D-F SPIRAL TUBING

A UNIFORM, HIGH QUALITY PRODUCT AT LOW COST

Good dielectric strength • Low dielectric loss properties
Good mechanical strength and moisture resistance

C-D-F is a dependable source of supply for all of your coil form spiral tubing needs. Uniform, high product quality is maintained by rigid standards of manufacture. C-D-F offers you fabricating skill, backed by exacting technical and inspection control. A recent C-D-F development is Grade 5 Constant Torque Tubing for use in coil forms. After the threaded iron tuning core is inserted and finally adjusted, you obtain the same stable torque rating.

Constant Torque features: exact internal threading . . . every thread engaged. 3-point contact with core prevents binding and permits positive tuning and re-tuning. Outer surface of tube has no weak spots, no external embossing to cause cement leakage. Available in lengths up to 14" to take .248" to .250" core with 28 threads per inch and also 6-32, 8-32 and 10-32 screw sizes. Write for samples.

Grade 5 Tubing is also custom-fabricated by C-D-F in conventional shapes to accommodate other sizes of tuning cores.

C-D-F produces spiral tubing in grades to meet most requirements. Use the Grade Selector Chart when requesting samples and additional information.

AVAILABLE GRADES

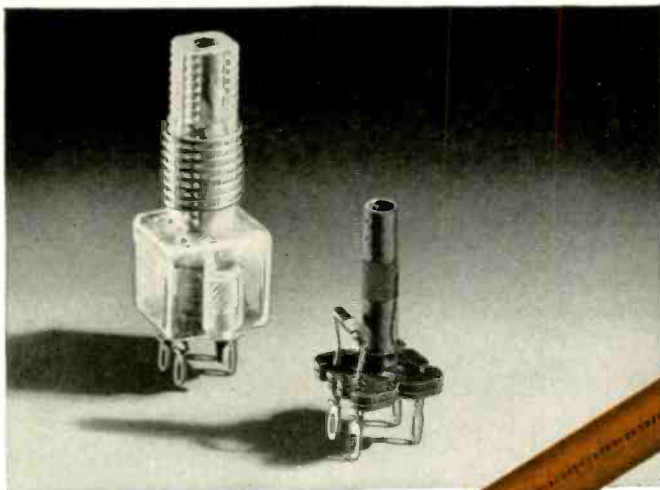
IMPREGNATED

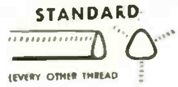
- 1 General Electrical and Mechanical Grade. ○
- 1A Electrical and Mechanical Grade—Special Punching. ○
- 2 Mild Stapling, Riveting, and Post Forming Quality. ○
- 2A Intermediate Fabricating and Stapling Quality. ○
- 3 Severe Stapling, Riveting, and Post Forming Quality. ○
- 5 Constant Torque and Formed-to-Shape Coil Form Tubing.
- 6 Special for High Humidity Applications. ○
- 6A Extra Hard, High Strength Tubing. ○
- 7 Soft Varnished Kraft Tubing. ○ □ ▭
- 7A Hard, Rigid Rectangular Tubing. □ ▭
- 8 Varnished Diamond Insulation—Tubing. ○
- 9 "Deflection Coil" Tubing. ○
- 10 Larger Size, Heavy Wall Tubing for Mechanical Uses. ○

UNIMPREGNATED

- 20 Special Wound in Specified Combinations of kraft paper, fish paper, etc. ○ □ ▭
- 21 Plain Kraft Paper Tubing. ○ □ ▭
- 22 Plain Diamond Insulation Tubing. ○
- 23 Plain Chipboard Tubing. ○

○ Round
Formed (fluted shape)
Formed and Notched
□ ▭ Square, Rectangular





STANDARD
(EVERY OTHER THREAD)

CONSTANT TORQUE
(EVERY THREAD)

SELECTION OF THE PROPER GRADE

While the differences between some of the grades are not great, they are quite distinct when specific requirements are considered. For most uses, the proper grade can be selected from the descriptions, size range, and properties tables in our catalog. If this should prove difficult in some cases, it is desirable for our C-D-F sales engineer to have as much information as possible about the application, especially fabricating requirements, in order that we may make suggestions. Your blueprint is usually sufficient if it carries some indication as to the quality desired. In other cases, the following check list will be found to be helpful:

Type of Application.

Properties required or the customer's specification for the material.

Fabricating quality desired. This is important where stapling, riveting, punching, or forming operations are to be performed by the customer.

Any unusual conditions which may affect the suitability of the material for the job. For tubing that is to accommodate tuning cores, actual samples of the cores are essential along with torque requirements (if known).

See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also write for 8-page Technical Folder ST-53 showing all grades of C-D-F Spiral Tubing, free test samples, or send us your print for quotation.

Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY
NEWARK 16, DELAWARE

INTERNATIONAL RECTIFIER CORPORATION

EL SEGUNDO CALIFORNIA

Selenium Rectifiers

POWER RECTIFIERS

Widest range in the Industry
Power Factor 95%
Ratings to 250 KW
Efficiency to 87%
Write for Bulletin C-349

HIGH VOLTAGE RECTIFIER CARTRIDGE TYPE

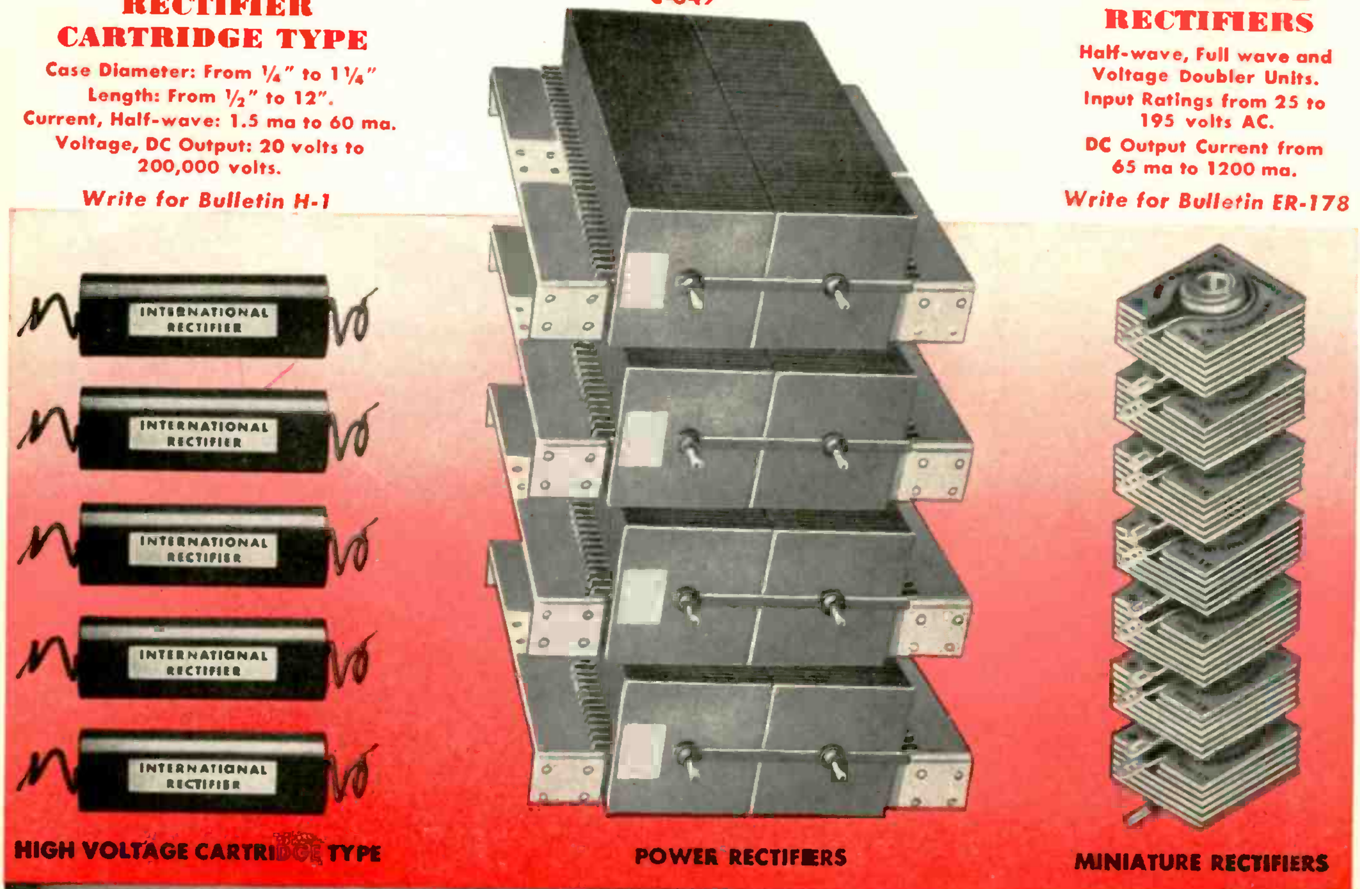
Case Diameter: From 1/4" to 1 1/4"
Length: From 1/2" to 12".
Current, Half-wave: 1.5 ma to 60 ma.
Voltage, DC Output: 20 volts to 200,000 volts.

Write for Bulletin H-1

MINIATURE RECTIFIERS

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

Write for Bulletin ER-178

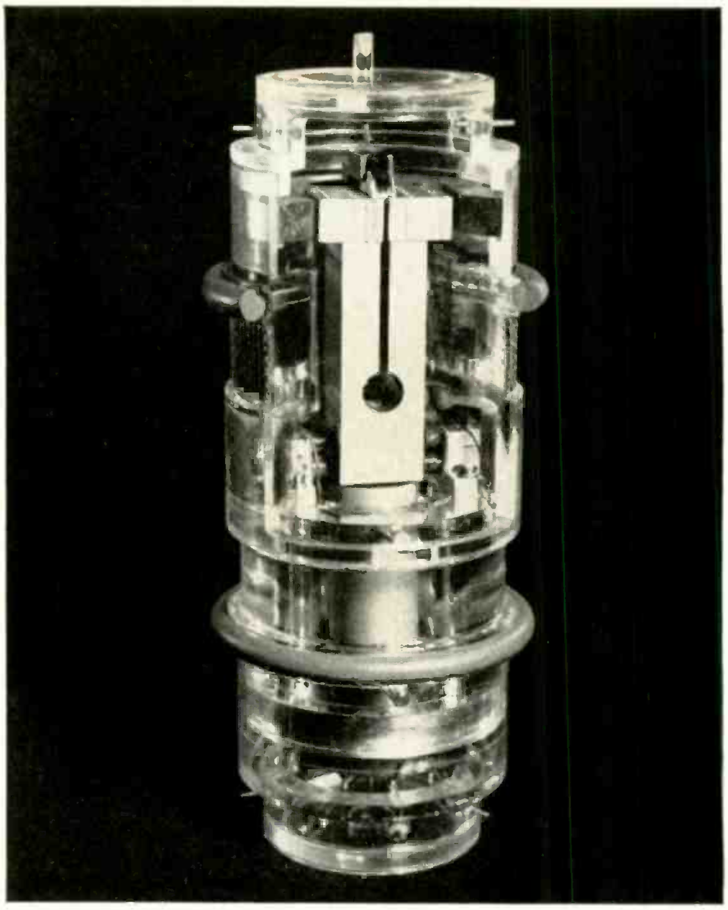


INTERNATIONAL RECTIFIER CORPORATION

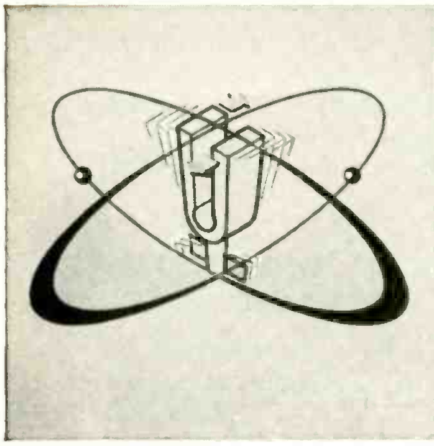
General Offices: 1521 E. Grand Ave., El Segundo, Calif. • Phone: ORegon 8-6281
Chicago Branch Office: 205 West Wacker Drive • Phone: Franklin 2-3889
New York Branch Office: 501 Madison Avenue • Phone: Plaza 5-8665

ON DISPLAY AT WESCON EXHIBIT, AUGUST 25-27

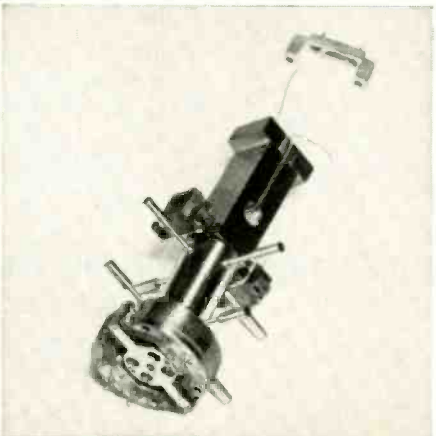
How Sperry solved the metal problems in THE NEW "GYROSCOPE" THAT NEVER SPINS



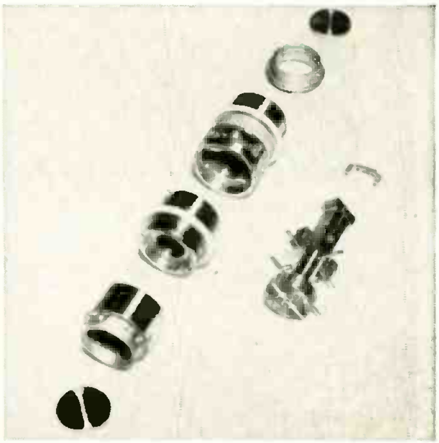
THIS IS THE GYROTRON*, Sperry's revolutionary new type of gyroscope that never spins. Driven without bearings, by electrical vibration, it can give precise measurements of the rate of turn in planes and missiles scorching along at supersonic speeds.



THE INCESSANT VIBRATION calls for a metal with unusual resistance to fatigue. Sperry designers found this property in Inconel® . . . and use Inconel for the vibrating heart of the Gyrotron — its "tuning fork."



INCONEL has other properties that are important in this "tuning fork." It is non-magnetic, tough, resistant to both wear and corrosion.



THE PROBLEM of matching special jobs to the right metal cropped up repeatedly as Gyrotron specifications were written. Every part, from permanent magnet to high permeability alloy to non-magnetic Inconel (except for an ounce or so of copper wire), is a nickel alloy.

When you have a new product on the boards, or plan to improve an old one, look to the INCO Nickel Alloys for the unusual combinations of properties you need. And look to INCO Technical Service for assistance on specific metal problems.

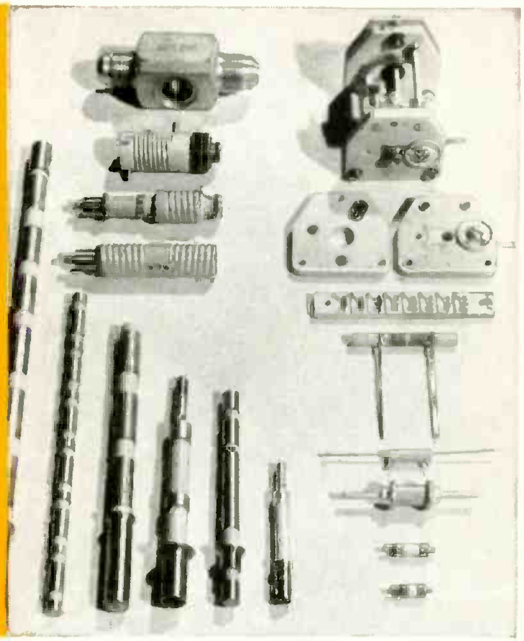
*GYROTRON is a registered trademark of The Sperry Gyroscope Company

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

INCO NICKEL ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • INCONEL® • INCONEL "X"® • INCONEL "W"®
INCOLOY® • NIMONIC® Alloys • NICKEL • LOW CARBON NICKEL
DURANICKEL®

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

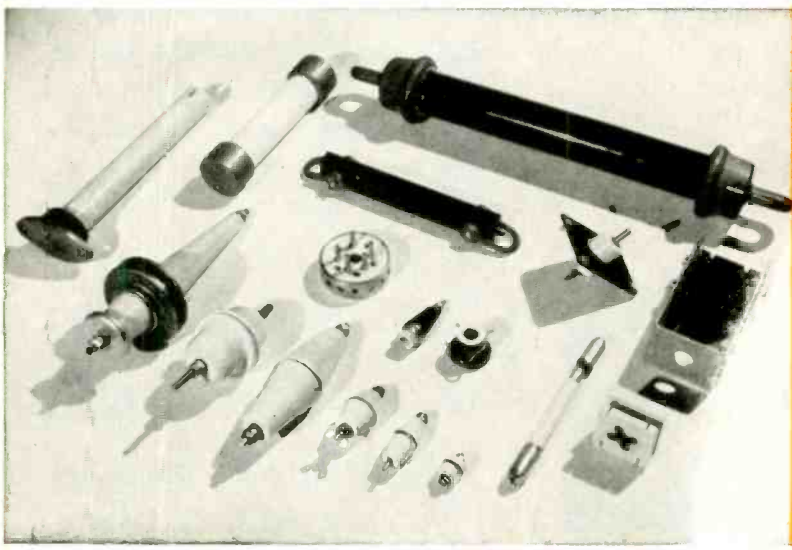
Your production procedure is simplified when you use high-precision Stupakoff ceramic-to-metal assemblies. Extensive experience in the field of electrical and electronic ceramics, thorough familiarity with methods of metallizing, and the use of modern precision manufacturing methods insure the high quality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

For high voltage wiring...
CORONA SHIELDS by Ucinite

Specially designed for television and other high voltage circuits, these Ucinite corona shields are made of cadmium-plated brass. With all sharp edges turned inward for maximum corona resistance, they provide excellent protection in electrical connections.

Ucinite is equipped to manufacture, assemble and wire to your specifications, a wide variety of electrical parts and assemblies for use in electronic apparatus of all types. For full information, call your nearest Ucinite or United-Carr representative, or write directly to us.

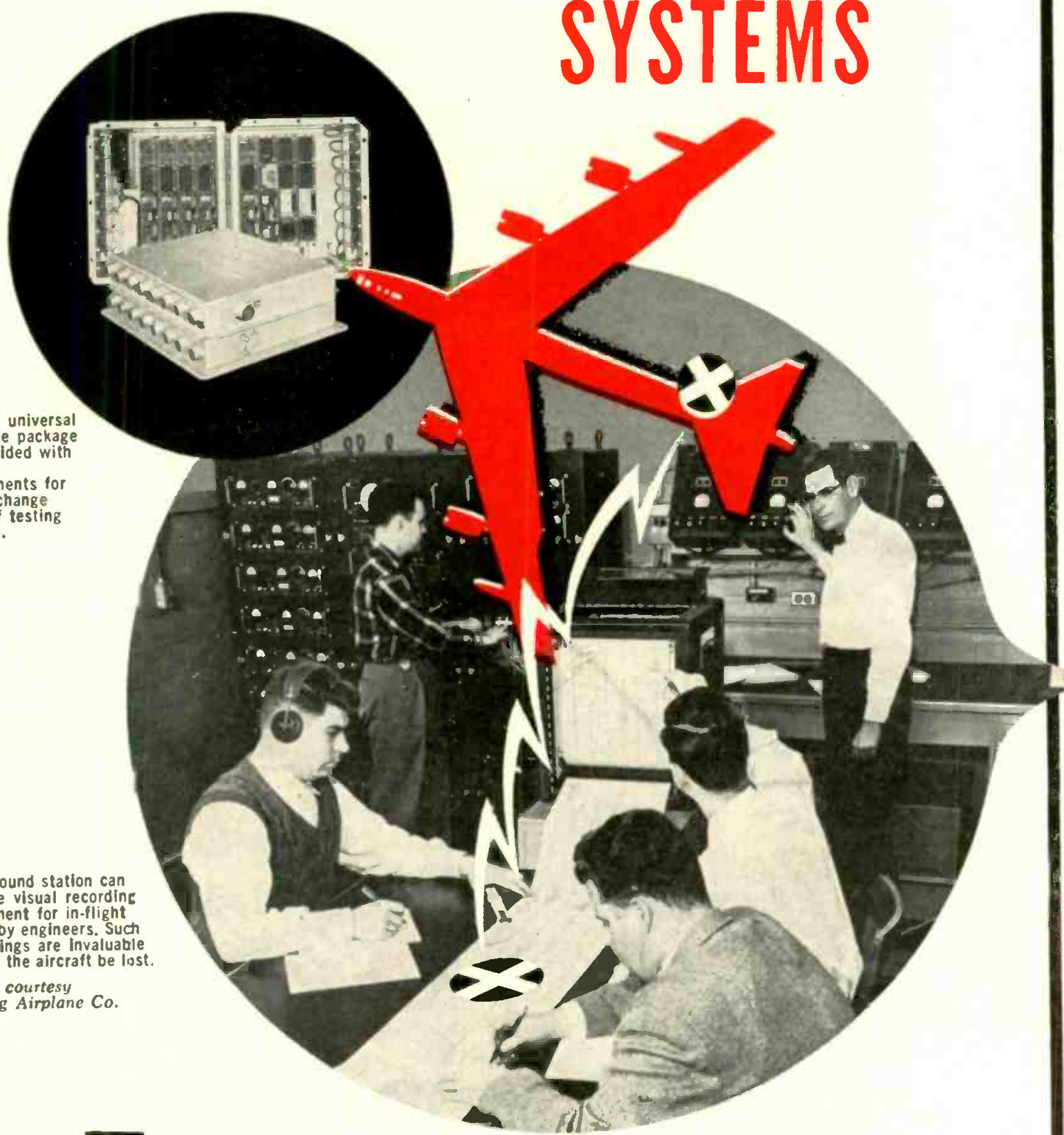
ELECTRICAL ASSEMBLIES Ucinite RADIO AND AUTOMOTIVE

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

Specialists in
ELECTRICAL ASSEMBLIES,
RADIO AND AUTOMOTIVE

FASTER, SAFER, LESS EXPENSIVE FLIGHT TESTING

BENDIX-PACIFIC TELEMETERING SYSTEMS



Typical universal airborne package is provided with plug-in components for quick change over of testing factors.

The ground station can include visual recording equipment for in-flight study by engineers. Such recordings are invaluable should the aircraft be lost.

Photo courtesy Boeing Airplane Co.

RADAR

SONAR

HYDRAULICS

TELEMETERING

ELECTRO-MECHANICAL

ULTRASONICS

The flexibility and effectiveness of Bendix-Pacific Telemetering Systems are materially speeding up flight test programs for several air frame companies, and cutting costs at the same time.

Standardized Systems are available which provide for compact, lightweight airborne equipment and stable ground recording stations. The systems will measure any kind of information that can be recorded by older methods—and with an accuracy that can be depended upon.

The effectiveness of Bendix-Pacific telemetering equipment is being demonstrated in the wide range and multiplicity of information transmitted simultaneously. Numerous flutter tests, for example, can be observed and flight conditions varied by radio communication while a single flight is in progress. The crew is free to concentrate on flying the airplane. The system also offers an important safety factor by warning of any dangerous conditions.

BENDIX-PACIFIC TELEMETERING SYSTEMS Accurately Measure
Vibration • Temperature • Pressure • Acceleration • Strain • Motion

PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

BENDIX PACIFIC

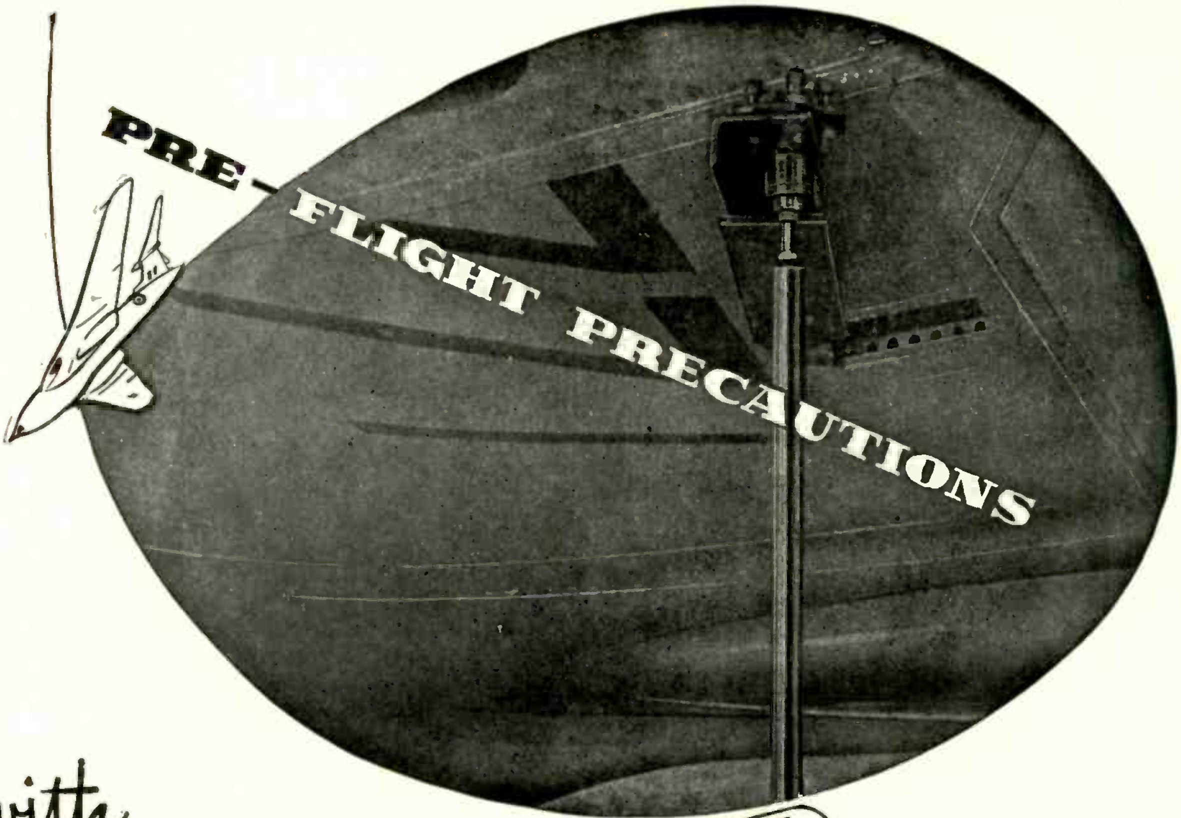
THE NAME *Bendix* AVIATION CORPORATION MILLIONS TRUST

East Coast Office: 475 5th Ave., N.Y. 17

Export Division: Bendix International 205 E. 42nd St., N.Y. 17

Canadian Distributors: Aviation Electric, Ltd., Montreal 9

PRE-FLIGHT PRECAUTIONS



with GOODMANS PERMANENT MAGNET SHAKERS

The flight characteristics of a newly designed aeroplane are the subject of lengthy calculations before the first prototype is built. Whilst the mathematical calculations are themselves accurate, they are based, as in all design work, on several assumptions which have to be verified by a series of pre-flight tests.

One of these essential investigations is the Ground Resonance test, the purpose of which is to determine the various complex modes of vibration of the airframe structure. The frequency of the mode and the dynamic response at remote parts of the aircraft must be accurately determined. The information obtained together with the aerodynamic derivatives is used in predicting the critical 'flutter' speed of the aircraft. The illustration shows one of the two Goodmans Model 8/600 Shakers which were used to excite the Handley Page 'Victor' for this very important test.

For wide frequency range vibration testing and dynamic response investigations, Goodmans Shakers are an obvious choice. These units require no field excitation and provide a faithful reproduction of the input wave form. Industrial applications of controlled vibration are continually increasing; maybe it can serve you—in which case our unique experience is at your service.

Just another of the wide applications of Goodmans Shakers

The range includes models from the 8/600 shown, developing a force of ±300 lb., to the midget model, with a force of ±2 lb., for optical cell research and hairspring torque testing, etc.

MAIL THIS COUPON

TO GOODMANS INDUSTRIES LIMITED
AXIOM WORKS, WEMBLEY, MIDDX., ENGLAND

Please mail me your catalogue and technical data sheets in connection with your PERMANENT MAGNET Shakers.

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GOODMANS INDUSTRIES LTD.

AXIOM WORKS • WEMBLEY • MIDDX • ENGLAND

Cables: GOODAXIOM WEMBLEY, MIDDX.

Here's a Thermostat Metal that takes a shower *and Likes it!*

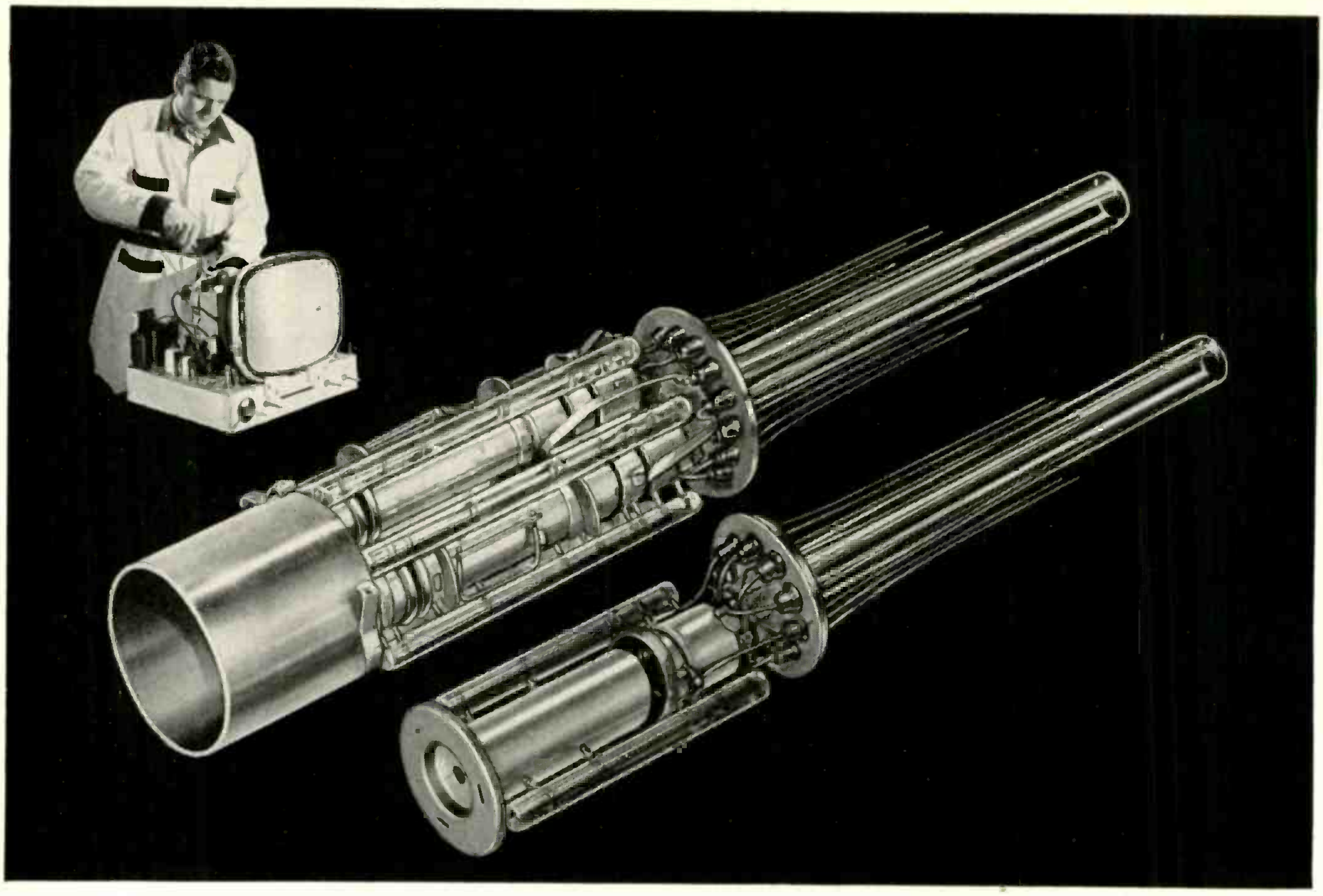
It's natural for a duck to take to water. And it's natural for General Plate *Truflex* J7 Thermostat Metal to operate without corrosion in water. Take for example the shower mixing valve illustrated. This and similar coils have operated continuously in showers and hot water tanks for over 15 years without failure due to corrosion.

Other *Truflex* J7 Thermostat Metal coils are operating successfully in such applications as hot water temperature measuring valves, tanning applications which often operate in mild acids, radiator valves and the like.

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

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

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



Miniature TV Tri-color cathode gun solves designer's dilemma

Sometime this year, a fortunate few thousand TViewers who can pay the freight will relax at home and watch their favorite stars cavort in color. Back of each screen is a triumph of engineering magic—a tri-color cathode ray gun, actually 3 cathodes—one for each primary color.

To bring color TV within pocketbook range of all of us, the heart of future guns will be a miniaturized version of the present disc cathode. The tubular nickel shank of this new disc cathode has been shortened from .312" to .220" and the outside diameter decreased from .121" to .090", resulting in a number of improvements adding to the efficiency of the assembly.

Cathode surface area is reduced. Smaller and shorter heaters used. Less power required (300-450 milliamps instead of the 600 required in older guns).

Lower heat radiation, due to less power, offers a constant heat as well as a cooler continual operation.

A smaller shank and cap which will not dish-in offers better transmission of electrons to the TV screen.

Smaller guns permit a more compactly assembled 3-gun unit. By moving guns closer together, the deflection of the electron beams is more closely controlled.

Miniaturization of the guns means a smaller neck on the finished TV tube. The 3-barrel color tubes take little more space than black and white types, and vital space is conserved for set manufacturers.

The advantages of the present larger disc cathode for monochrome guns—wide choice of material for cap and shank; close "E" dimension control—are also incorporated in the new design.

If you're interested in more information on materials used in the new disc cathode, and details on Nickel and Nickel Alloy Tubing, mail coupon today for a blueprint and Data Memo 5 and 19. There's no obligation.

Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.
Electronics Division.

Please send: ☐ Blueprint ☐ Data Memo 5 and 19 on Superior Nickel and Nickel Alloy Tubing.

Name________________

Company________________

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Superior Tube

The big name in small tubing

All analyses .010" to ⅝" O.D.
Certain analyses in light walls up to 2½" O.D.

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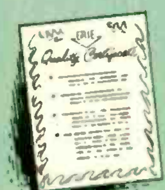
Included in every shipment of Erie Capacitors

ERIE®
Quality Certificate

What is an ERIE Quality Certificate?

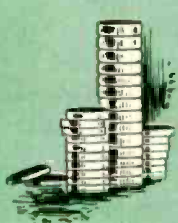


An Erie Quality Certificate is a form that lists the results of both electrical and mechanical tests for every shipment of Erie Capacitors. These tests are made by competent quality control inspectors using modern and precise measuring equipment.

Will it Cut Costs?

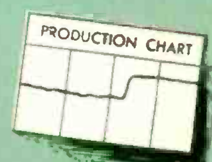
YES — With the Quality Certificate you cut costs by reducing incoming inspection. You save the bother, time, and expense of returning faulty material because you are dealing with capacitors of a known quality. You also reduce the risk of putting faulty capacitors in your products.

Here's an Extra Dividend!



Erie Quality Certified capacitors cost you no more than other kinds. You benefit because quality products are always cheaper to use and add quality to your finished products.

Will it Speed Production?



YES — It takes less time for Quality Certified Erie capacitors to get from your receiving doors to your production lines. It eliminates costly trouble-shooting delays on your assembly line and in your inspection of the finished products.

What Does the Quality Certificate Offer?

The Quality Certificate lists the sample size and test results for each inspection sequence or series of inspection tests. The frequency distribution of capacitance values in the sample is also shown.
Electrical tests include dielectric strength, insulation resistance, and dissipation factor. Other tests such as temperature coefficient, case insulation breakdown are performed and results listed where applicable. The certificate also contains a complete inspection check list for mechanical and visual items. The sampling tables used are MILITARY STANDARD 105 with AQL's (Acceptable Quality Level) ranging from 0.4% for performance items to 1.5% for non-functional deviations.

Again the Pioneer

As in so many other important developments in electronic components, Erie again leads the field. Erie is the first ceramic capacitor manufacturer to give customers this complete quality information with each shipment.

ERIE
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RESISTOR CORP.

ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

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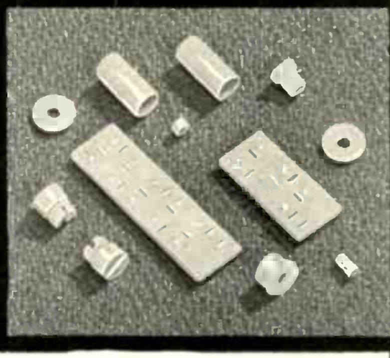
GLASS PREFORMS — Iron Sealing and Kovar Sealing Glass precision molded to the closest tolerances in the industry. Resist mercury attack, have ample mechanical strength, and seal readily. Our laboratory is prepared to assist you in selecting the proper glass for any metal.

FORMULA 800 PREFORMS — Mansol's newest development — using an Epoxy Resin to improve product efficiency. Possesses extremely high bonding strength, with no shrinkage, on metals to metals and metals to non-metals. Worth looking into! Can save you many man-hours of expensive labor.

a consistently dependable source for all types of... MOLDED POWDER PREFORMS custom-made to exact specifications



STEATITE PREFORMS — We specialize in die pressed ceramics held to the closest tolerances. All tools and dies are made in our own shop to assure quick delivery.

NEW PLANT AND FACILITIES — We are proud of our modern, new plant devoted entirely to the development and production of all types of preforms.

Research, Engineering and Manufacturing skills guarantee the highest standards of . . .

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HOW MANSOL SOLVES PREFORM PROBLEMS — The complete story concerning our services, facilities and production techniques can be had free of charge just by writing to Dept. N, Mansol Ceramics, Belleville, New Jersey.

INVESTIGATE MANSOL'S TECHNICAL KNOW-HOW TODAY AT NO COST OR OBLIGATION. Mansol's engineers are at your service, ready to discuss your powder molding problems, whether they be glass for seals, spacers, or lead through bushings.

If you are still making your own preforms, Mansol would like to show you how to save money by eliminating rejects.

for **TRUE**

HERMETIC

SEALING

Canseals *by cannon*

Hermetically-sealed multi-contact Canseal connectors made by Cannon are really rugged! And . . . they are the only connectors that give you **true hermetic sealing under adverse pressure and atmospheric changes.** Here's why . . .

Cannon pioneered the first successful hermetically-sealed connector more than six years ago . . . since then has continously refined and increased the line. All have special steel contacts. Glass insulation . . . **fused to both contacts and shell for a perfect permanent seal** . . . is stronger than steel, withstands temperatures to 1000° F, and permits the use of the **highest conductive steel** contacts compatible with any glass fusing operation.

Available in a wide variety of insert layouts for control, relay, power, and instrument applications in Series GS (AN type), KH, RKH, U, DAH, BFH, TBFH, DBH, DCH, KH30 standard, miniature and sub-miniature sizes. Also, special mounting flanges and brazing service to help you obtain a strong and leakproof overall assembly.

CANNON PLUGS

SINCE 1915

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first in connectors


DH SERIES


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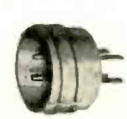
KH SERIES

Please refer to Dept. 120

CANNON ELECTRIC COMPANY, 3209 Humboldt Street, Los Angeles 31, California

Factories in Los Angeles; East Haven; Toronto, Canada; London, England.
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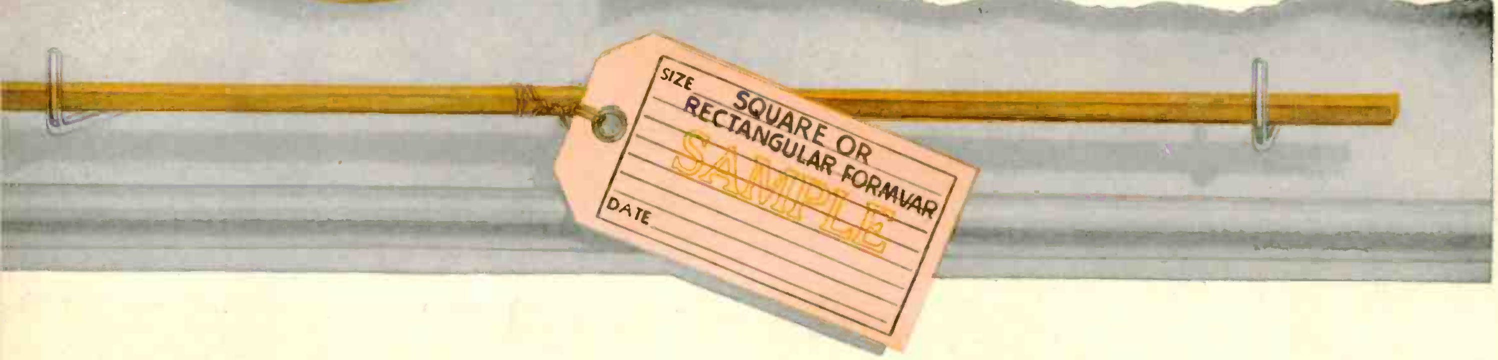
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RECTANGULAR FORMVAR
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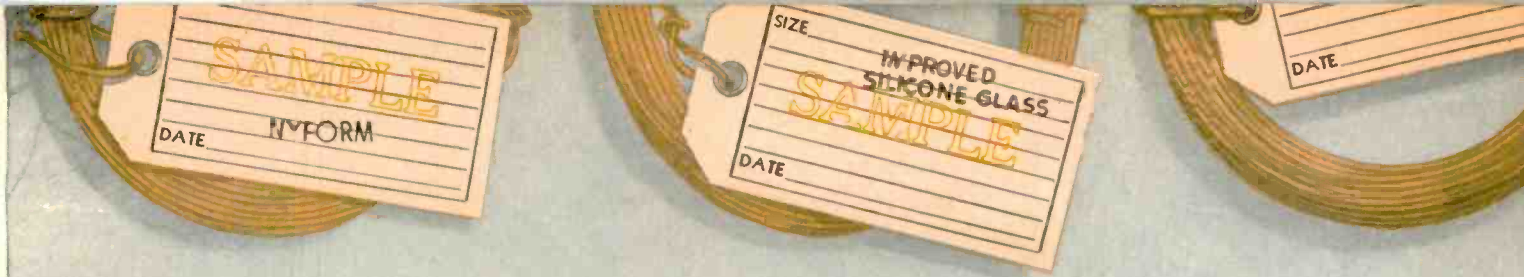
DATE



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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!

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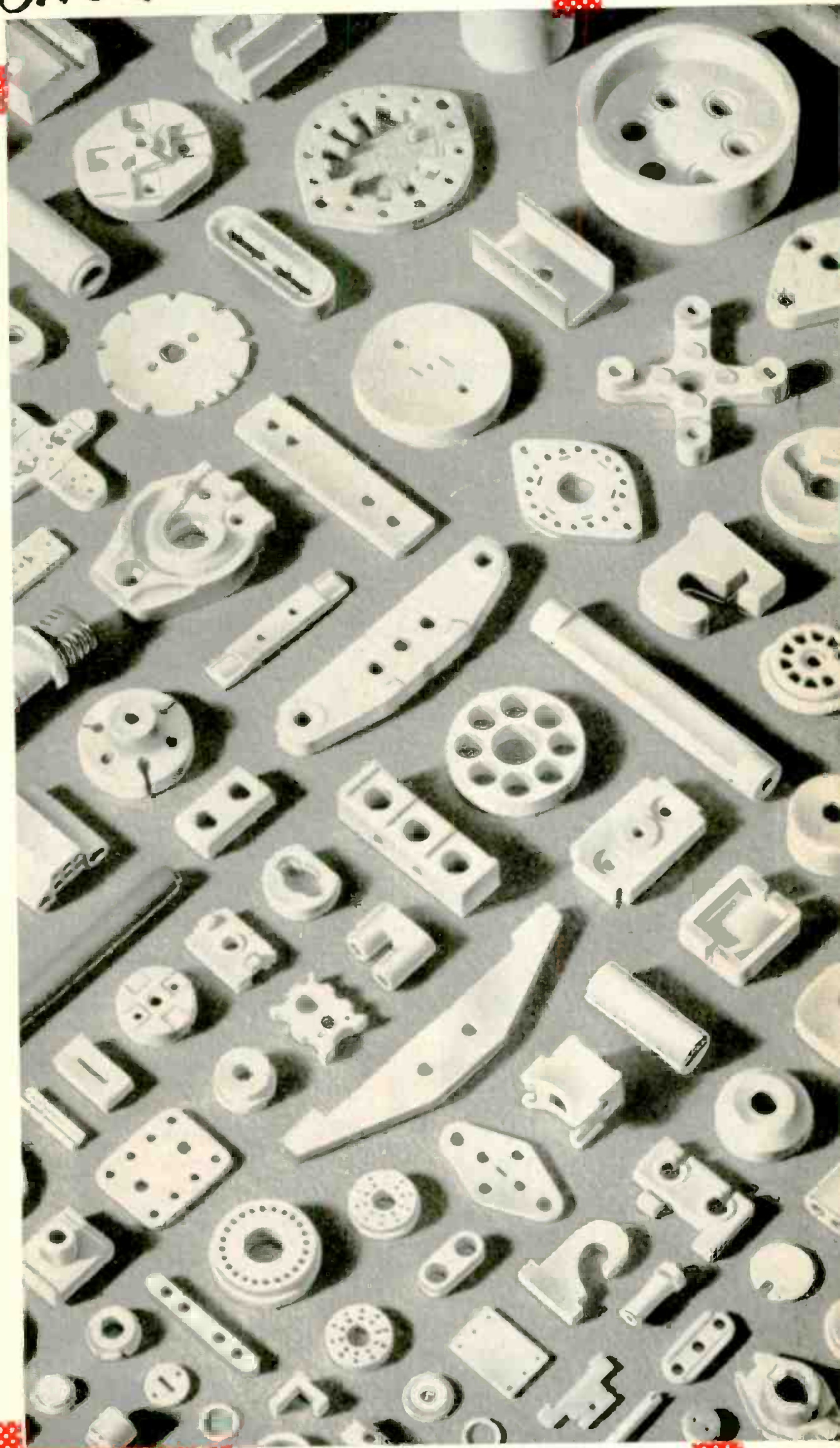
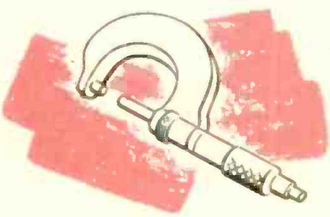
Save assembly time . . .
with quality-controlled ceramics



made of

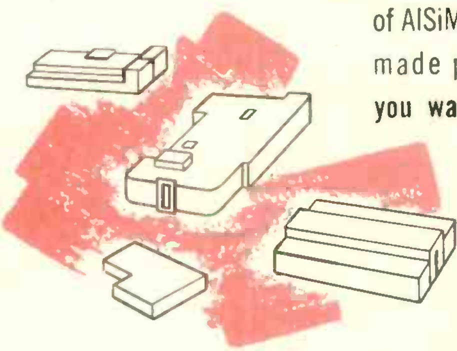
AlSiMag®

Your line workers will appreciate the ease and speed with which they can assemble AlSiMag ceramics. Your production planning staff will be well pleased with the excellent quality as well as the rapid delivery of these parts.



Physical dimensions and tolerances are checked at every key stage of manufacture by thoroughly trained Quality Control inspectors to insure shipment of a superior product.

Four large, completely equipped plants assure you of hundreds—or hundreds of thousands—of AlSiMag precision made parts **when you want them.**



You can confidently specify AlSiMag ceramics—backed by over fifty years of specialized experience in the technical ceramics field.

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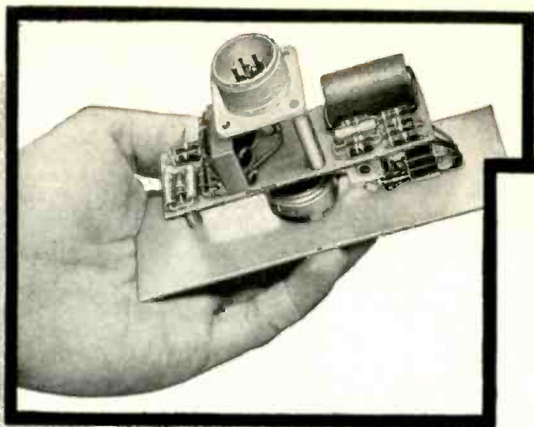
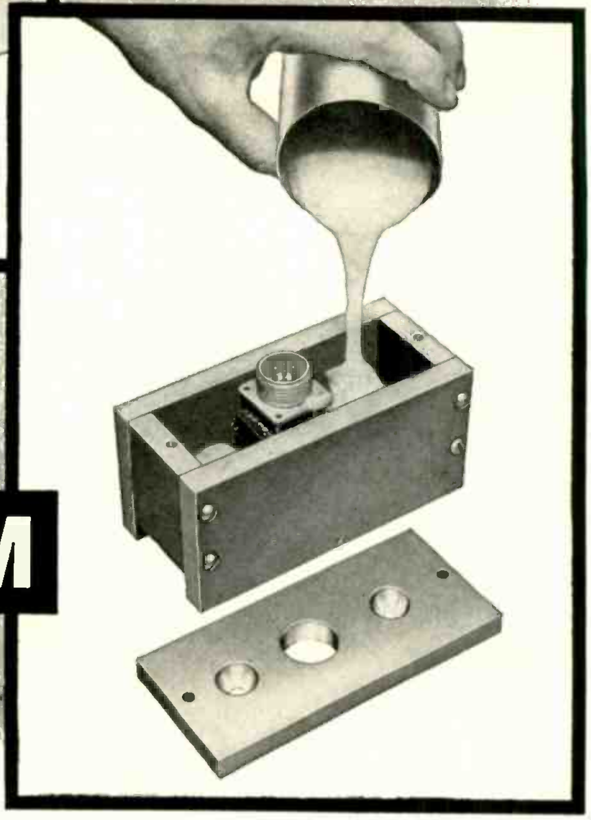
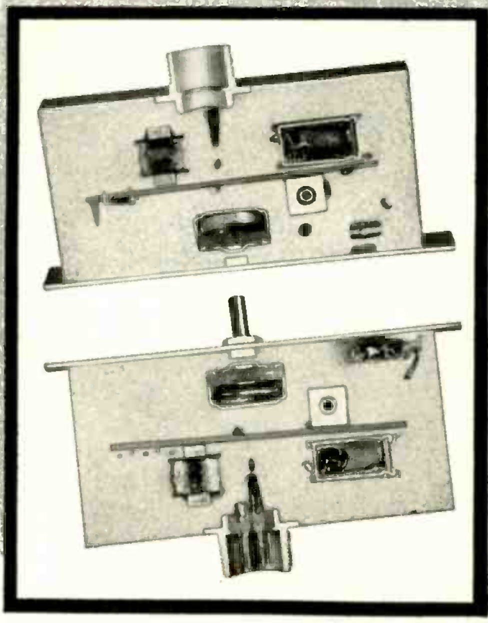
this control needed protection



here's the easy way they protected it with

NOPCO® LOCKFOAM





result: a complete barrier against vibration, corrosion, dampness, fungi

Hamilton Standard Division, United Aircraft Corporation, needed a potting material for the electronic temperature control unit that governs cockpit air-conditioning—found Nopco Lockfoam ideal for the purpose.

Nopco Lockfoam is indeed ideal for this and many other similar tasks because of the absolute protection it affords against damage from severe vibration. Its light-weight closed-cell structure makes a tamper-proof assembly, and gives a high impermeability to dampness, corrosion, and fungi growth. Also, its pour-in-place technique effects great economy of assembly time.

Further, each of the 50 different formulations available is highly consistent and reproducible.

Perhaps the rare combination of properties of this versatile plastic can help with some product *you* have in mind. *Write today for the Nopco Lockfoam booklet.*

Where Can YOU Best Use These Properties?

Near-perfect Radar Transmission

Ease of Fabrication
It's "poured-in-place"

Great Strength with Light Weight

Excellent Electrical Properties
6 lb/cu ft Lockfoam tested at 9.375 KMC
Dielectric Constant 1.05
Loss Tangent .0005

Good Thermal Insulation
"K" Factors
.018 at 8 lb/cu ft
to .025 at 11 lb/cu ft

Wide Range of Densities
From 2 to 35 lb/cu ft

Great Versatility
50 different formulations available

Plastics Division
NOPCO CHEMICAL COMPANY
Harrison, New Jersey
4858 Valley Blvd., Los Angeles 32, Calif.

C-A-C

H ERMETIC · H UM · H IGH — S EALED · S HIELDED · S TABILITY

HS SERIES TOROIDS

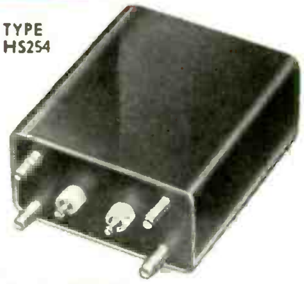
For IMMEDIATE Delivery

TYPE HS715

DIMENSIONS

Length	2-9/16"
Width	1-5/16"
Height	2-13/16"
Weight	14 oz.
Mounting	2-1/16 x 1-[illegible]/16"
Screws	6/32" studs
Cutout	7/8 x 1/2"

TYPE HS254



DIMENSIONS

Length	1-29/32"
Width	1"
Height	2-1/4"
Weight	8 oz.
Mounting	1-5/16 x 9/16"
Screws	6/32" studs
Cutout	7/8 x 1/2"

TYPES HS930 & HS395

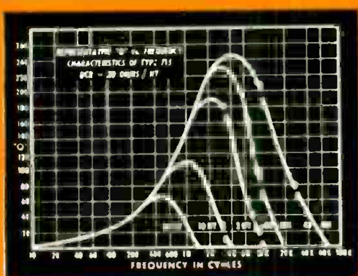
DIMENSIONS

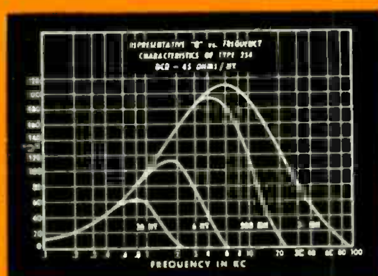
Length	1-9/32"
Width	11/16"
Height	1-23/32"
Weight	4 oz.
Mounting	7/8 x 9/32"
Screws	4/40" studs
Cutout	1/2 x 5/16"

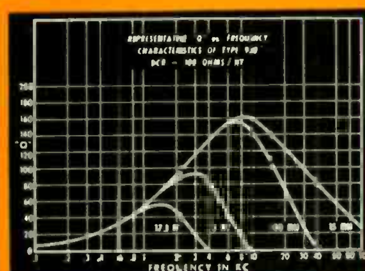
TYPES HS206, HS848 & HS608 & HS073

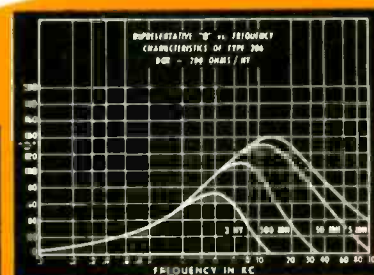
DIMENSIONS

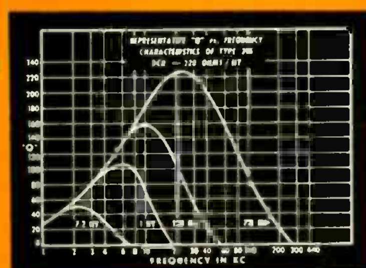
Length	1-1/16"
Width	1/2"
Height	1-1/4"
Weight	1.5 oz.
Mounting	3/4"
Screws	4/40" studs
Cutout	1/2 x 5/16"

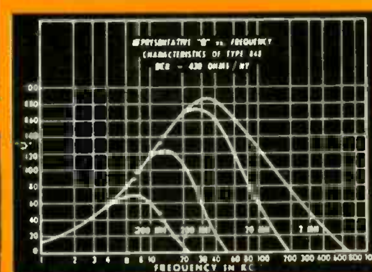


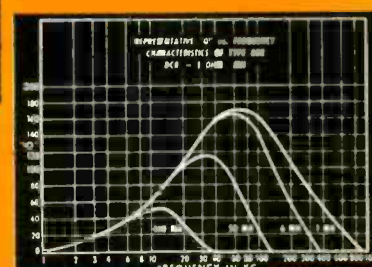


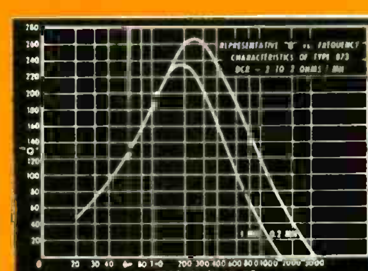












LIST OF STOCKED UNITS

All other values and types on Special Order

Suffix Number	HS 206—	HS 930—	HS 254—	HS 715—
—1	5.0 MH	5.0 MH	20 MH	24 MH
—2	6.0 MH	6.0 MH	24 MH	30 MH
—3	7.2 MH	7.2 MH	30 MH	36 MH
—4	8.6 MH	8.6 MH	36 MH	43 MH
—5	10 MH	10 MH	43 MH	50 MH
—6	12 MH	12 MH	50 MH	60 MH
—7	15 MH	15 MH	60 MH	72 MH
—8	17.5 MH	17.5 MH	72 MH	86 MH
—9	20 MH	20 MH	86 MH	100 MH
—10	24 MH	24 MH	100 MH	120 MH
—11	30 MH	30 MH	120 MH	150 MH
—12	36 MH	36 MH	150 MH	175 MH
—13	43 MH	43 MH	175 MH	200 MH
—14	50 MH	50 MH	200 MH	240 MH
—15	60 MH	60 MH	240 MH	300 MH
—16	72 MH	72 MH	300 MH	360 MH
—17	86 MH	86 MH	360 MH	430 MH
—18	100 MH	100 MH	430 MH	500 MH
—19	120 MH	120 MH	500 MH	600 MH
—20	150 MH	150 MH	600 MH	720 MH
—21	175 MH	175 MH	720 MH	860 MH
—22	200 MH	200 MH	860 MH	1.00 HY
—23	240 MH	240 MH	1.00 HY	1.20 HY
—24	300 MH	300 MH	1.20 HY	1.50 HY
—25	360 MH	360 MH	1.50 HY	1.75 HY
—26	430 MH	430 MH	1.75 HY	2.00 HY
—27	500 MH	500 MH	2.00 HY	2.40 HY
—28	600 MH	600 MH	2.40 HY	3.00 HY
—29	720 MH	720 MH	3.00 HY	3.60 HY
—30	860 MH	860 MH	3.60 HY	4.30 HY
—31	1.00 HY	1.00 HY	4.30 HY	5.00 HY
—32	1.20 HY	1.20 HY	5.00 HY	6.00 HY
—33	1.50 HY	1.50 HY	6.00 HY	7.20 HY
—34	1.75 HY	1.75 HY	7.20 HY	8.60 HY
—35	2.00 HY	2.00 HY	8.60 HY	10.0 HY
—36	2.40 HY	2.40 HY	10.0 HY	12.0 HY
—37	3.00 HY	3.00 HY	12.0 HY	15.0 HY
—38		3.60 HY	15.0 HY	17.5 HY
—39		4.30 HY	17.5 HY	20.0 HY
—40		5.00 HY	20.0 HY	24.0 HY
—41		6.00 HY	24.0 HY	30.0 HY
—42		7.20 HY	30.0 HY	36.0 HY
—43		8.60 HY	36.0 HY	43.0 HY
—44		10.0 HY		50.0 HY
—45		12.0 HY		60.0 HY
—46		15.0 HY		
—47		17.5 HY		

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This new, high-speed direct-drive counter . . . with its one-piece "show window" case . . . was first developed for use in navigational and directional instruments. Then, because of its many adaptable features, it is eligible for employment in many other jobs. It's good for speeds up to 1800 rpm . . . temperatures from 67° to 185° F . . . and it's corrosion resistant. Drive shafts can be longer on either side or both. And base may be lengthened to take more figure-wheels if you want. All in all, a remarkably versatile performer . . . one of scores of standard and special Veeder-Root Counters for every mechanical and electrical application from Electronics to Automation. Write:

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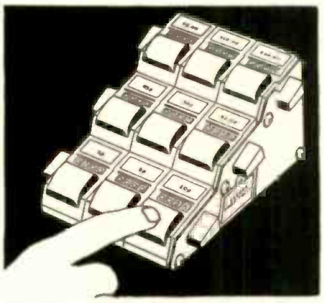
® **"The Name that Counts"**



New *Vary-Tally* Multiple-Unit Reset Counter comes in any combination up to 6 banks high, and 12 units wide. Write for news sheet and prices.

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For The ELECTRONIC INDUSTRY

Moldite has taken the initiative in establishing accepted electrical standards long required by the electronic industry. Every coil and set manufacturer, every engineer has designed coils to utilize Moldite "standards". The reasons are obvious. *Moldite Core Standards Offer . . .*

ECONOMY	HIGH QUALITY	UNIFORMITY
AVAILABILITY	INTERCHANGEABILITY	FLEXIBILITY

This means a better product backed by years of Moldite leadership in engineering and research. No one has done more than Moldite to give the industry a superlative core or coil form for every electronic application. *So Design with Moldite Core Standards.*

. . . Send for our new Catalog No. 110 — THE MOST COMPLETE LINE OF CORES IN THE INDUSTRY!

MOLDITE FERRICORES

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FERRITE CORES
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Samples promptly submitted upon request for design, pre-production, and test purposes

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LAMINATED PAPER BASE PHENOLIC TUBING

Outstanding for many years as the Top Performer, Clevelite is unmatched in its ability to meet unusual specifications.

Built-in Dimensional Stability, High Dielectric Strength, Low Moisture Absorption, Great Mechanical Strength, Excellent Machining Qualities and Low Power Factor make Clevelite Tubing outstanding.

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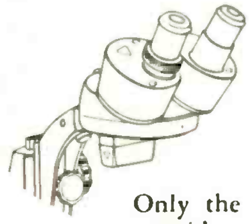

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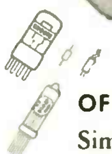

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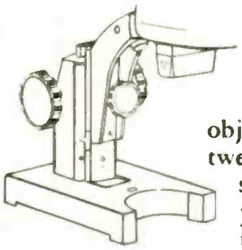

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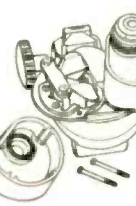
Ample clearance between objective lens and stage for hands, tweezers, tools. Focusing knobs are set back, within effortless reach, yet out of the way of jigs and tools.



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Clamps and gibs lock prisms into lifetime alignment, safe from shock damage. Permits safe, trouble-free mounting in machine or fixture. Patented Neoprene ring seals out dust. Saves money on repairs, down-time.

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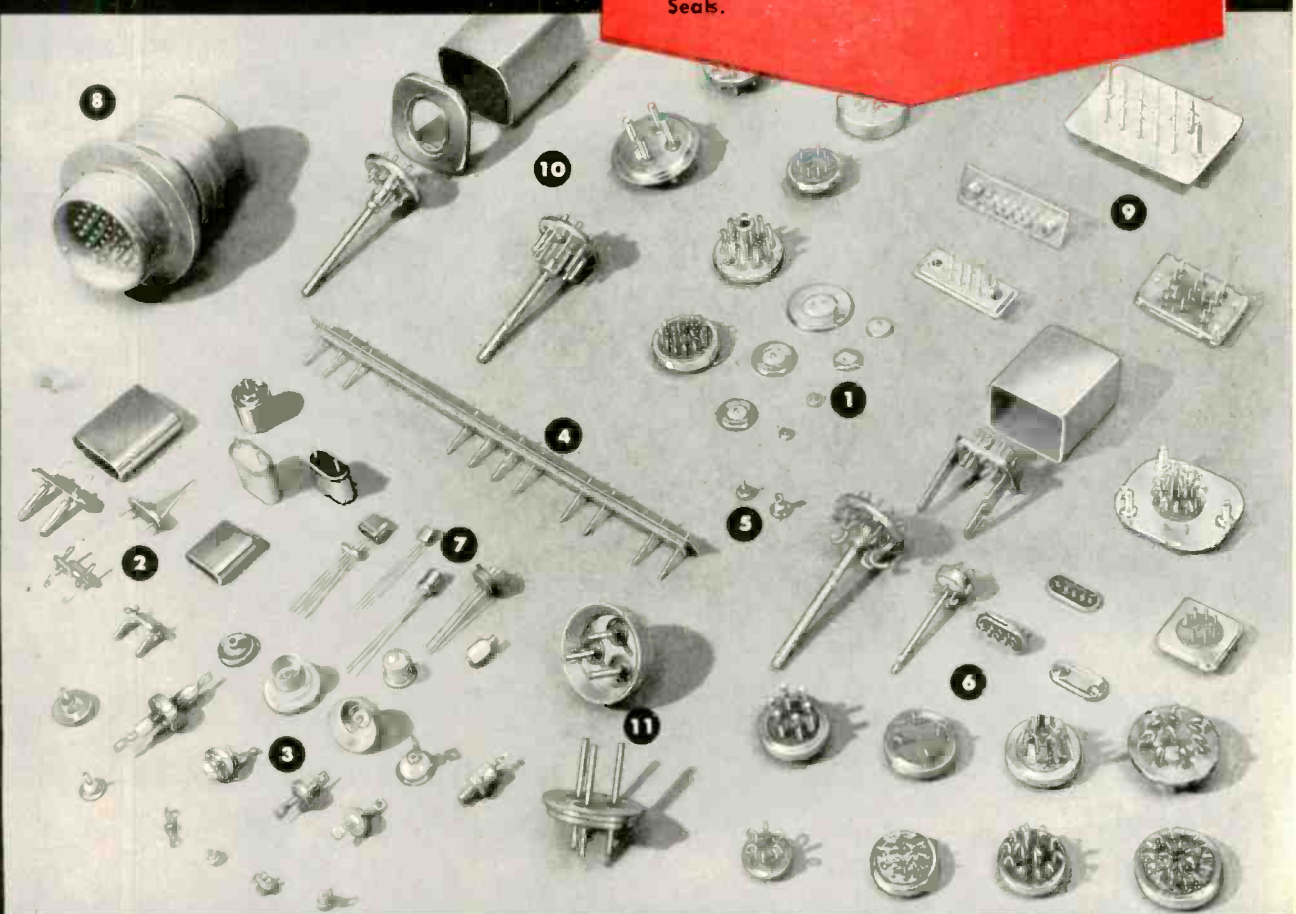
The prime source for variety in sizes, terminations and shapes: quality: performance —at thoroughly acceptable cost to you. Special terminals for any purpose. In VAC-TITE* Compression Seals as well as conventional kovar designs.

*VAC-TITE is HERMETIC's vacuum-proof, compression-construction, glass to metal seal. In addition to special shapes, many standard sizes such as .800 O.D. and .900 O.D. multi-terminal headers and a large variety of individual terminals are available in VAC-TITE Compression Seals.



FIRST AND FOREMOST IN MINIATURIZATION

Now

STILL FASTER COMPUTERS

with G.E.'s new high-perveance, high-capacity tube!

- **Per plate: gives 25 ma avg current, dissipates 4 w.**
- **Special cathode design increases on-off dependability.**
- **Is life-tested under cutoff conditions.**

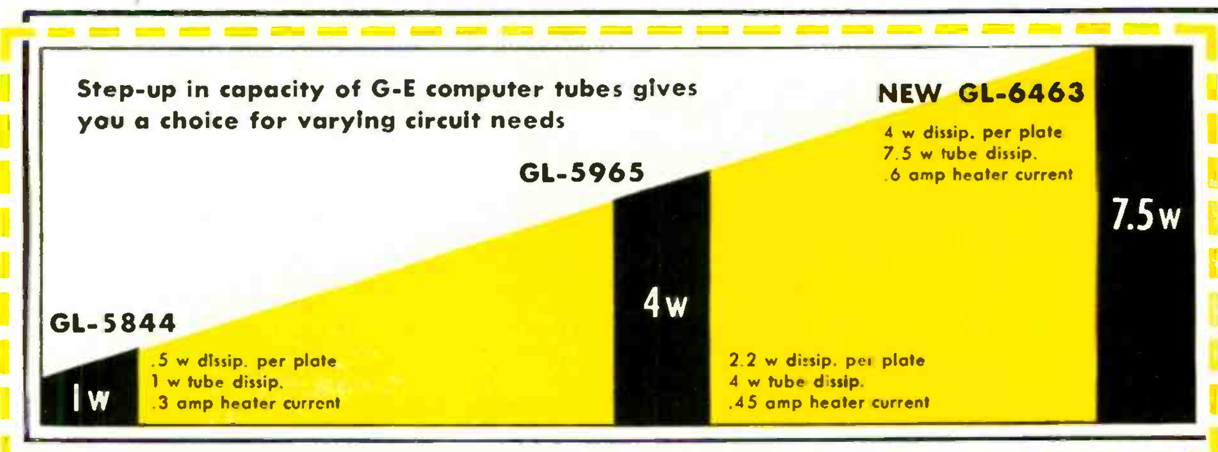
GL-6463

9-pin twin triode

SPEEDS UP ELECTRONIC CALCULATING! Type GL-6463—newest product of G-E tube design service—enables you to build computing machines that are far faster than others now in use. To increase computer speeds appreciably, it is necessary to reduce tube plate load resistance . . . which, in turn, calls for a higher plate current in order to maintain voltage.

HIGH-PERVEANCE GL-6463 has plenty of current output for new, high computer speeds . . . plus ample plate dissipation, so that the tube will do its job long and dependably. Like other G-E computer tubes, the heater and cathode power requirements are low, for economy. Also, on-off reliability is designed into the tube, which will operate efficiently after being biased to cutoff for long periods.

NEWEST OF 3 G-E TYPES, WITH HIGHEST CAPACITY! The GL-6463 carries forward G.E.'s extensive design program of special tubes for computers. In the 3 types now available, you have a range of choice from low to high capacity. Get ratings, performance curves, and prices! *Tube Dept., General Electric Company, Schenectady 5, N. Y.*



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162-188

HEAVY DUTY, PRECISION REGULATED POWER SUPPLIES

FOR LESS THAN THE COST OF BUILDING THEM YOURSELF

Bench Model 50
0-500 VDC @ 0-500 MA $415.00

LAMBDA'S TWO WIDEST RANGE, MOST VERSATILE POWER SUPPLIES

Rack Model 50-R
0-500 VDC @ 500 MA $395.00

These general purpose, heavy duty power supplies save you time, money and experimentation. They are tested, fully guaranteed, now in use in many leading research and industrial laboratories and manufacturing plants. You get quick delivery, dependable equipment ready for immediate installation.

SPECIAL FEATURES

- ▶ Hermetically sealed oil filled condensers
- ▶ Stable 5651 reference tubes
- ▶ Easy-to-read 4" meters
- ▶ Overload circuit breakers (magnetic type)
- ▶ Vernier high-voltage control
- ▶ Time-delay tube protection

SPECIFICATIONS

INPUT .... 105-125 VAC, 50-60 C, 800 W (max)

DC OUTPUT NO. 1: (regulated for line and load)

Voltage .... 0-500 VDC (continuously variable)
Current .... 0-500 MA (over entire voltage range)
Regulation (line) .... Better than 0.15% or 0.1 V
Regulation (load) .... Better than 0.5% or 0.3 V
Internal Impedance .... Less than 2 ohms
Ripple and Noise .... Less than 8 millivolts rms
Polarity .... Either positive or negative may be grounded

DC OUTPUT NO. 2: (regulated for line only)

Voltage Ranges	Internal Impedances:
a) 0-50 VDC (no load)	3,300 ohms (max)
b) 0-200 VDC (no load)	17,500 ohms (max)

Regulation (line) .... Better than 0.1%
Ripple and Noise .... Less than 5 millivolts rms
Polarity: Positive terminal connected internally to negative terminal of DC output No. 1

AC OUTPUTS (unregulated):

Two outputs, isolated and ungrounded. Each is 6.5 VAC at 5A (at 115 VAC input). Allows for drop in connecting leads. May be connected in series for 12.6 V (nominal) at 5A, or in parallel for 6.3 V (nominal) at 10A.

SIZES AND WEIGHTS:

Bench Model 50	Size: 12½" H x 22" W x 15" D Weight: 110 lb. net; 175 lb. shipping
Rack Model 50-R	Size: 10½" H x 19" W x 14¼" D Weight: 89 lb. net; 143 lb. shipping

LAMBDA ELECTRONICS CORP.
103-02 NORTHERN BLVD. CORONA 68, NEW YORK

NEW AMP

PATENTED "F" CRIMP

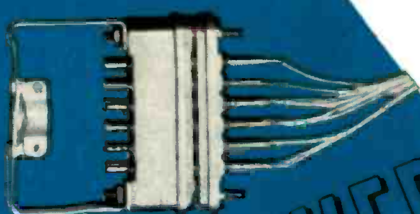
TAPER PINS

FOR WIRING

AN TYPE CONNECTORS

Wires are *Taper Terminated* at rates up to 4,000 per hour with AMP's AUTOMATIC WIRE TERMINATOR. Pins, barely larger than the wire, feed in strip form from reels mounted on machine.

No solder, no flux, no solder pots or irons needed—just lock pin in tapered socket with AMP's "measured energy" CERTI-LOK insertion tool. Resulting connections are uniform and reliable—have extremely high contact pressure resulting in extremely low contact resistance.



AMP Taper Pins tested in AN type connectors exceed the applicable performance requirements of Military Specifications for AN connectors and solderless terminals. Taper Pin Connections are even more secure and show no change in contact resistance after vibration, temperature cycling, salt spray, and thermal shock tests. Copies of these test reports are available on request.

APPROVED

Find out about the New AMP "CREATIVE APPROACH TO BETTER WIRING"

... An evaluation survey without cost or obligation.

IMPROVE RELIABILITY
SAVE TIME
REDUCE COST

Now AN type connectors can be wired 5 to 10 times faster **with even superior performance reliability.** There are no cold solder joints, burned insulation, embrittled wire and breakage at solder cups or short circuits due to loose strands and excess solder.

For many years the Aircraft, Electronics and Communication industries have awaited this new and simpler method, since the soldering of wires to conventional AN connector contacts is a slow and painstaking process involving much skill and repeated inspection checks.

With AMP's new Taper Technique, a special AMP Patented "F" Crimp Taper Pin is attached to the wires by high speed automatic machines. This pin is then installed in the connector with one easy and positive stroke of AMP's new "measured energy" CERTI-LOK insertion tool. The result is uniformly better connections, produced in much less time with tremendous cost savings.

Tests prove that AMP Taper Pins provide a greater degree of uniformity than soldered connections. Reliability is actually increased because the possibility of human error in assembly has been greatly reduced.

Leading Connector manufacturers are now supplying AN and other types of multiple contact connectors for use with AMP Taper Pins. Write today for further information.

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AMP

NEW *Multi-Purpose* Oscilloscope

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- **10-KV Accelerating Potential**
- **600,000,000 to 1 Sweep Range**
- **Direct-Reading in Time and Amplitude**
- **Versatile Triggering Circuitry**

TYPE 531

You just plug in the proper vertical preamplifier to have at your service a wide-band dc oscilloscope, a wide-band high-gain oscilloscope, a wide-band dual-trace oscilloscope, or a differential-input high-gain dc oscilloscope. The Type 53-Series Plug-In Units are small, weigh less than 6 lbs. each, and you can change them in a few seconds.

This new instrument is designed to make your oscilloscope dollar go farther. Development of additional plug-in units already in progress will increase the versatility of the Type 531, and assure its modernity well into the future. *But your greatest gain is the many hours of valuable engineering time you save through its use.*

OSCILLOSCOPE CHARACTERISTICS

24 Calibrated Sweeps
0.1 µsec/cm to 5 sec/cm. Accurate 5-x magnifier permits calibrated sweep times to 0.02 µsec/cm. Sweep continuously variable from 0.02 µsec/cm to 12 sec/cm. Sweep calibration accurate within 3%.

New Cathode-Ray Tube
Tektronix T51P metallized CRT has helical post-accelerating anode; deflection-plate leads are brought out at the neck.

DC-Coupled Vertical Output Amplifier
Designed for use with any of the Type 53-Series Plug-In Units.

Balanced Delay Network
Provides 0.25-µsec vertical signal delay.

Horizontal Input Amplifier
Sensitivity 0.2 v/cm to 20 v/cm, continuously variable.

Internal or External Triggering
Amplitude level selection or automatic triggering.

Amplitude Calibrator
Square wave, 0.2 mv to 100 v in 18 steps, accurate within 3%.

DC-Coupled Unblanking

CRT Beam Position Indicators

Electronically Regulated Power Supplies

Price $995 plus price of desired plug-in units

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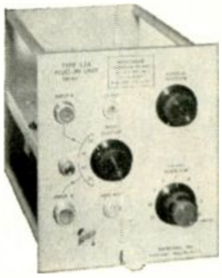
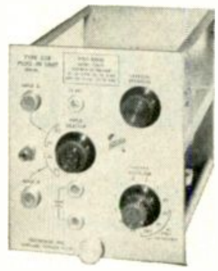
For complete specifications and shipping schedules call your Tektronix Field Engineer or Representative or write to:

PLUG-IN UNIT CHARACTERISTICS

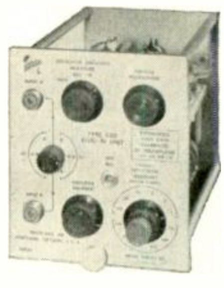


Type 53A Wide-Band DC Plug-In Preamplifier—dc to 10-mc passband, 0.035-µsec risetime. Sensitivity 0.05 v/cm to 50 v/cm, ac or dc, continuously variable, with nine calibrated steps from 0.05 v/cm to 20 v/cm. Two input connectors with 80-db isolation. Price $85.



Type 53B Wide-Band High-Gain Plug-In Preamplifier—same as the Type 53A with the addition of an ac-coupled input stage providing three additional calibrated sensitivity steps, 5 mv/cm, 10 mv/cm and 20 mv/cm. Passband 5 cycles to 9 mc, 0.04-µsec risetime. Two input connectors with 80-db isolation. Price $125.

Type 53C Dual-Trace Plug-In Preamplifier — two identical amplifier channels, each with dc to 8.5-mc passband, 0.04-µsec risetime, sensitivity 0.05 v/cm to 50 v/cm continuously variable with 9 calibrated steps from 0.05 v/cm to 20 v/cm. Electronic switching triggered by oscilloscope sweep, or free running at about 100 kc. Polarity reversal switches. Price $275.



Type 53D Differential High-Gain DC Plug-In Preamplifier—sensitivity 1 mv/cm at dc to 250 kc—with passband increasing to 750 kc at 50 mv/cm and lower. Sensitivity in calibrated steps—1 mv/cm to 50 v/cm, or continuously variable—1 mv/cm to 125 v/cm. Differential input. Price $145.

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Producing iron cores that are really uniform, or matching a new batch of cores to the exact specifications of a previous run are critical jobs!

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Electronic Components Division
STACKPOLE CARBON COMPANY,
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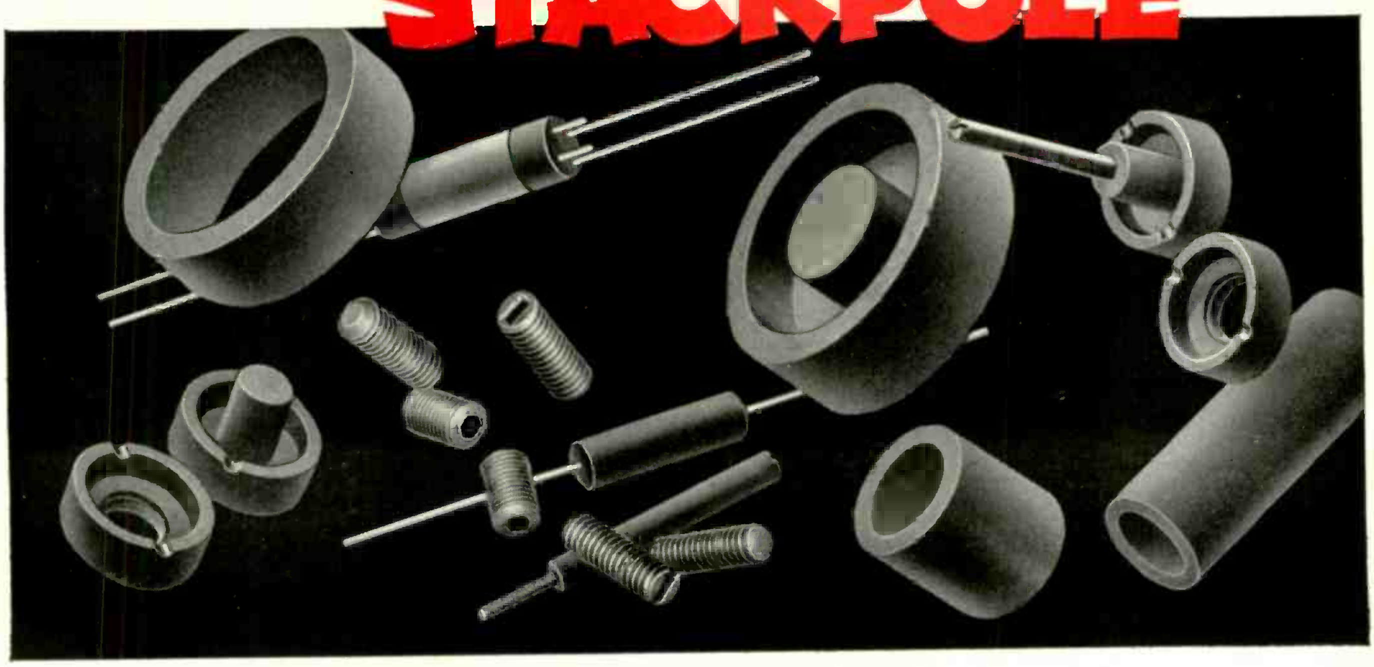
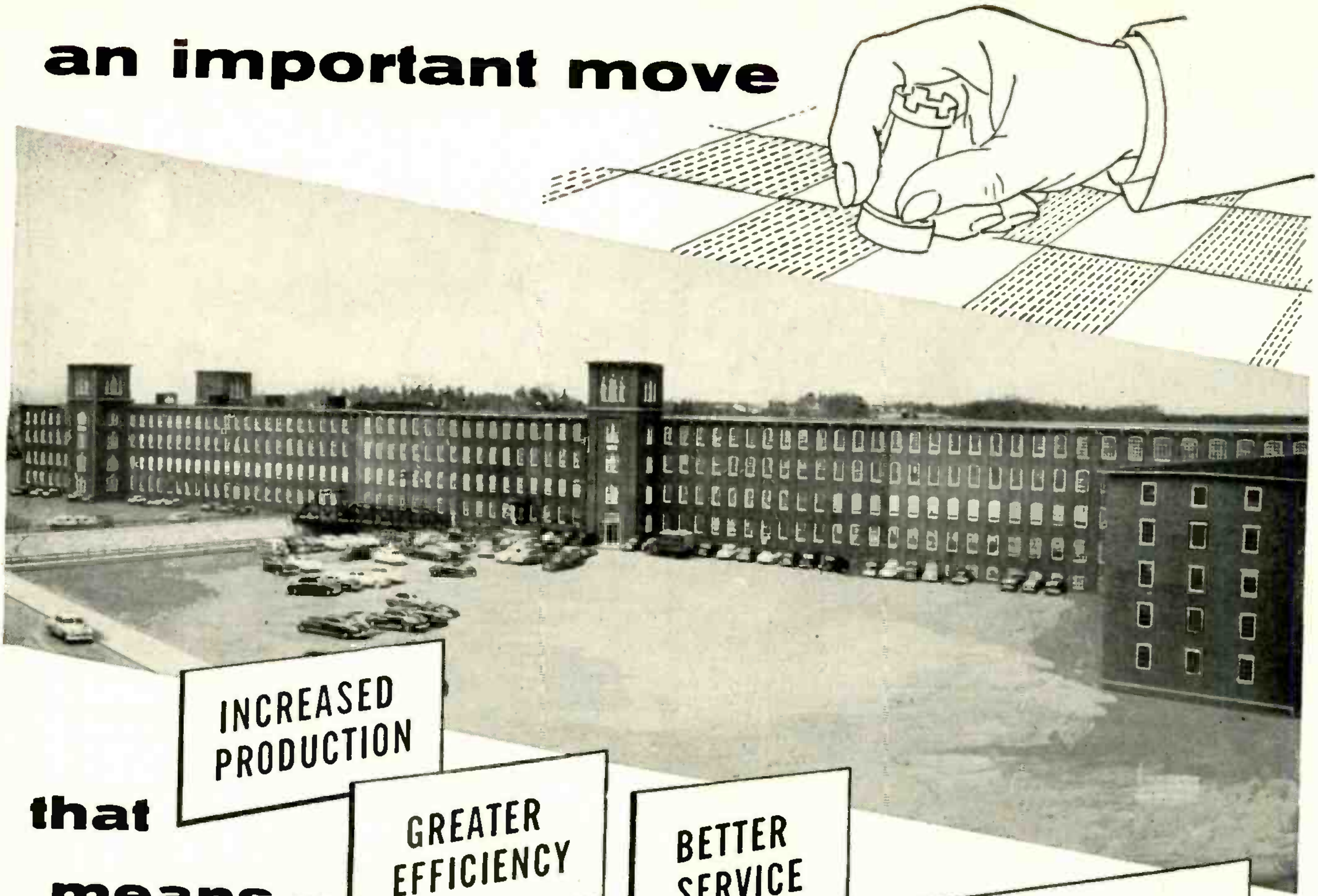


an important move



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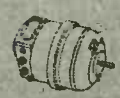

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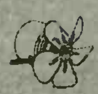

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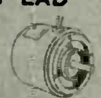

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Enclosed in Plastic Thermo-setting Impregnated Paper Tube.

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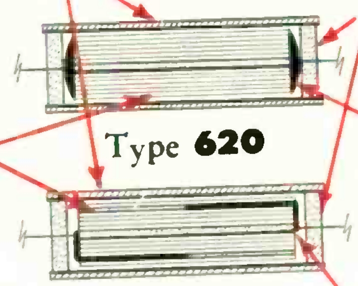
MYLAR Dielectric *Miracle X Impregnated.* Same excellent properties obtainable in our hermetically sealed Mifilm Capacitors.



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THE OLD WAY:

Collect 1. A variable transformer
2. A voltmeter
3. Connection leads and then connect

THE NEW WAY:

Get all at once in a

VOLTBOX A-C POWER SUPPLY

VOLTBOX TYPE UC1M
PRICE: $53.00

Here's your variable a-c voltage test gear all ready in a compact, cast-aluminum, portable unit that includes:

- **A POWERSTAT variable transformer**
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U-2400	240	50/60	0-280	9.0

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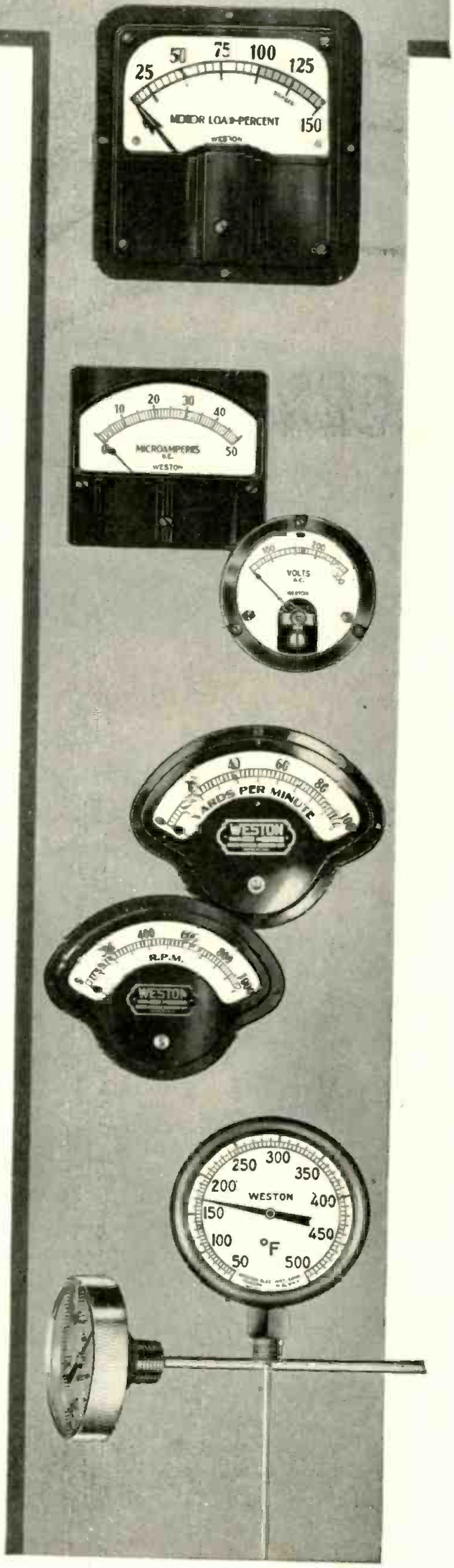
designer's INSTRUMENT guide



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.

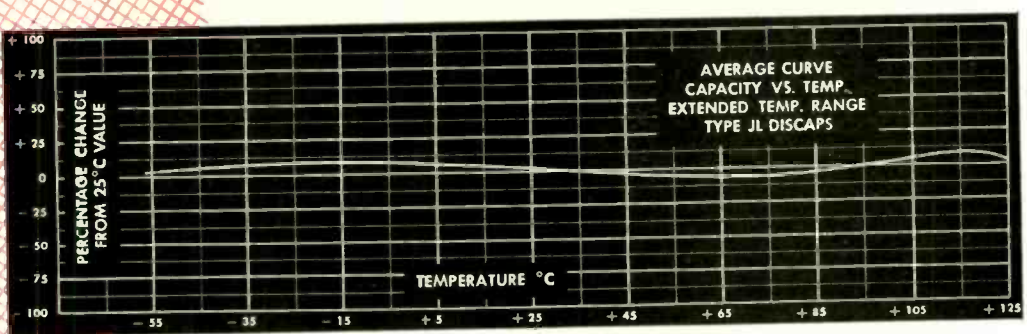
WESTON *Instruments*

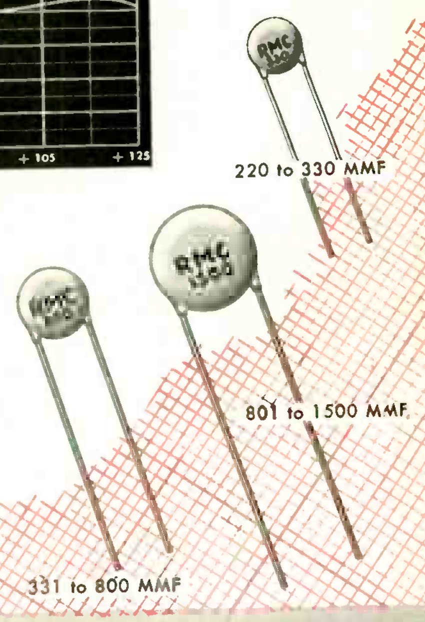
investigate the advantages of Type JL RMC DISCAPS®

More and more of the leading electronics, radio and TV manufacturers are specifying Type JL DISCAPS as the ideal cost saving replacement for paper or general purpose mica capacitors. In addition to a lower initial cost, Type JL DISCAPS feature smaller size and greater mechanical strength to effect additional economies in production assembly.

This series is manufactured in a wide range of capacities and offers exceptional stability over an extended temperature range. The maximum capacity change between −60° C and +125° C is only ±7.5% of capacity at 25° C. Type JL DISCAPS have a standard working voltage of 1000 V.D.C. and are available in tolerances of ±10% or ±20%.

Our engineers are prepared to work with you on problems requiring standard or special types of ceramic capacitors, write today.





POWER FACTOR: 1% max. @ 1 K C (initial)
POWER FACTOR: 2.5% max. @ 1 K C, after humidity
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ± 10% ± 20% at 25° C

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.
DISTRIBUTORS: *Contact* Jobbers Sales Co., P. O. Box 695, Fairlawn, N. J.

A New High in Rectifier Performance

New Vickers

combines . . . .

HIGH VOLTAGE

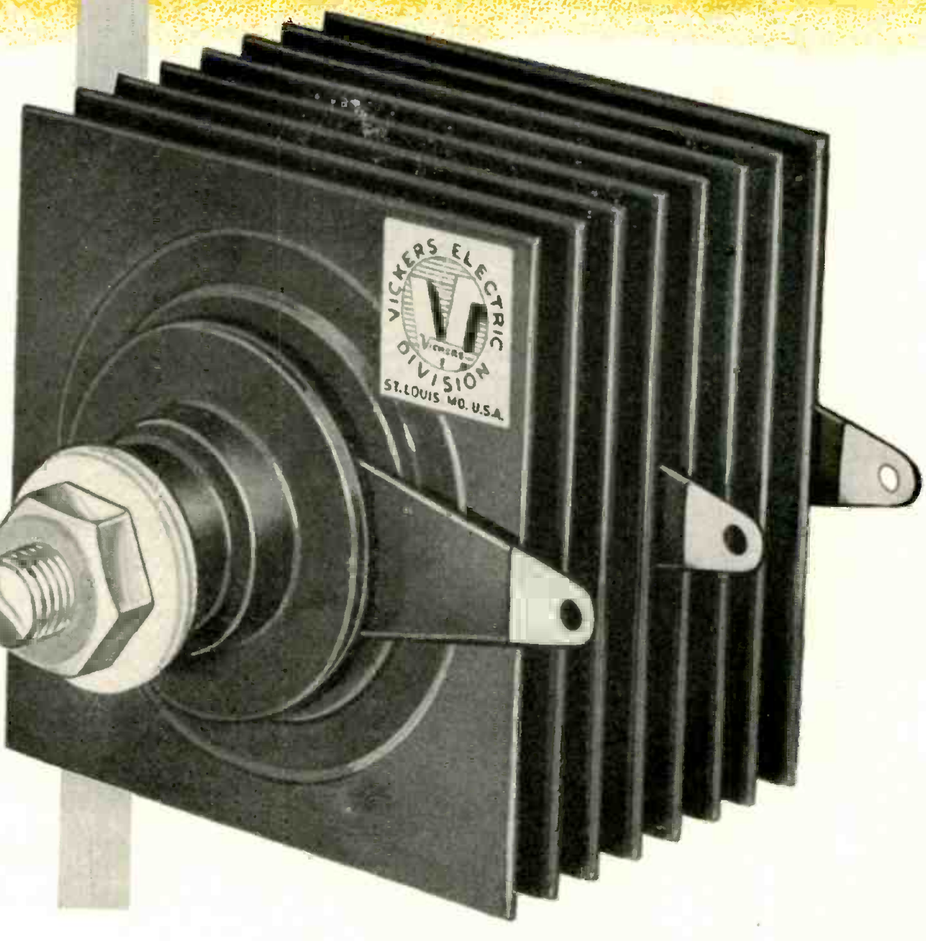
HIGH AMBIENT

LONG LIFE

gives you

more watts per dollar initial cost

. . . lower annual cost

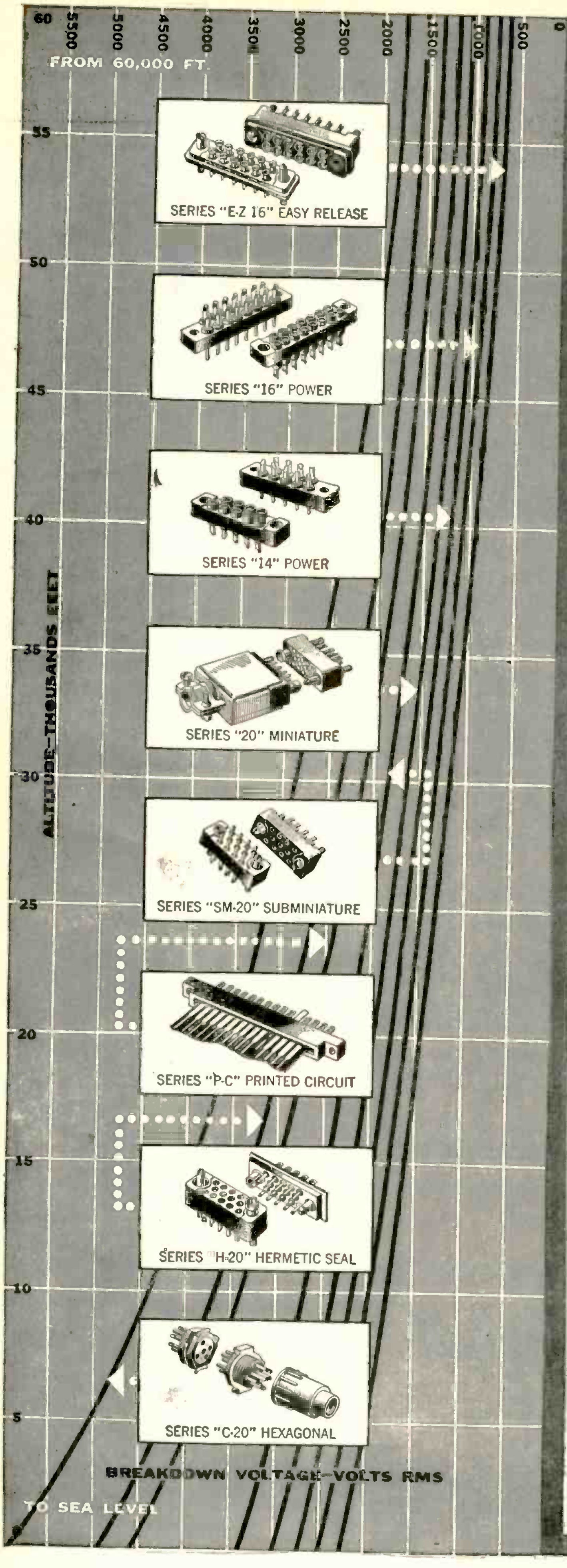


VICKERS ELECTRIC DIVISION

VICKERS Inc.

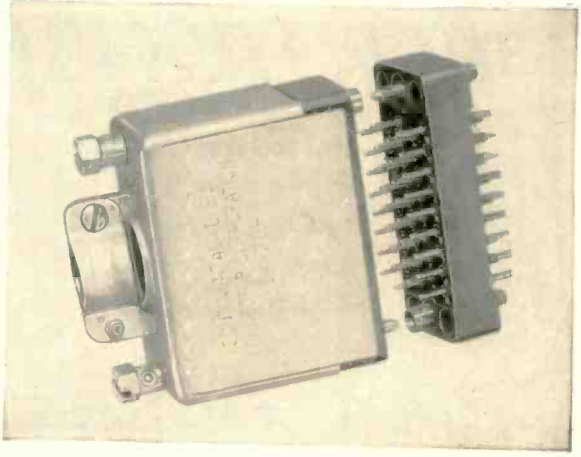
A UNIT OF THE SPERRY CORPORATION

1801 Locust St., St. Louis, Missouri



new... precision Continental Connectors*

simplify your connector problems



SERIES "20" MINIATURE with POLARIZING SCREWLOCK (PAT. PEND)

Polarizing screwlock guide pins and sockets provide this connector with positive means of locking plug and receptacle against vibration or accidental disconnection. Connector is easily opened without prying or forcing. Available in 14 different contact arrangements for 7 to 104 circuits, and in choice of Melamine, Plaskon-Alkyd and Diallyl Phthalate insulating materials. All models available with hood (as illustrated).

Note: New Series "14" power connectors also available with polarizing screwlock.

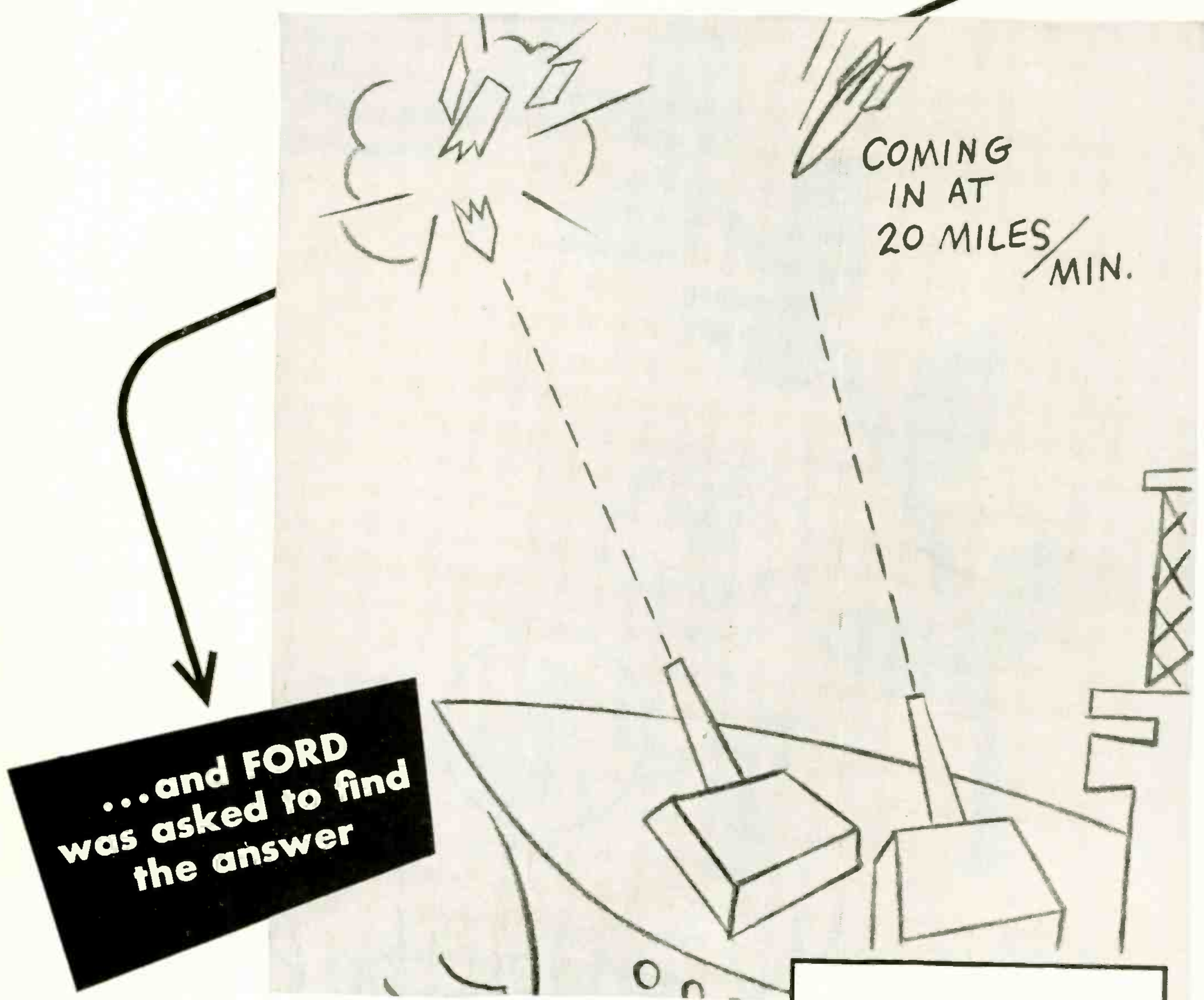
Write for illustrated engineering literature to Dept. E2P7, DeJUR-Amsco Corp., 45-01 Northern Blvd., L. I. City 1, N. Y.

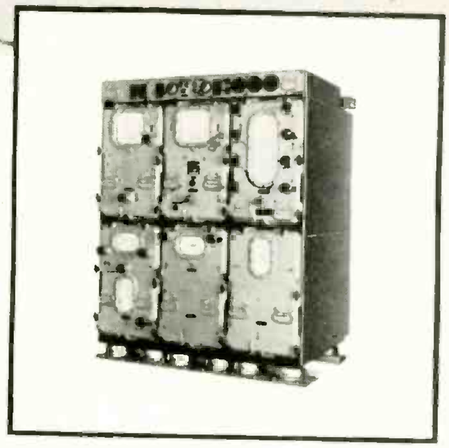
Electronic Sales Division **DeJUR**

45-01 Northern Blvd., Long Island City 1, N. Y.

*WORLD'S LARGEST MANUFACTURERS OF MINIATURE PRECISION CONNECTORS

HOW TO HIT A SUPERSONIC MISSILE ?
in flight





An enemy guided missile comes winging towards our task force . . . at speeds of up to 20 miles a minute. What kind of computer can predict and compute the necessary data fast enough to shoot down the missile . . . and be reliable every time? That was the problem posed to Ford Instrument Company engineers . . . and in cooperation with the Navy, they found the answer. Compact equipment, housed in easy-to-service units . . . that stand at the front line of our defense.

This is typical of the problems that Ford has been given by the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company come the mechanical, hydraulic, electromechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

22

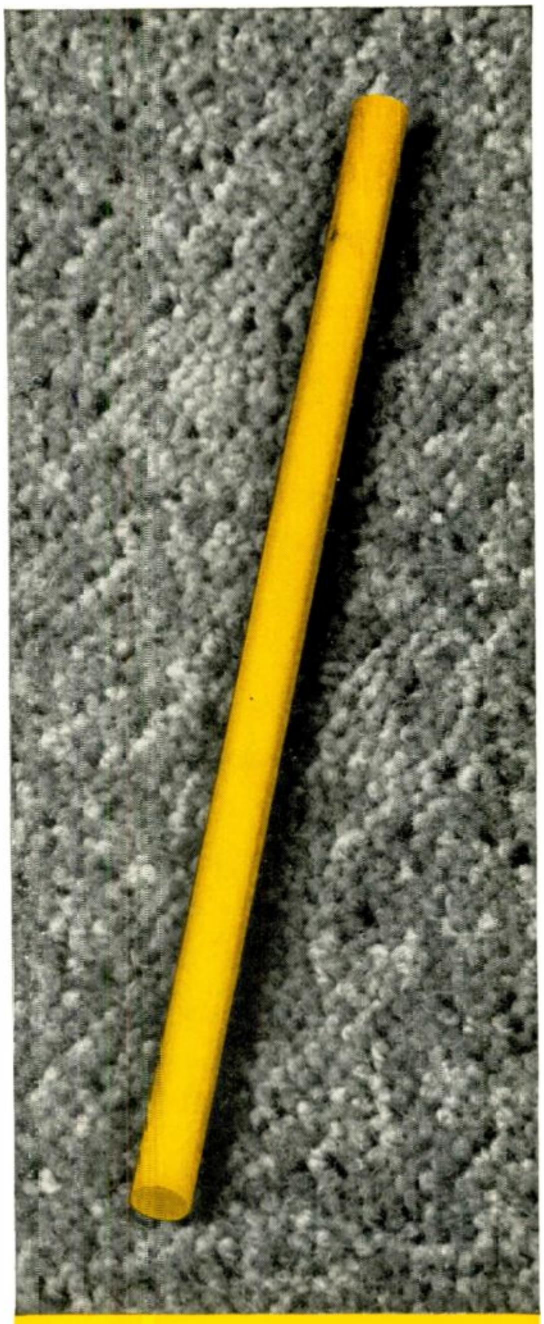
You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

FORD

FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION

31-10 Thomson Avenue, Long Island City 1, N. Y.



Colors available in production quantities include:

Natural . . . white . . . yellow (two shades) **. . . buff . . . orange . . . pastel red . . . red . . dark red . . . brown . . . green . . . blue . . . black.**

SPECIFICATIONS: GPG Rod

Flexural strength	65,000—85,000 psi.
Compressive strength (radial)	950—1,100 psi.
Arc resistance	120 sec.
Water absorption	0.10—0.20%
Resin content	50%
Specific gravity	1.60
Standard diameter	⅛" to ½"
Standard lengths	24" to 34"

Also available Chalk-Filled (GPG-C) and Flame-Retardant (GPF). Inquiries invited for larger diameters, longer lengths and special shapes.

Here's good news for your product . . .

TAYLOR POLYESTER GLASS RODS

An unusual material developed by Taylor—polyester glass rods in natural, white, black and ten attractive colors—offers unlimited possibilities in many of the products you manufacture. For the first time, you can have a glass-reinforced plastic that is uniformly colored all the way through. Drill it . . . cut it . . . grind it . . . you'll see no fibrous appearance of glass filaments.

Although this new material weighs only one-fifth as much, it possesses flexural and tensile strength equal to that of low carbon steel. It's non-corrosive, and resists deformation from bending. Picture how you can use its color for decoration, identification, or coding . . . its high strength-to-weight ratio for structural parts . . . its excellent electrical properties in shafts for electronic components.

Taylor specialists will be glad to talk over the ways you can put this material to work. They'll be glad to discuss, too, the improvements in production and product quality that you can realize through the use of Taylor Vulcanized Fibre and Taylor Melamine, Phenolic and Silicone Laminates.

TAYLOR FIBRE CO.
Norristown, Pa.—La Verne, Calif.

TAYLOR
Laminated Plastics
Vulcanized Fibre

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.

Sole producers of Nichrome, Advance, Karma

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

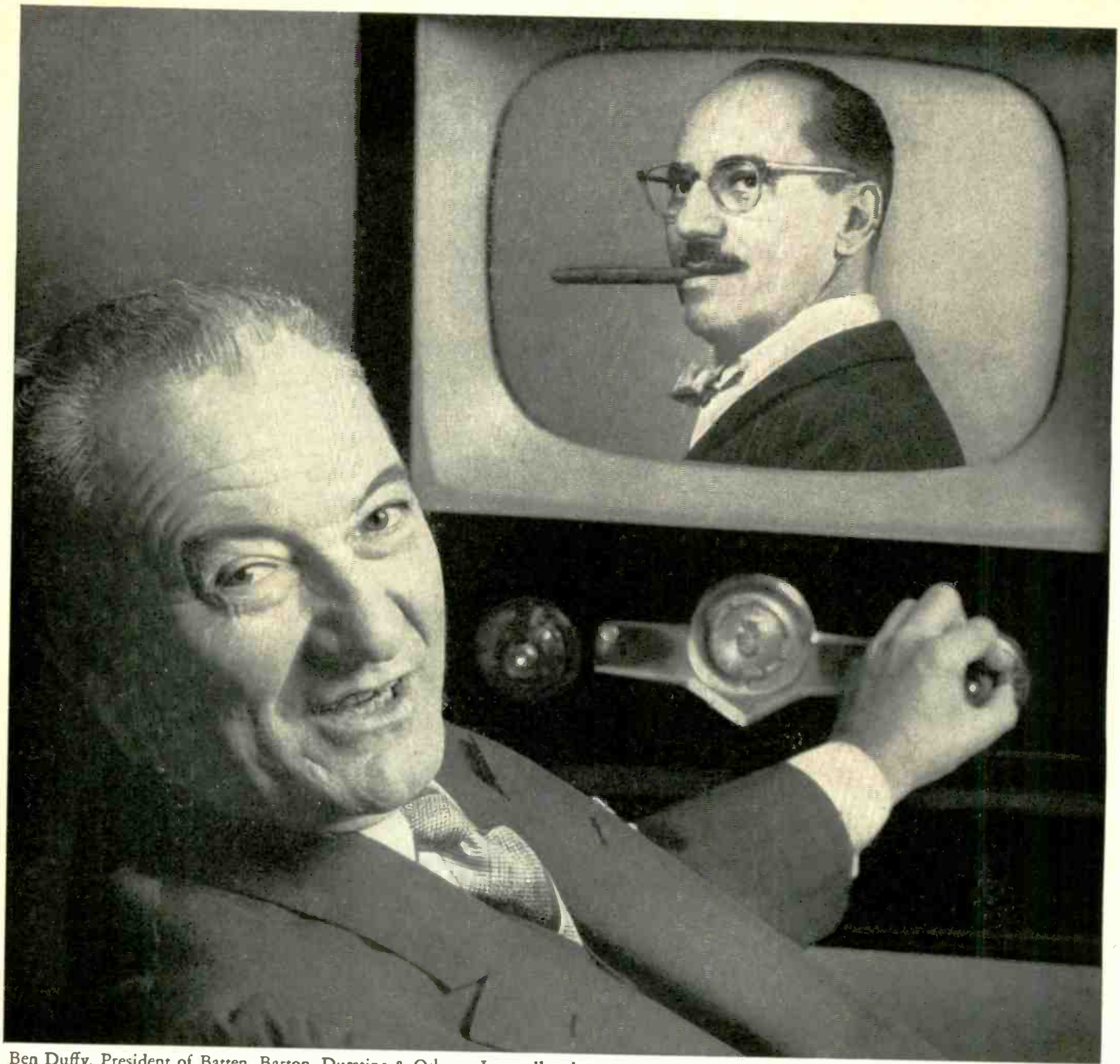
Driver-Harris Company

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



Ben Duffy, President of Batten, Barton, Durstine & Osborn, Inc., tells why:

"You don't have to wait for Groucho!"

"Snap on your TV set Thursday night—there's Groucho," Ben Duffy points out, "and he never fails to be there.

"You—and BBDO—can thank Air Express for that. It's Air Express that carries Groucho's films regularly.

"TV films are always due at a certain hour, often the whole way across the country. The same with printing plates. They may have to reach 100 different cities to make a specific edition of many publications.

"Air Express gets these essential materials there—every day in the year. It's the most reliable service we know.

"Frequently, we send duplicate shipments in case one should be marred or lost in handling—but this precaution has never once been necessary.

"Important, too, is the fact that almost all our shipments—more than 1,000 a year—cost us less with Air Express than with other air services."

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

Air Express

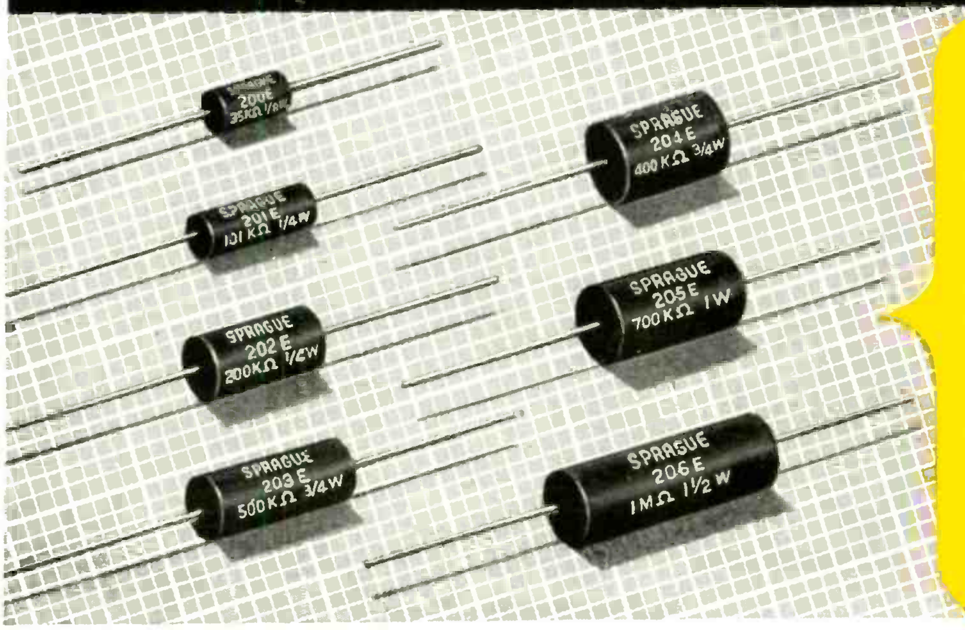
GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* RAILWAY EXPRESS AGENCY

PERMASEAL®

PRECISION RESISTORS

NOW! ENCAPSULATED AXIAL LEAD STYLES FOR 85°C, 125°C and 150° AMBIENTS



85°C PERMASEAL® RESISTORS

SPRAGUE TYPE	SIZE D	SIZE L	SIZE LEADS	RATED WATTS	MAX. OHMS
200E	1/4	1/2	No. 22 AWG	.20	140,000
201E	1/4	3/4	No. 22 AWG	.33	225,000
202E	3/8	3/4	No. 20 AWG	.50	500,000
203E	3/8	1	No. 20 AWG	.75	700,000
204E	1/2	3/4	No. 20 AWG	.75	1.2 MΩ
205E	1/2	1	No. 20 AWG	1.00	1.7 MΩ
206E	1/2	1 1/2	No. 20 AWG	1.50	2.8 MΩ

125°C PERMASEAL® RESISTORS

SPRAGUE TYPE	SIZE D	SIZE L	SIZE LEADS	RATED WATTS	MAX. OHMS
300E	1/4	1/2	No. 22 AWG	.10	140,000
301E	1/4	3/4	No. 22 AWG	.15	225,000
302E	3/8	3/4	No. 20 AWG	.25	500,000
303E	3/8	1	No. 20 AWG	.30	700,000
304E	1/2	3/4	No. 20 AWG	.30	1.2 MΩ
305E	1/2	1	No. 20 AWG	.40	1.7 MΩ
306E	1/2	1 1/2	No. 20 AWG	.60	2.8 MΩ

PERMASEAL accurate wire-wound resistors are ideal for point-to-point wiring, for terminal board mounting and for use on processed wiring chassis.

Encapsulated for protection against high humidity, these resistors will stand up in military and industrial electronic service. The protective housing also guards against physical damage during installation and during equipment maintenance.

Standard designs are available in seven different physical sizes for operation at full rated wattage at ambient temperatures of 85°C and 125°C. Special units can be made for operation at 150°C ambient with full rated wattage dissipation.

Unusual long-term stability of resistance is another plus feature of Sprague Permaseal Resistors—as the result of careful matching of winding forms, resistance wire and encapsulating material—together with a thoroughly controlled aging process during manufacture. Permaseal Resistors are available in resistance tolerances down to 0.1%, when necessary.

SPRAGUE

FOR COMPLETE DATA, WRITE FOR COPY OF SPRAGUE ENGINEERING BULLETIN NO. 122, WITHOUT DELAY.

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

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

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

Completely Self-contained Miniature

FREQUENCY STANDARD

WITH EXCEPTIONAL ACCURACY

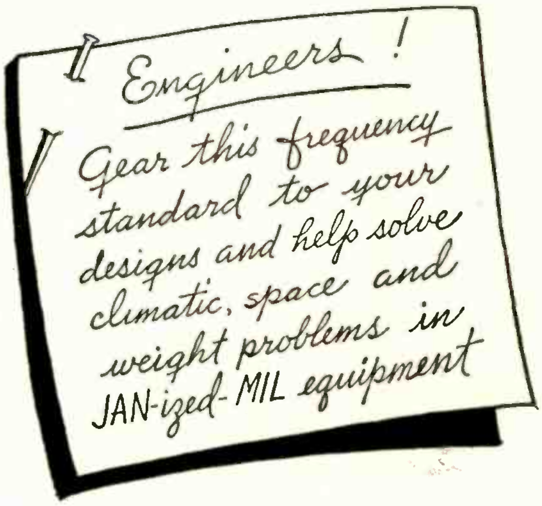
ACTUAL SIZE

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

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

WRITE FOR DESCRIPTIVE LITERATURE, SPECIFYING "TYPE 2007"

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

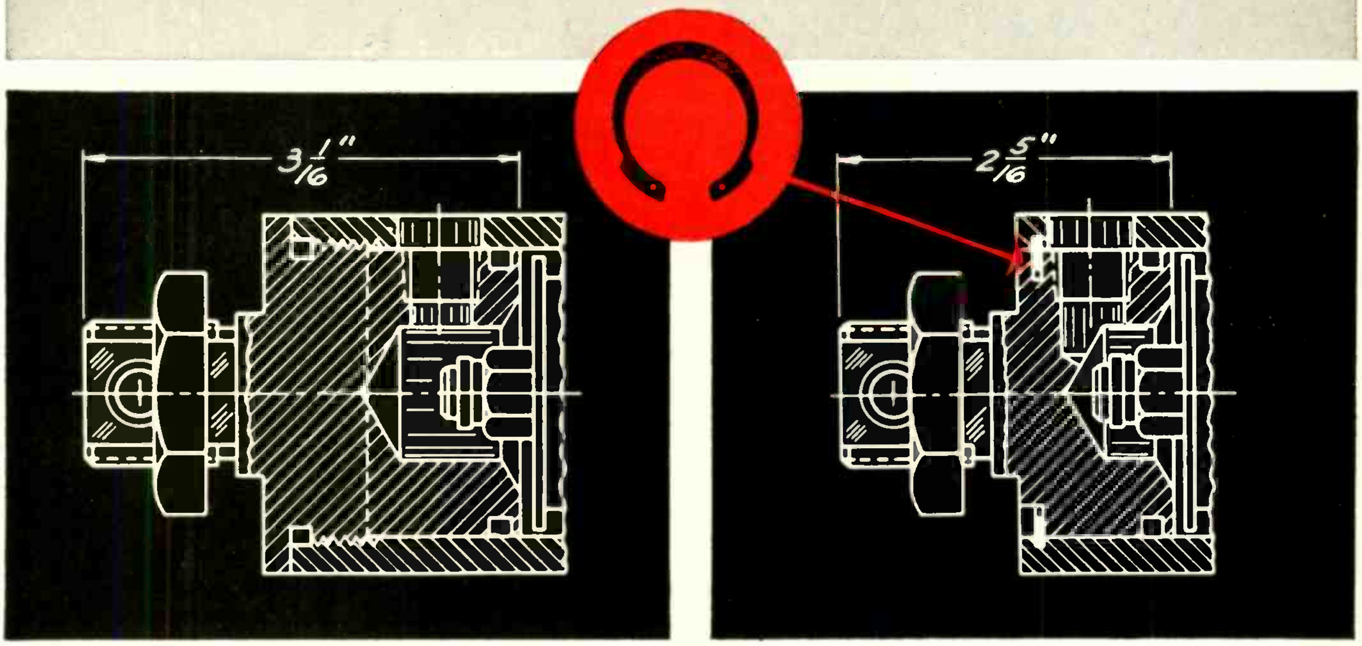


American Time Products, Inc.

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

MANUFACTURING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

Waldes Truarc Rings Cut Costs $3.26 per Unit, Reduce Size and Weight of Air Cylinder!



OLD STYLE air cylinder, with thread-secured head, required costly tapping, chasing and assembly operations. Also, satisfactory maintenance of packing unit necessitated use of pipe wrenches on painted surfaces.

NEW cylinder head is secured with precision-ground Waldes Truarc Rings. This produces perfect alignment of head within the housing, difficult to obtain with screw-thread seating. Maintenance is quick and easy.

WALDES TRUARC RINGS PERMITTED THESE SAVINGS

Production Time Cut	17 minutes
Weight Saved	1¾ lb.
Length Shortened	1½ inches
Cost Saved	$3.26 unit

■ The A. K. Allen Company of Brooklyn, New York, maker of *AllenAir* cylinders, now uses two Waldes Truarc Inverted Rings (series 5008) to secure heads rigidly within tubes.

■ TRUARC Rings, in this application, are ground parallel by A. K. Allen to .001 tolerance. In a static hydraulic bursting test, the 3" unit (recommended for 350 p.s.i.) withstands a pressure of 2000 p.s.i. And at bursting-point, the brass groove gives way; the Truarc Ring remains intact.

■ Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and to disassemble. 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 precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool

SEND FOR NEW CATALOG

WALDES TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

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

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,485,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081; AND OTHER PATENTS PENDING.

E076

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

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

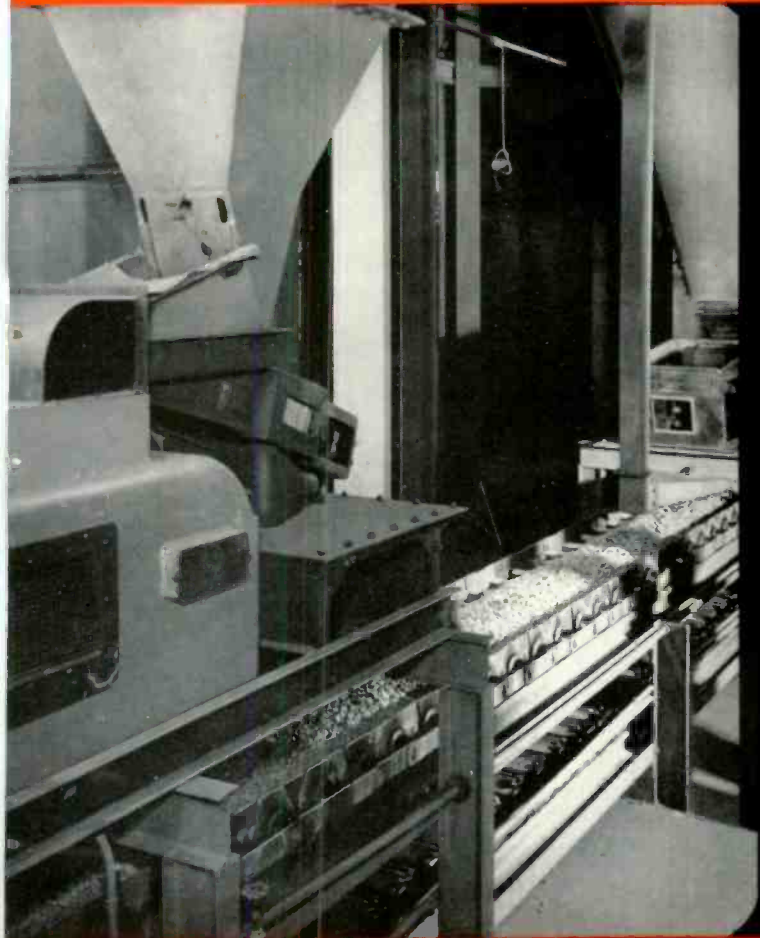
Name ....

Title ....

Company ....

Business Address ....

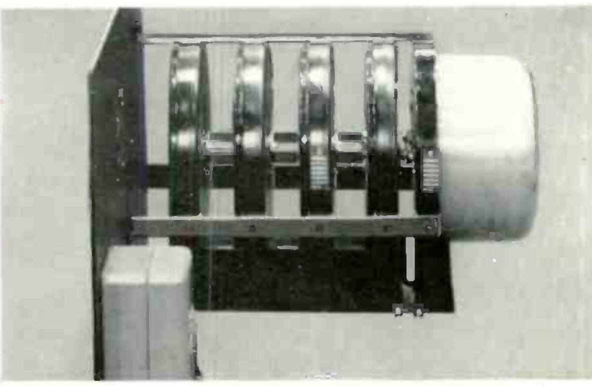
City .... *Zone* .... *State* ....



Guaranteed accurate to within 1%

WAYTROLS PROVIDE continuous proportioning of raw materials.

Whether weighing cornflakes or crushed stone, Ward Leonard rheostats help "Waytrol" feeder measure exact loads



FOUR-DECK, MOTOR-DRIVEN WARD LEONARD RHEOSTAT, shown here on control panel, controls speed of Waytrol delivery belt.

• Here's the machine that practically "spoon-feeds" modern industry. Hundreds of raw materials – from abrasives to zinc ore – are measured out and delivered from one stage of their industrial processing to another on Jeffrey-Traylor weighing, batching and proportioning systems.

Using the weight of the material itself to regulate the amount delivered, these Waytrol systems electronically feed even the most hard-to-handle solids so accurately that variations are held to well within one percent.

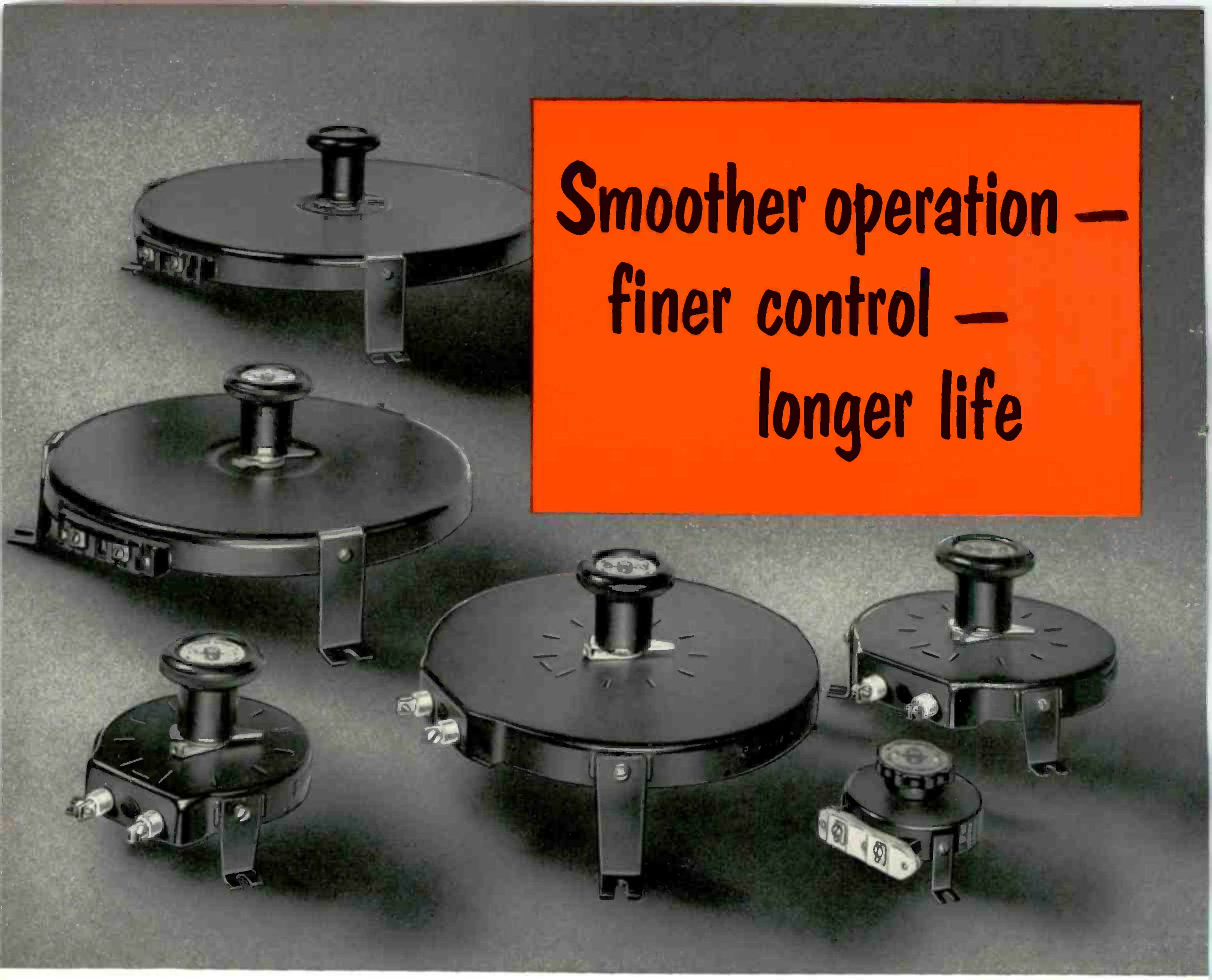
Contributing to this high precision are the Ward Leonard rheostats used to control the output of the vibrating feeder which delivers to the weighbelt. Precise rheostat performance is absolutely essential since "Waytrol" accuracy depends on uniform belt unloading by the feeder.

If accuracy is important in your product, it will pay you to select electrical controls from Ward Leonard's complete line. Write Ward Leonard Electric Co., 300 South St., Mount Vernon, N.Y.

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

Smoother operation — finer control — longer life



Here's what you get from the world's most complete rheostat line

• Ward Leonard's new Vitrohm pressed steel rheostats are part of the most complete line of power rheostats ever offered for industrial and commercial applications.

They're designed to provide smoother operation, lower operating torque, longer life and more steps of control. All rheostat materials, from vitreous enamel frit to heat-resistant finish, as well as all manufacturing processes, are carefully controlled by Ward Leonard engineers. After assembly, thorough electrical and mechanical tests guard against any constructional defects.

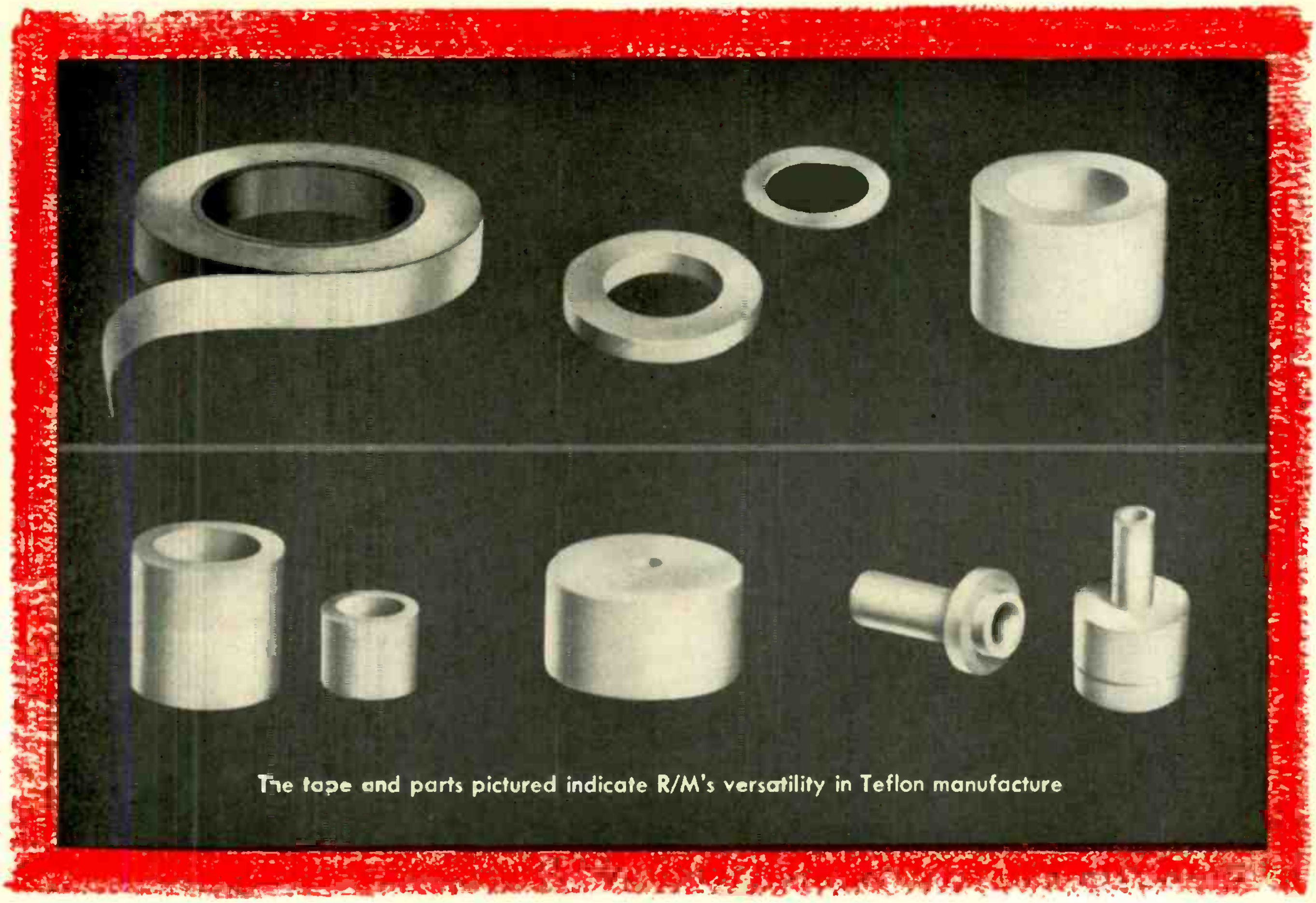
For a complete description of the entire line — with mountings, manual and motor drive accessories, a variety of enclosures and optional features — send for your free copy of Bulletin 60A. Ward Leonard Electric Company, 300 South Street, Mount Vernon, N.Y.

SPECIFICATIONS

Rheostat Size (in inches)	Sigma Watts (2 to 1 current taper)	Steps of Control per Plate — Type of Contacts: S	M	CC	LB
4	120	43	—	—	—
6	330	41	72	20	—
8	450	41	105	—	—
13	1000	67	161	—	—
15½	1500	—	—	71	99
18	2000	—	—	71	111
15x24	3200	—	—	49	—
FACE PLATE — Standard frame capacity 400 amps. max., 60 control steps					

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892



The tape and parts pictured indicate R/M's versatility in Teflon manufacture

R/M Teflon*

gives you the plus of R/M's unmatched skill, experience, facilities

**Du Pont's trade-mark for its tetrafluoroethylene resin*

Teflon is probably the most important development of the Age of Plastics — its possibilities look endless. Parts made from it are accomplishing things long considered impossible by engineers in the electronics and electrical manufacturing fields.

If you have a problem to be solved, the chances are that R/M, with its unmatched skill, experience and facilities, can solve it. We approach every challenge with the view that nothing is impossible until proved otherwise.

You can rely on R/M for three things: dependable source for Teflon rods, tubes, sheets or tape; fabrication of Teflon parts to your specifications; collaboration in the search for new uses to which this remarkable product can be put.

Teflon Properties: High resistance to acids and gases even at high temperatures • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500°F. in continuous operation • As tape, leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily Tensile strength 1500-2500 psi

RAYBESTOS-MANHATTAN, INC.

ASBESTOS TEXTILE DIVISION • MANHEIM, PA.

FACTORIES: Manheim, Pa. • No. Charleston, S. C. • Passaic, N. J. • Neenah, Wis. • Crawfordsville, Ind. • Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Manufacturers of Asbestos Textiles • Teflon Products • Packings • Brake Linings • Brake Blocks Clutch Facings • Fan Belts • Radiator Hose • Rubber Covered Equipment • Mechanical Rubber Products • Abrasive and Diamond Wheels Sintered Metal Products • Bowling Balls

The New Servoscope® puts another engineer on your staff

...but not on your payroll

The New Servoscope Saves Man-Hours

Are you engineering any type of feedback control system—regulators, governors, process controls, positioning or speed servos? With a Servoscope an extra engineer will be working for you on design synthesis, analysis or production test.

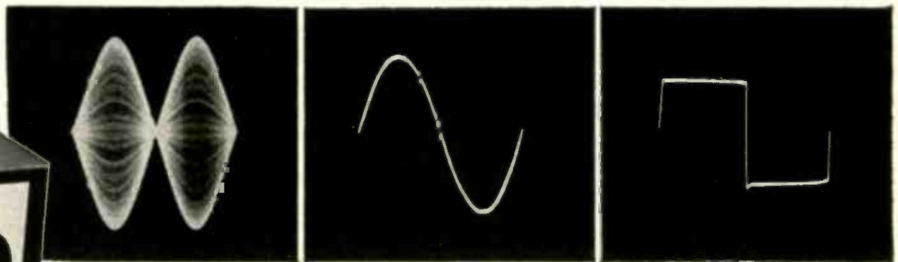
Discovers Mistakes Before You Make Them

Breadboard your intended servo system or other circuit designs—then, by either the frequency response or the transient response method, magnitude and phase curves can be obtained directly within minutes.

The Servoscope is available in two standard models - 1100A (0.1 to 20 cps.), 1100B (.15 to 30 cps.). Custom modifications for higher frequencies and units with built-in oscilloscopes quoted on request.

For detailed information on how this versatile test instrument can save manpower, materials and money, write Dept. E-7

Output wave forms of Servoscope displayed against internal linear sweep generator, frequency ½ cps.



SERVO CORPORATION OF AMERICA

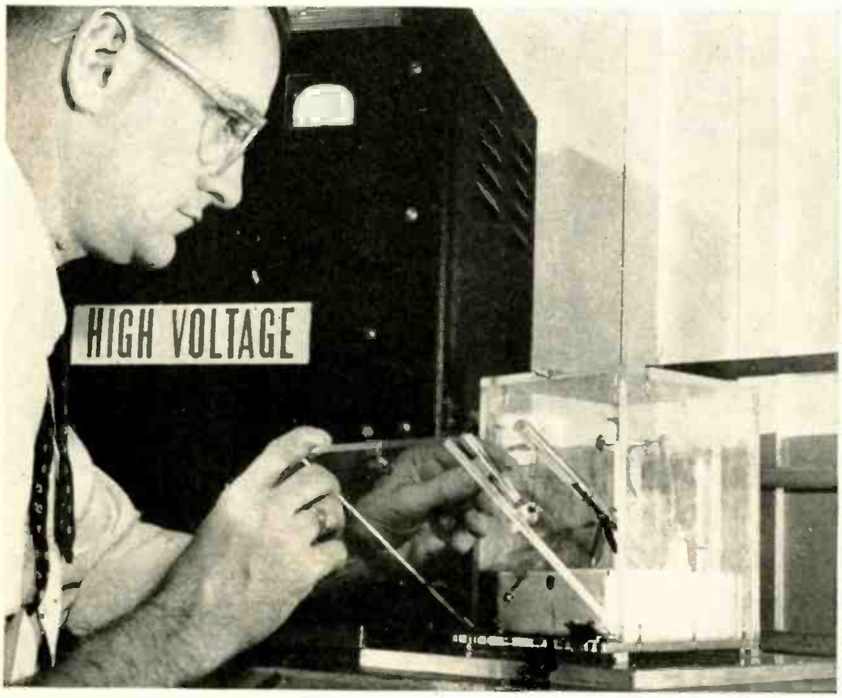
New Hyde Park, New York

SC 115

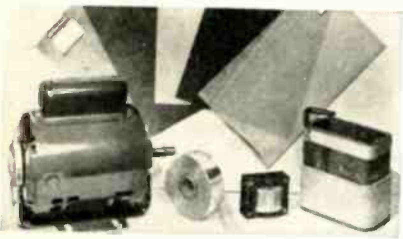
New Du Pont MYLAR offers this unique balance of properties:

REG. U. S. PAT. OFF.

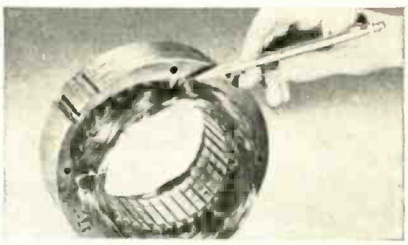
- High dielectric strength
- Exceptional thinness
- High tensile strength
- Thermal stability
- Chemical inertness



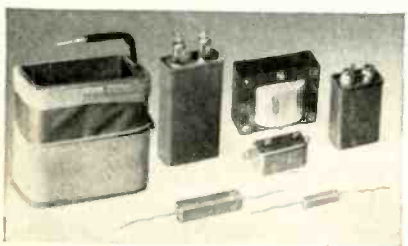
Capacitor testing in this jig confirms the high dielectric strength of "Mylar" . . . over 4000 volts per mil.



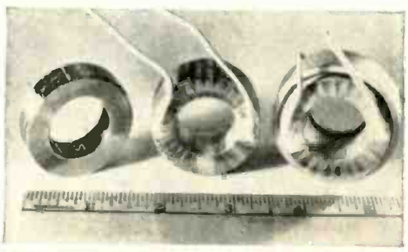
Exceptional tensile strength of "Mylar," 23,500 lbs. per sq. in., permits manufacture of rugged electrical components.



"Mylar" film that is used to insulate this stator is about half as thick as the material it replaces.



Size reduction of capacitors, transformers and other electrical equipment is made possible by the use of "Mylar."



High dielectric strength, combined with toughness, makes "Mylar" adaptable to a variety of coil insulating uses.

NEW possibilities in the design of electrical equipment are opened by a new product of Du Pont research—"Mylar" polyester film. The unusual balance of electrical, mechanical and chemical properties offered by this film makes it suitable for a wide variety of insulating applications.

"Mylar" exhibits excellent dielectric strength, high volume and surface resistivity. Its tensile strength, one third that of machine steel, permits its manufacture in gauges ranging from ¼ of a mil (0.00025 inch) to 7½ mils (0.0075 inch). "Mylar" retains its remarkable properties over a wide temperature range, remaining flexible and stable from -60° to 150°C.

"Mylar" is moisture- and solvent-insensitive . . . unaffected by most organic and inorganic vapors. Its use under a variety of climatic conditions is possible because "Mylar" is completely fungus and mildew-proof.

A new booklet is now available to show where this versatile film's properties can be used to advantage. If you would like a copy to help you evaluate the possibilities of "Mylar" for improving your products, write to: E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room 2E, Wilmington 98, Del.

DU PONT MYLAR®

Polyester Film

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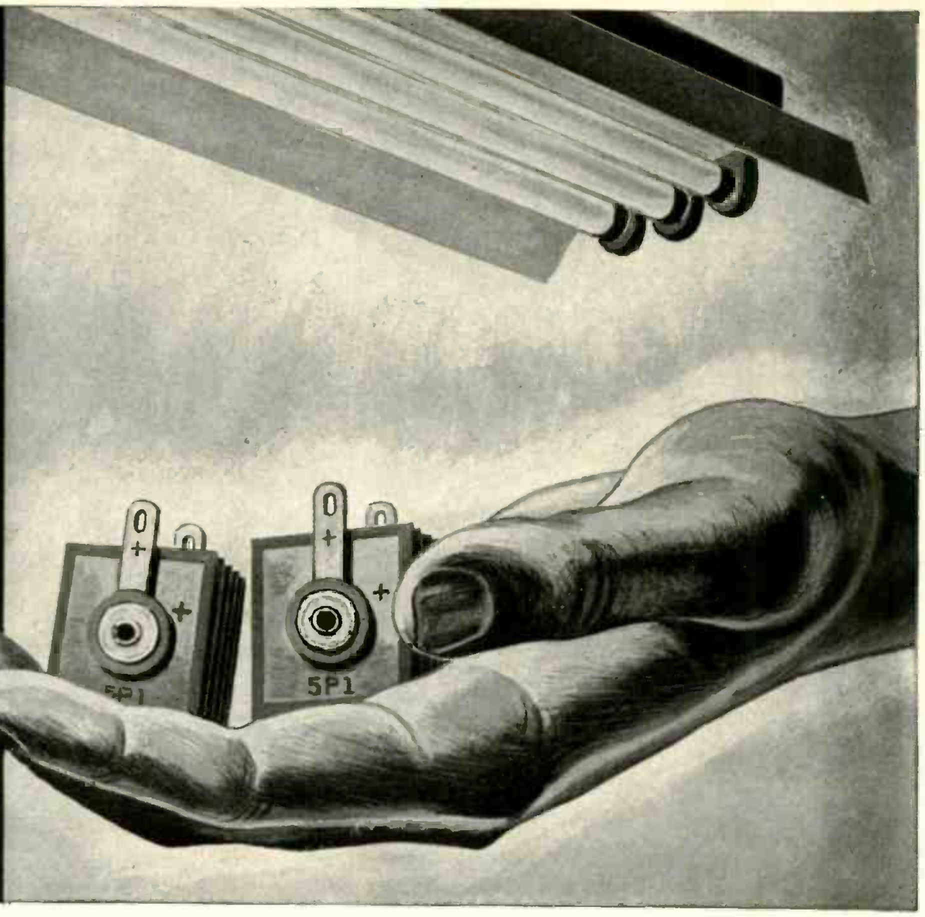
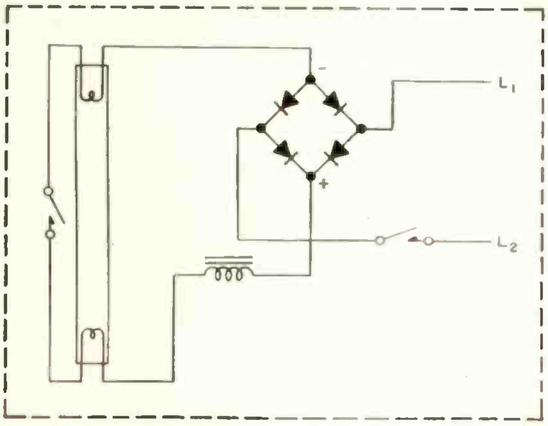
. . . *THROUGH CHEMISTRY*

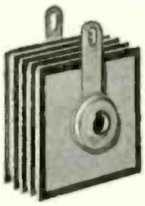
Remarkable life results reported in unique application



SELENIUM RECTIFIERS



Circuit for eliminating fluorescent flicker in 25 cycle and universal operation, as used in "Noflik" lights.



PLACED IN BRILLIANT LIGHT BY SPECIAL FLUORESCENT FIXTURES

WOULDN'T YOU be "*light*hearted" if you received a comment like this? *We* were when Canadian Fluorescent Co.'s president wrote: "During the six years that thousands of "Noflik" lights equipped with your rectifiers have been in use — in many cases under continuous operation — we have found Radio Receptor units to be remarkably long-lived and entirely satisfactory."

Canadian Fluorescent, which has licked the flicker in 25 cycle fluorescent lighting with its "Noflik" fixtures, uses four half wave radio type RRCO. selenium rectifiers and a specially designed ballast.

Radio Receptor rectifiers as well as RRCO. germanium transistors and diodes are "*Really Reliable.*" Find out for yourself. If you have a problem where these fine components could be used, make sure to ask us for engineering data. We'll gladly supply it without obligation . . . And request our comprehensive new 24 page rectifier bulletin No. 177-E.

Seletron & Germanium Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

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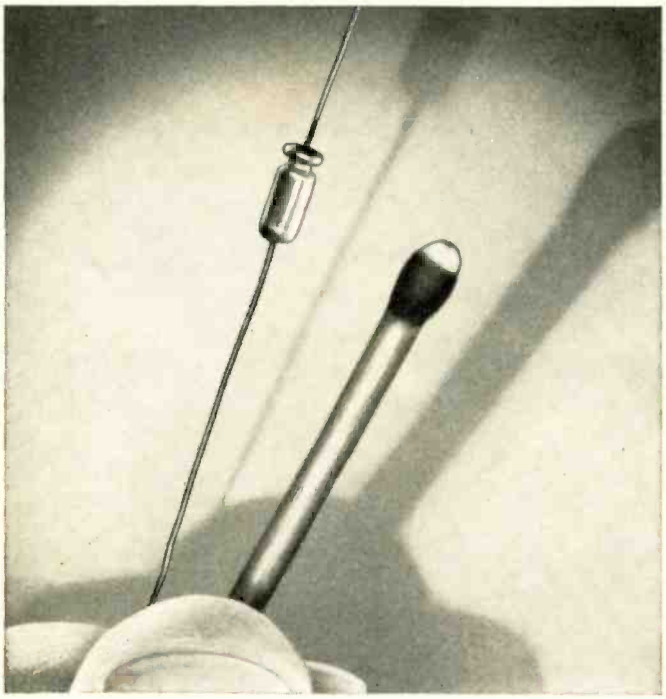
TELEPHONE: WATKINS 4-3633 • FACTORIES IN BROOKLYN, N.Y.

Really Reliable!

DESIGNER'S

Micro-miniature Tantalytic capacitors give new design flexibility

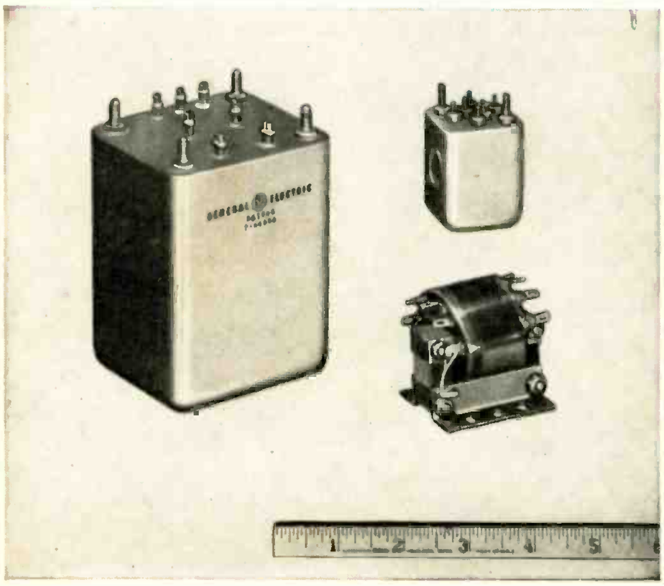


Smallest electrolytic capacitors commercially available

Micro-miniature Tantalytic capacitors can now be supplied in ratings up to 20 volts, or, up to 8 microfarads in the $\frac{5}{16}$" long case—higher capacitance in a $\frac{1}{2}$" case size . . . with -0% to $+100\%$ capacitance tolerance. They give you new design flexibility in low-voltage, d-c circuits—particularly transistorized subminiature assemblies where space is at a premium.

Designed especially for nonresonant, noncritical applications such as coupling, by-pass and filtering, G-E micro-miniature Tantalytic capacitors outperform aluminum electrolytics in electrical stability, operating and shelf life because of the inert characteristics of tantalum metal. They operate over a -20C to $+50$C range and may be stored at -65C. With some capacitance derating, Tantalytic capacitors perform well below -20C—with some life limitations they will also perform satisfactorily above $+50$C.

You may obtain samples 2 to 3 weeks after your order is received at the factory. Production lots are supplied 6 to 8 weeks after the order is received. For more information see your G-E Apparatus Sales representative, or write for Bulletin GEA-6065.



G.E. builds dependability into electronic transformers—3 ways

From laboratory samples to the last production model, dependability is built into G-E electronic transformers. Here's how:

1. INTEGRATED FACILITIES: G-E labs, testing facilities, and materials sources are co-ordinated to help get you the transformers you want—when you want them.

2. MECHANIZATION: The G-E plant is mechanized and staffed to handle large-quantity production, while maintaining laboratory sample quality.

3. EXPERIENCE: G-E personnel have worked hand-in-hand with electronics manufacturers for years and consequently keep *your* problems in mind as they produce transformers for your particular, specialized applications. See your G-E Apparatus Sales representative for more information.

GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

New electronic relays have high sensitivity

This new electronic resistance-sensitive relay is able to amplify minute currents carried by very delicate contacts. Even a wet thread will provide enough signal for it to operate.

Sensitivity level is set by adjusting dial, which can be locked in place. The relay may be remotely controlled from as far away as 500 feet. Each can be set for either "normal" (relay "drops-out") or "reverse" (relay "picks-up") operation of the magnetic relay included in the device.

Built for long life, its enclosure is weather-resistant and dust-tight. Terminals are easily accessible; all components of this G-E relay are open for ease in servicing. For further information send for Bulletin GEA-5893.

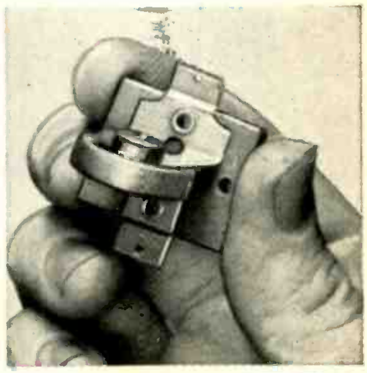
Fast, accurate circuit analysis

This self-contained, highly stable G-E self-balancing potentiometer rapidly converts small d-c voltages to measureable currents—*without* loading the measured circuit—for analysis of electronic circuits. It is consistently accurate because simple controls, and automatic, rapid circuit balance minimize operator errors. Easily changed resistor permits selection of input ranges from 100 microvolts to one volt d-c full scale with 5-milliampere d-c output. See Bulletin GEC-367.

Tiny signals amplified

Combining amplifying and rectifying elements in a unit, G-E amplistats (self-saturating magnetic amplifiers) "sense" small signal changes, amplify them greatly, and impart the amplified signal to a system to obtain the desired control. They give you the practical advantages of virtually instantaneous response, low power consumption, long life, and electrical signal isolation. Obtain assistance in applying G-E amplistats at your G-E Apparatus Sales Office. See Bulletin GEA-5950.

Small rectifier has high output



G-E germanium rectifiers offer the highest output in the smallest of rectifiers. For example, the dime-sized, sealed, air-cooled type is available in ratings up to 50 volts, 0.4 amperes d-c. Germanium rectifiers have these advantages: *high efficiency*—operate 98% to 99% efficient; *compactness*—small size and weight per watt output means you can build more compact assemblies; and *long life*—two-year life tests show no detectable aging. Write for Bulletin GEA-5773.

EQUIPMENT FOR ELECTRONIC MANUFACTURERS

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Meters, instruments
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Insulation testers
Vacuum-tube voltmeter
Photoelectric recorders
Demagnetizers

General Electric Company, Apparatus Sales Division
Section D667-28, Schenectady 5, New York

Please send me the following bulletins:
✓ for reference only X for planning on immediate project

☐ GEA-5773 Germanium Rectifiers
☐ GEA-5893 Electronic Resistance Sensitive Relay
☐ GEA-5950 Amplistats
☐ GEA-6065 Micro-miniature Tantalytic Capacitors
☐ GEC-367 Self-balancing Potentiometer

Name ....

Company ....

City .... State ....

KEPCO
VOLTAGE REGULATED POWER SUPPLIES

MODEL 750

MODEL	VOLTS	CURRENT	REGULATION	RIPPLE
750	0-600	0-750 Ma.	0.5%	10 Mv.
760	0-600	0-1.5 Amp.	0.5%	10 Mv.
770	0-600	0-2.25 Amp.	0.5%	10 Mv.
780	0-600	0-3 Amp.	0.5%	10 Mv.

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

DC POWER SUPPLY SPECIFICATIONS

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

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

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

†All AC Voltages are unregulated.

WORKMANSHIP

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

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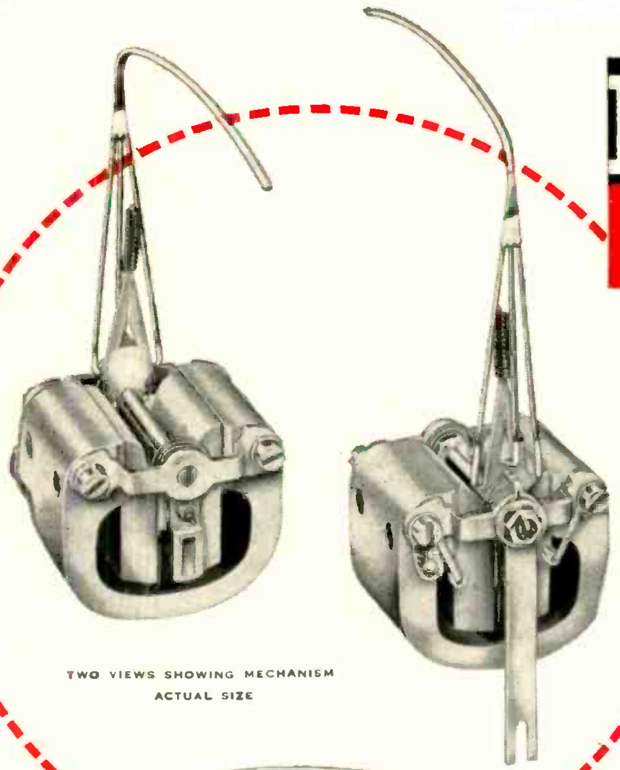
FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. No. 789



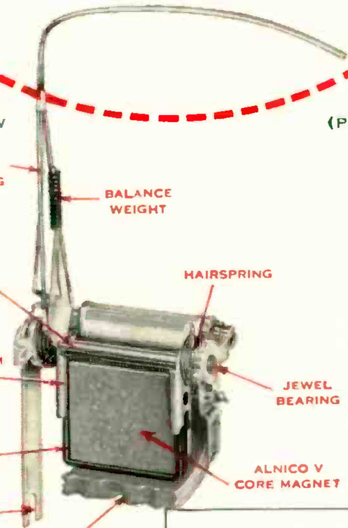
TWO VIEWS SHOWING MECHANISM
ACTUAL SIZE

marion

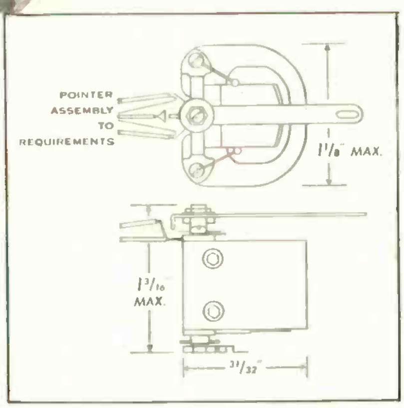
advancement in instrument design

POWERFUL MOVING COIL MECHANISM HAS GYRO-LIKE STABILITY

CUT-AWAY VIEW



(PATENTS PENDING)



The Marion Type MEP-1 meter mechanism was designed to develop highest possible torque for a given volume of magnetic material. Its high torque, heavy eddy current damping and low relative inertia provide unusual performance characteristics simulating the stability of a gyro, in like environment. Already it is setting new and higher standards for reliability in moving coil indicating mechanism design for aircraft application, where the influence of vibration and rapid attitude changes on pointer indication are significant factors.

The gyro-like stability of the MEP-1 mechanism results from its unique mechanical design. An end-pivoted coil assembly, with a one piece bearing shaft and precise mechanical assembly operates in a self-shielded magnet structure which produces approximately 6000 Gauss in a single air gap. When the end-pivoted moving coil, of long turning radius, operates in a magnetic field of such strength, substantial gains in torque and eddy current damping are realized. This great torque, combined with relatively light weight, permits unit bearing loadings substantially lower (i. e. larger pivot and jewel radii) than heretofore normal.

MECHANISMS BY MARION

Although developed expressly for application in aircraft navigational instruments, many of the MEP-1 characteristics make it desirable for use as the sensitive element in control devices where it is required to initiate a control function. It is one of a number of Mechanisms by Marion that extend the field of moving coil mechanism application where previously size, weight or performance characteristics prevented their use.

Marion Electrical Instrument Company,
401 Canal Street, Manchester, N. H.

marion meters

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MICROWAVE Associates INCORPORATED

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ATR, TR, MAGNETRON TUBES AND SILICON DIODES WAVEGUIDE COMPONENTS AND TEST EQUIPMENT

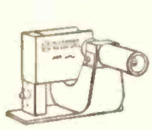
This is a partial listing.
Send for complete catalog literature.

SILICON DIODES

	CENTER FREQUENCY (mc)	MAX CONVER LOSS (db)	MAX NOISE RATIO (times)	VSWR (max)	IF IMPEDANCE (OHMS)
•IN21B	3060	6.5	2.0	-	200–800
•IN21C	3060	5.5	1.5	-	200–800
•IN150	6750	6.0	2.0	1.5	250–500
•IN160	6750	6.5	2.7	-	200–800
•IN23B	9375	6.5	2.7	-	200–800
•IN23C	9375	6.0	2.0	1.5	325–475
•IN149	9375	5.5	1.5	1.5	325–475
IN78	16000	7.5	2.5	-	325–625
IN26	23984	8.5	2.5	-	300–600
IN53	>30000	8.5	2.5	-	400–800
IN32	3295	Fig. Merit >85		Video Impedance 4K–22K	

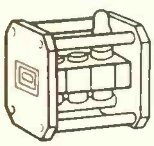
• Also available with reversed polarity

MAGNETRONS



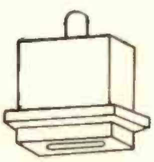
TUBE TYPE	FREQUENCY Mc	NOMINAL PEAK OUTPUT KW	PEAK VOLTAGE ANODE KV	VOLTAGE RATE OF RISE KV/μs	AV. ANODE CURRENT MA	PEAK ANODE CURRENT A	PULSE DURATION μs	DUTY CYCLE	PULLING FACTOR (max) Mc	INITIAL HEATER VOLTAGE V	INITIAL HEATER CURRENT A
5789	34512-35208	40	10.0-13.0	110-120	5.0	20.0	0.25	.00025	40	6.0	2.0-2.4
	34512-35208	30	10.0-13.0	110-120	6.5	15.0	0.5	.0004	40	6.0	2.0-2.4
	34512-35208	20	10.0-13.0	110-120	6.0	10.0	1.0	.0006	40	6.0	2.0-2.4
2J42	9345-9405	8	5.3-5.7	60	9.0	4.5	1.0	.002	15	6.3	0.43-0.60
	9345-9405	8	5.3-5.7	60	4.0	4.5	2.2	.0009	15	6.3	0.43-0.60
	9345-9405	8	5.3-5.7	60	2.9	4.5	0.8	.00065	15	6.3	0.43-0.60
6027 (2J42A)	9345-9405	20	6.4-7.4	60	7.5	7.5	1.0	.001	15	6.3	0.43-0.53
	9345-9405	10	6.0-7.0	60	7.0	3.5	1.0	.002	15	6.3	0.43-0.53
4J52	9345-9405	80	14.0-16.0	100	15.0	15.0	1.0	.001	15	12.6	1.8-2.4
	9345-9405	80	14.0-16.0	100	15.0	15.0	5.0	.001	15	12.6	1.8-2.4
6444 (ESM-48)	9800-10000	0.001 CW	0.45-0.50	—	15.0	.015	CW	1.0	15	6.0	0.4-0.5

TR TUBES



TUBE TYPE	FREQUENCY RANGE Mc	LOW LEVEL UNFIRED RATINGS VSWR max	INSERTION LOSS db	IGNITOR INTER-ACTION db	IGNITOR DROP 100μA – V	HIGH LEVEL FIRED RATINGS PEAK POWER KW	FLAT LEAKAGE MW	SPIKE LEAKAGE ergs	RECOVERY TIME μs @ –3db	ARC LOSS db	VSWR max
1B63A	8490-9578	1.9	.3-.7	0-.2	200-375	4-200	10-40	.05-.2	1-10	.8-.1	—
6334	8490-9578	1.4	—	0-.2	200-375	4-200	0-20	0-.1	1-10	.8-.2	1.2
5863	8490-9578	1.9	.3-.7	0-.3	250-400	4-1000	5-30	.05-.15	1-8	.8-.1	—
6164	8490-9560	2.0	.3-.7	0-.3	250-400	4-1000	5-30	.05-.15	1-8	.8-.1	—
1B58	2659-2969	1.65	.3-.5	0-.3.	250-400	10-750	10-40	.05-.3	3-15	.7-.1	1.15
5927	3070-3530	1.9	.3-.7	0-.3	275-425	10-750	10-50	.05-.3	3-15	.7-.1	1.15

ATR TUBES



TUBE TYPE	FREQUENCY RANGE Mc (VSWR 10:1)	LOW LEVEL UNFIRED RATINGS MIN. ISOLATION db	LOADED Q max	TUNING SUSCEP-TANCE	EQUIVALENT CONDUCT-ANCE max	HIGH LEVEL FIRED RATINGS PEAK POWER KW	RECOVERY TIME μs	ARC LOSS db	VSWR max	MECHANICAL MOUNT
1B35A	9000-9600	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Choke Socket
6163 †	8800-9300	12	6.5	±.06	0.06	4-250	2-20	.8-.1	1.1	Choke Socket
1B37A	8500-9000	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Choke Socket
5864	9000-9600	12	8.0	±.06	0.1	4-500	2-20	.8-.1	1.1	Choke Socket
6276	9000-9600	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Woven Braid Gasket
6284	8500-9000	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Woven Braid Gasket
6393	9000-9600	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Molded Rubber-Metal Gasket
6369	8500-9000	12	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Molded Rubber-Metal Gasket
6396 †	8700-9700	10	6.5	±.06	0.1	4-250	2-20	.8-.1	1.1	Molded Rubber-Metal Gasket
1B56	2750-2950	10	5.5	±.05	0.05	20-1000	2-25	.8-.1	1.15	Woven Braid Gasket
6024	2700-2900	10	5.5	±.05	0.05	20-750	2-20	.8-.1	1.15	Woven Braid Gasket
5921	3100-3300	10	5.5	±.05	0.05	20-1000	2-25	.8-.1	1.15	Woven Braid Gasket
5922	3300-3500	10	5.5	±.05	0.05	20-1000	2-25	.8-.1	1.15	Woven Braid Gasket

† 2 tubes series-mounted back-to-back.

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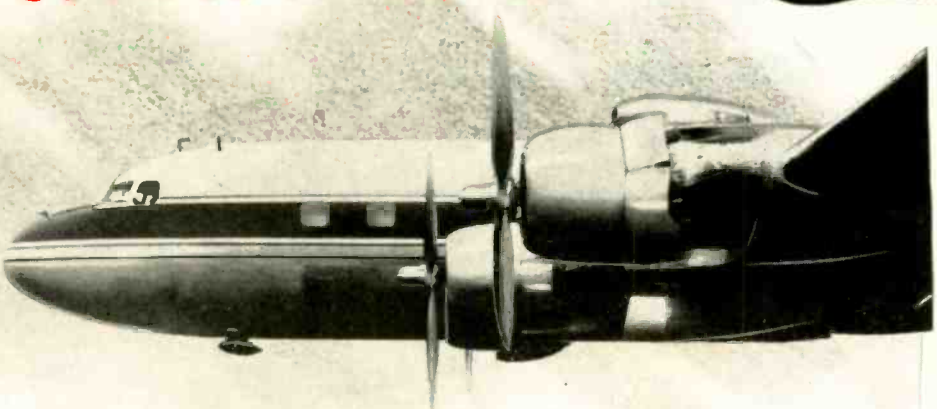

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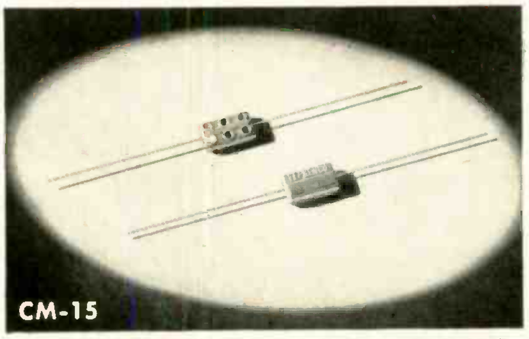

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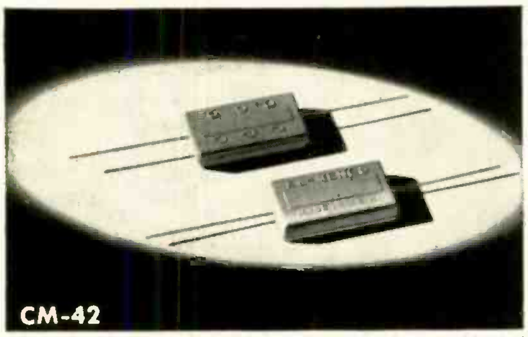

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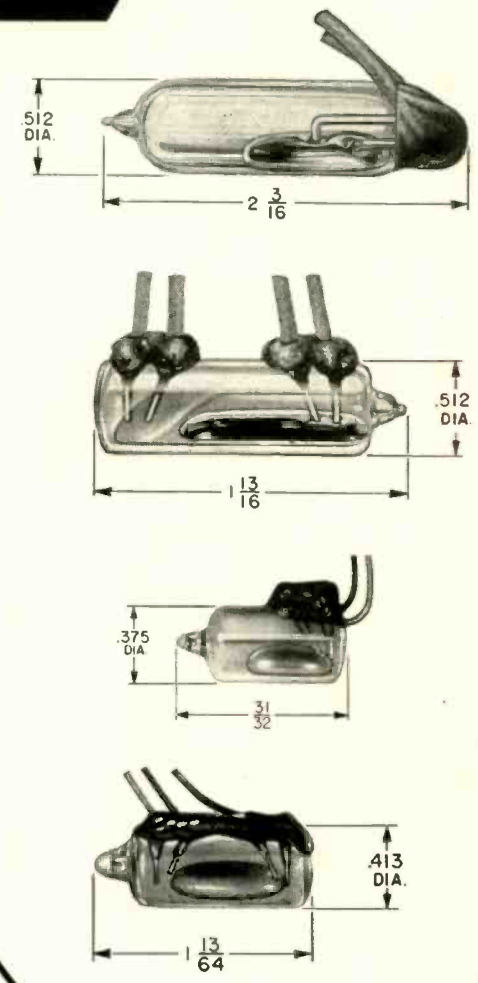

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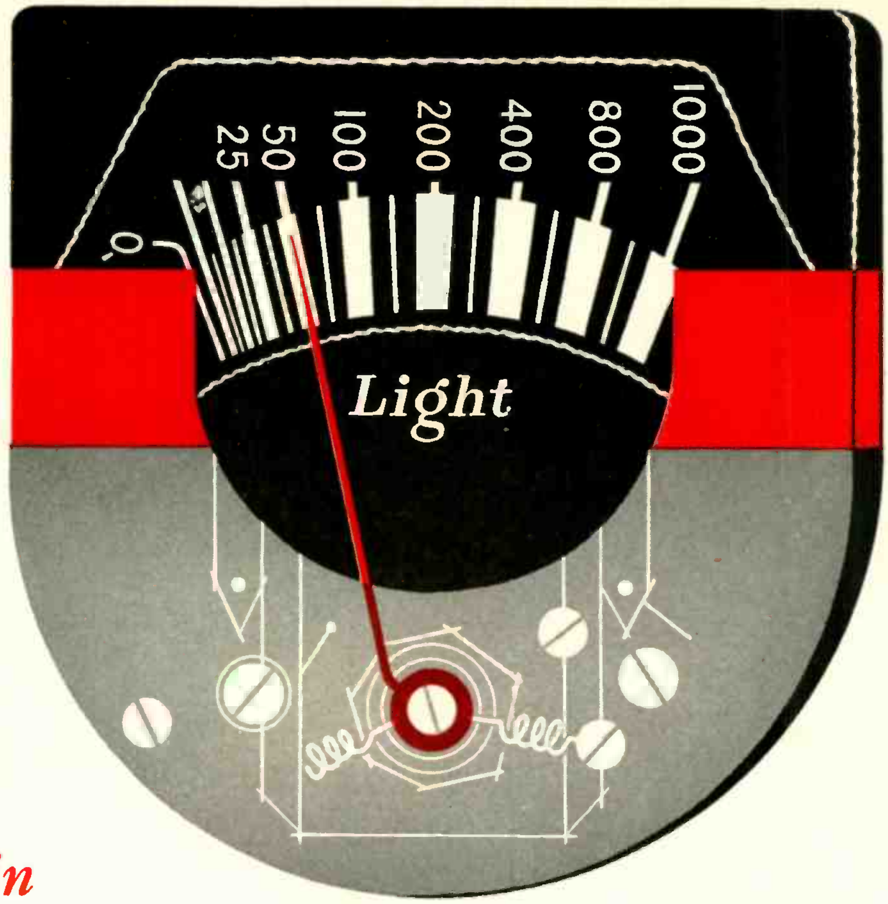

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FINANCIAL AID TO HIGHER EDUCATION

What Business Can Do to Help Our Colleges and Universities

Is the financial squeeze now gripping our colleges and universities grave enough to warrant direct action by the business community? If so, what can business do about it? This editorial is addressed to these two questions.

In the previous editorial in this series of two, it was demonstrated that **our colleges and universities, and particularly the independent institutions, face financial difficulties, which, unless relieved, promise to get progressively worse and might ultimately result in a national disaster.** This state of affairs obviously gives the business community a crucial stake in helping to relieve the plight of these institutions. For our business organizations can be no stronger than the total community of which they are a part.

It does not follow automatically, however, that every business firm should give direct financial aid to education. Already the business structure is heavily burdened with activities unrelated to its main purpose. These include acting as tax collector for more than $65 billion of federal, state and local taxes in the year 1953. There is a limit to the amount of such public enterprise that can be loaded on the business system.

Business Holds Key to Answer

If, however, the survival of a key part of our educational system depends on its having financial help from the business community, that help should be provided. And this is the situation of our independent privately endowed colleges and universities.

Of course, our tax-supported institutions of higher learning must also be kept strong, financially and otherwise. But they have recourse to public support not available to the independent institutions. Largely on this account, their present financial difficulties are much less acute than those of the independent colleges and universities.

These independent institutions have seen price inflation eat away much of the value of their endowments. Moreover, there is no prospect that these endowments can be sufficiently replenished by gifts from the wealthy people who provided them in earlier years. Progressive income and estate taxes have seen to that. Thus, they are faced not only with a peculiarly acute financial problem, but also one which cannot be solved except by tapping other sources of aid.

Tax Support No Solution

It is conceivable that the independent colleges and universities might solve their financial problem by seeking support from tax revenues. If they did this, however, they would lose their distinctive character as independent institutions, and our system of higher education would lose one of its major elements of strength. That is the existence in our educational system of both independently financed and tax-supported colleges and universities. Each has its special contribution to make to a well-balanced system of higher education.

Business is directly dependent upon higher education to staff its increasingly complex and exacting operations. A key part in this process is played by the small, independent liberal arts colleges which are the hardest hit financially of all our institutions of higher learning. "These," states the Council for Financial Aid to Education, recently formed by a group of business leaders, "have contributed a high proportion of the intellectual, scientific and religious, as well as business leadership of the nation. Their programs are devoted to the teaching of values, particularly the values of freedom. They are a vital bulwark to our system of free enterprise."

Means of Providing Help

There are many means by which business firms can extend help to our colleges and universities. The most obvious, of course, is to make outright grants of money either to individual institutions or to groups of institutions for such uses as the institutions think best. Another means of help, increasingly employed by business firms, is to establish scholarships to pay the full cost of college or university courses of study. Sometimes the scholarships are open for general competition, sometimes they are limited to employees and children of employees of the firm granting them. Not infrequently those winning the scholarships spend some part of their school vacations working in the companies granting the scholarships.

A number of companies have recently provided for what have come to be called "scholarships in reverse." These companies pay a flat sum to a college or university for every one of its graduates they employ. Financing of university research programs also offers a broad avenue for financial aid to our universities by business.

Need Two-Way Communication

Some business firms have well-developed programs for financial aid to education. But they are exceptional. For most companies the problems involved are new and strange. These companies were created with the basic purpose to make money, not to give it away. Successful philanthopic operations involve a whole set of problems with which they have very little experience. Not the least of these is how to make business a dependable source of financial aid to education, since business has no assurance that the profits of one year will not be losses the next.

Considerations such as these emphasize the wisdom of a recent Industry-College Conference on aid to higher education by business, in making the first of its ten conclusions that "better communication, by direct contact, is needed for each [industry and the colleges] to understand the problems of the other." At this juncture the creation of mutual understanding is much more important than the raising of some money and letting it go at that. The problem of aid to education by business has its immediate urgency, but there is also a long-range program to be developed on which business and the colleges and universities must pull together in the years ahead to find a satisfactory solution.

As stated at the outset, failure to find a satisfactory solution could result in a national disaster. This means that, **to give proper heed to their own future prosperity and the future welfare of the nation, business firms generally must go to work on the problem of financial aid to higher education. They must go to work first, to understand the problem; second, to establish two-way communication with our colleges and universities about it; and third, to develop a program which pays proper heed to the needs and capabilities of both business and higher education.**

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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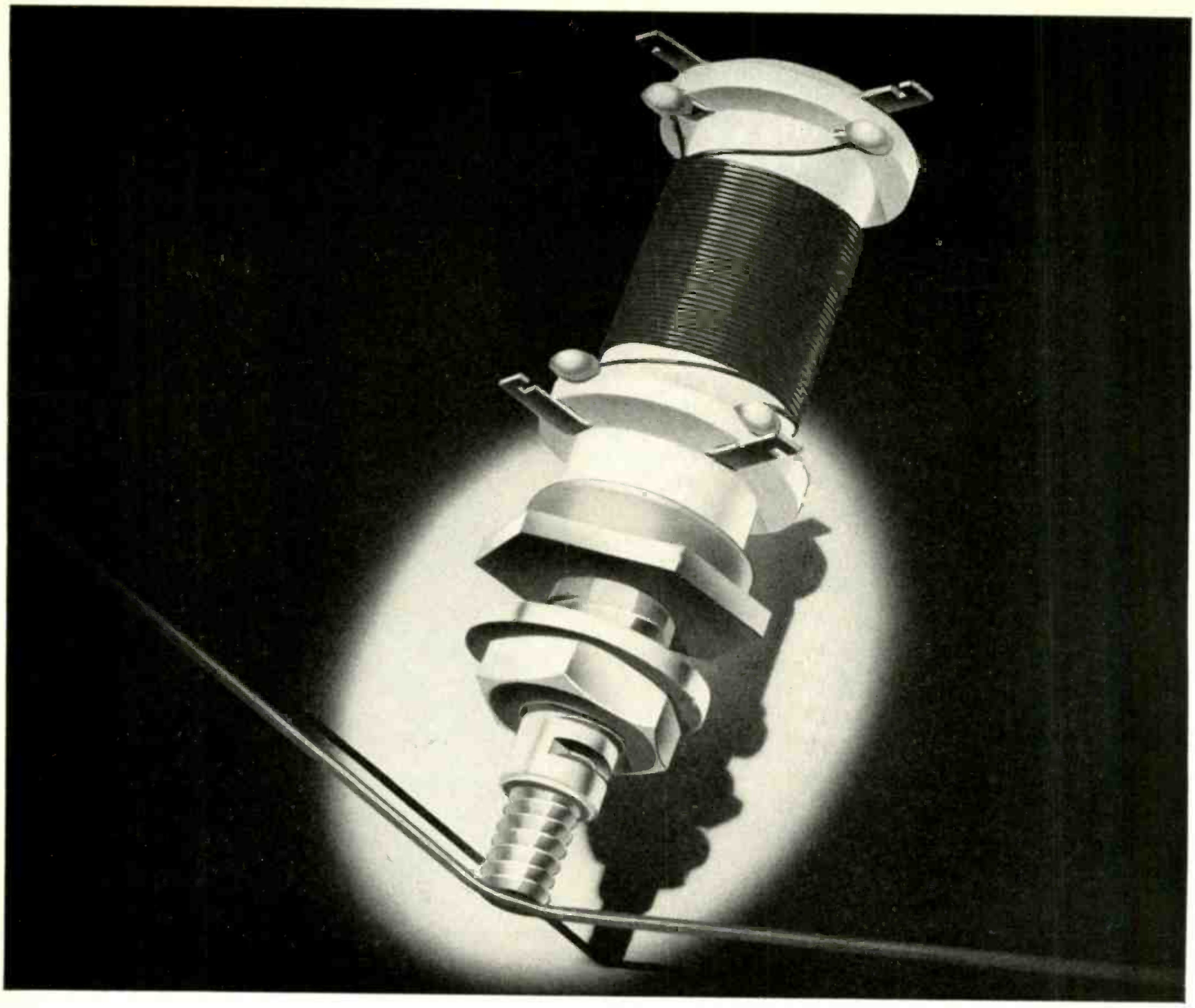

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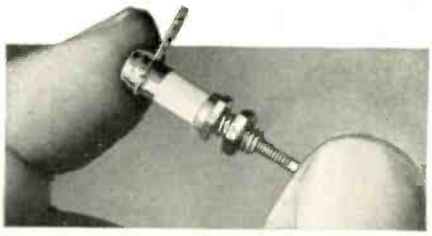
As a result, you get a *guaranteed* electronic component — custom or standard — whose performance you can depend upon.

Precision-made C.T.C. components that benefit from C.T.C. high quality standards include terminals, terminal boards, capacitors, swagers, hardware, insulated terminals and coil forms. For all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Slug Tuned Coil Data: Single layer or pie type windings to your specifications. Forms of quality paper base phenolic or grade L-5 silicone impregnated ceramic. Mounting studs are cadmium plated brass; ring type terminals are silver plated brass. All units include slugs and mounting hardware. One style (Type C) available with retaining collars of silicone fibreglas which permit 2 to 4 terminals. Windings can be coated with resin varnish, wax or lacquer.



New CST-50 variable ceramic capacitor surpasses range of capacitors many times its size. Stands only 19/32" high when mounted, is less than ¼" in diameter and has an 8-32 thread mounting stud. A tunable element of unusual design practically eliminates losses due to air dielectric giving large minimum to maximum capacity range (1.5 to 12MMFD).

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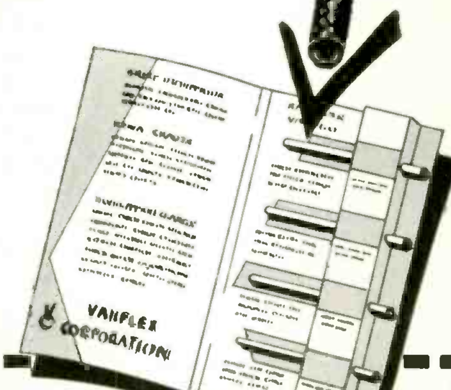
Available in Grades A-1 and B-1 tubing and Grades C-1 and C-2 sleeving.

Let us help you with your problem. Describe it in a letter—no cost, no obligation.



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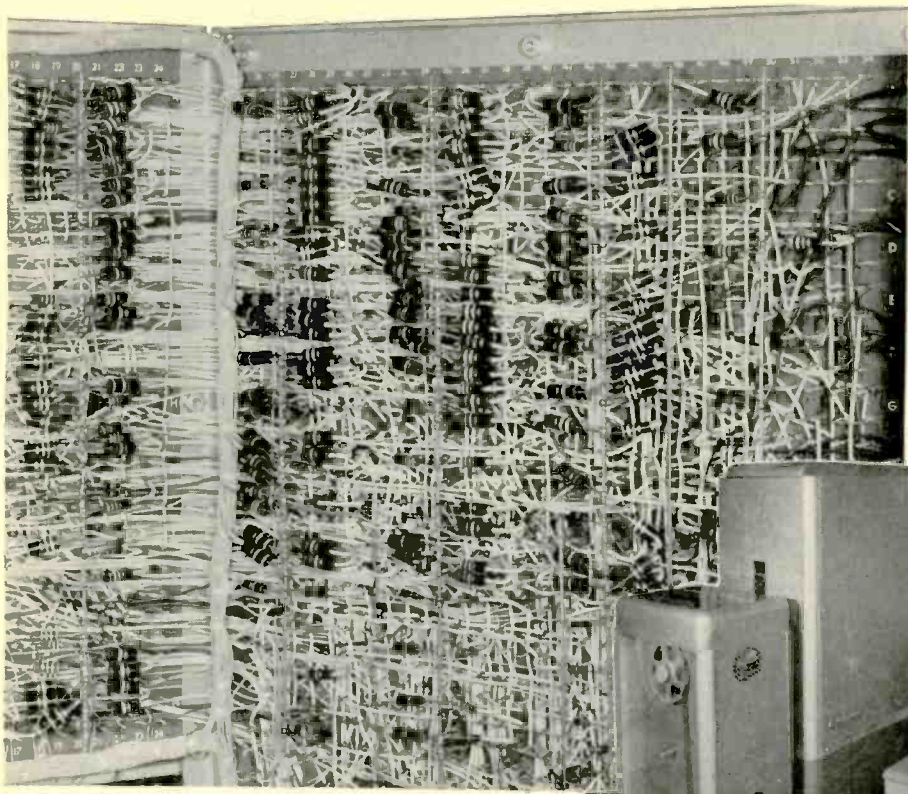
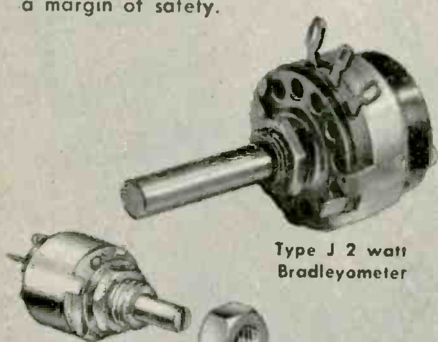


BACK OF DIODE BOARD
showing Bradleyunit Resistors

At the left is a rear view of a portion of the complex circuitry of the diode board in the CRC 102A general purpose computer. Several hundred Allen-Bradley Bradleyunits are visible. Their dependable characteristics are necessary for the continuous accuracy of this computer.

High Quality Fixed Resistors

Bradleyunits are rated at an ambient temperature of 70C . . . not at 40C . . . giving them an ultra-conservative rating. No other molded fixed resistors have such a margin of safety.



Type J 2 watt Bradleyometer

Type G ⅓ watt Bradleyometer

High Quality Adjustable Resistors

Bradleyometers incorporate a composition resistor molded to the resistance-rotation curve that is specified. They are unaffected by temperature or humidity.

CRC HIGH RELIABILITY COMPUTER
relies on Bradleyunit Fixed Resistors

The CRC 102A general purpose computer, made by the Computer Research Corporation of Hawthorne, California, is a versatile digital computer consisting of a computing unit and a control console which may be used with a variety of input-output equipment. It can perform 25 different arithmetic and logical commands in less than 15 milliseconds. As many as 80 complete 3-address commands can be executed per second. Such performance demands precision and dependability of all components.

Bradleyunit fixed resistors are standard equipment on the CRC 102A, and many other computers, because they are so conservatively rated. They will operate at full rating for 1,000 hours with less than 5 per cent resistance change, because they are rated at 70C . . . not 40C. They withstand heat and humidity, and have high mechanical strength.

Bradleyunits are solid molded with their leads imbedded in the densely compacted body of the resistor. No wax impregnation is needed to pass salt water immersion tests. The differential tempering of the leads prevents sharp bends near the resistor. They are made in all standard R. E. T. M. A. values in the ½ watt and 2 watt ratings from 10 ohms to 22 megohms, and the 1 watt rating from 2.7 ohms to 22 megohms.

Let us send you a complete Allen-Bradley resistor chart.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.

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CROSS TALK

►**MILITARY BUSINESS . . .** A Washington source for whose predictions we have considerable respect says the dollar value of electronic equipment shipped to the military in the fiscal year beginning July 1 will be up about 2 percent over last year. Our informant has been accurate within 1 percent on similar prognostications.

If this one is right, military business will be up more than 2 percent in units despite rising production costs because the Department of Defense is obviously wielding a much sharper pencil on prices than has been the custom since Korea.

The 2-percent figure may seem low to some military people and high to some government contractors but it should be remembered that both have fallen into the habit of thinking in terms of orders placed rather than orders shipped. We'll bet on it, even discounting any increase that might occur because of the worsening international situation.

►**UHF TV . . .** The nation's capital is full of suggestions for making uhf television broadcasting pay. There are so many suggestions, in fact, that we refrain from further muddying the water with more and list instead a few things that should be kept in mind in any approach:

When the freeze was lifted many applicants assumed that granting of a station license insured financial success in any market, of any size, anywhere; this just isn't so.

Competition is inherent in the broadcasting business in this country and should be neither legislated in nor legislated out; it should be fair, open competition.

People not now served, or inadequately served, do not care whether they get their pictures via vhf or uhf just so they get good programs; frequencies are mere numbers on a knob to the public.

More stations are needed to provide a national television service comparable to radio. The FCC says that most of these stations will have to be on the ultrahigh frequencies to avoid serious interference. If this is so then licensees will come and licensees will go, but the number of successful uhf stations will slowly but surely increase.

Where the need for a service exists someone always finds a way to make money supplying it.

►**ENGINEER-EXECUTIVES . . .** Our *Backtalk* columns are freely offered to anyone who cares to comment on a recent statement by R. F. Pearse before a technical society in Chicago.

Said Dr. Pearse, who is sincerely interested in developing executives for the future: "Personality traits common to engineers are (1) insistence on always being right, (2) hostility toward authority, (3) avoidance of close inter-personal relationships and, (4) limited effectiveness in getting results through others."

True, in general, or not?

►**ANOTHER EXTRA . . .** In this issue is the second of three editorial "extras" promised (p 129, Jan.) for 1954.

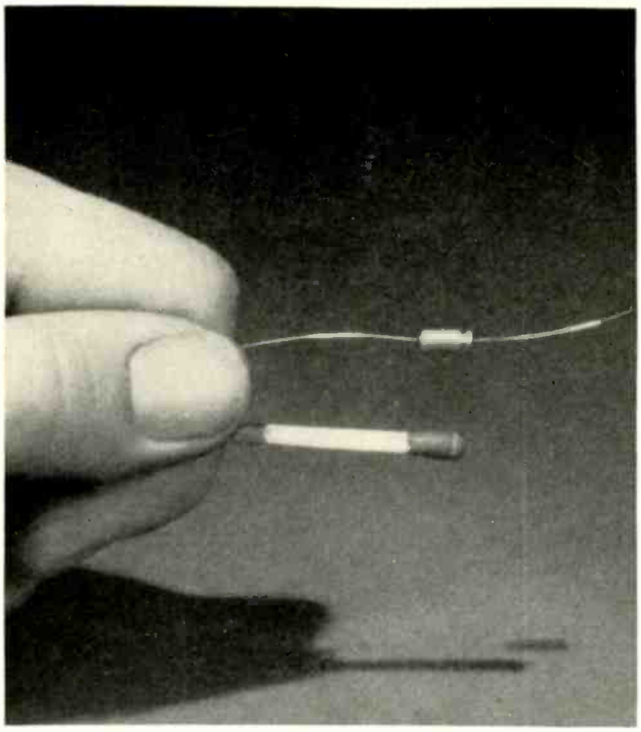
Beginning on the next page is an article analyzing recent trends in the design of fixed capacitors. Similar articles covering other basic components such as variable capacitors, fixed resistors, potentiometers and transformers will follow during the year.

Electronics is primarily a business of assembling components made by somebody else. Components are becoming smaller, lighter, more efficient and more reliable under increasingly severe conditions of shock, temperature and humidity.

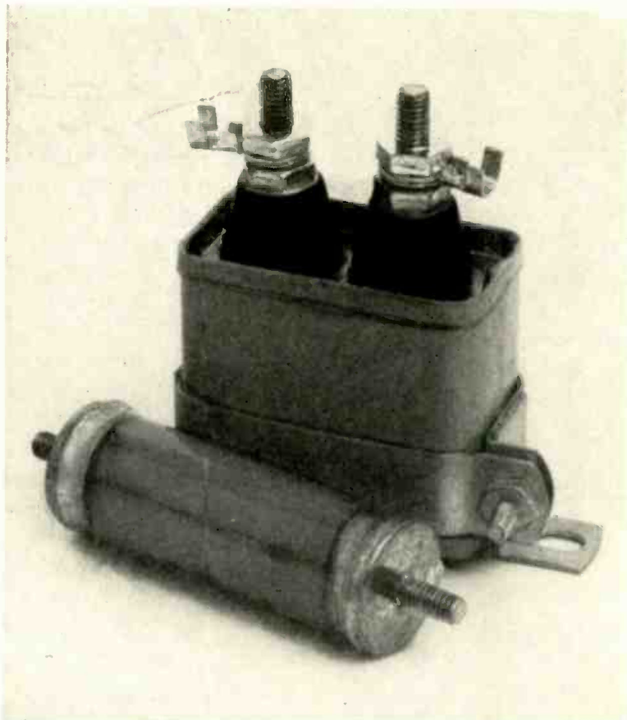
Just keeping up to date is a difficult job for engineers. Our new article series has been written to order to simplify this job

FIXED CAPACITORS

Part I of a series that will interpret recent developments for each basic component in the field of electronics. With capacitors, emphasis today is on temperature problems associated with use of new materials and techniques giving more capacitance in less space



Microminiature tantalum electrolytic capacitor made by GE, showing small size as compared to match head. Rating is 8 microfarads at 4 dcwv, as required for use in many transistorized circuits



Plastic-dielectric capacitor with glass housing, made by Carson Electric, is half the size and weight of comparable conventional 0.1 microfarad, 1,000 dcwv oil-filled paper capacitor in background

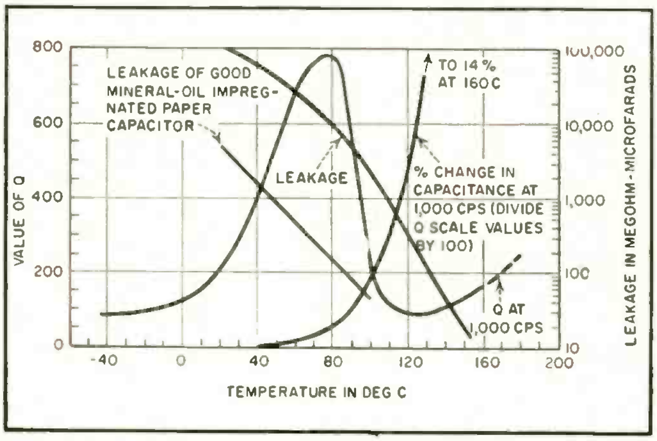


FIG. 1—Representative characteristics of Mylar film capacitors as function of temperature, with paper capacitor curve for comparison

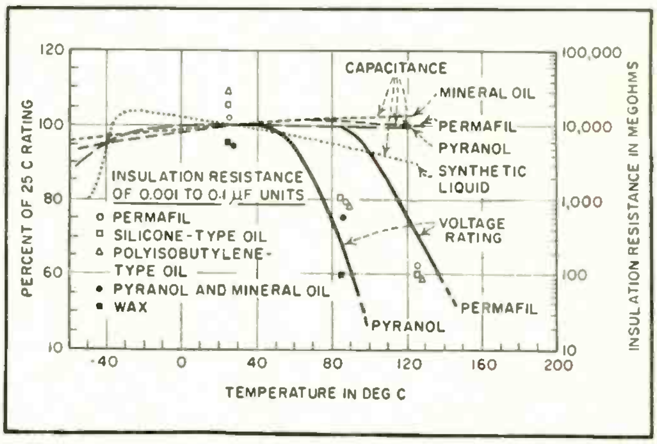


FIG. 2—Temperature characteristics of four representative types of impregnated paper capacitors, as obtained from published GE data

By FRANK ROCKETT

Research and Engineering Division
Airborne Instruments Laboratory
Mineola, N. Y.

Undergo Miniaturization

TRANSISTORS, printed wiring, airborne electronics and guided missiles are just a few of the reasons why there is pressure on design engineers today to squeeze their component parts into less and less space. But miniaturization alone isn't enough for most of these applications; operating temperature, humidity, and a host of other factors also become important in varying degrees according to the conditions of use.

Reduced size has advantages that counteract to some extent the difficulties it introduces in capacitor fabrication and circuit wiring. The amount of material used is reduced; weight is decreased. On the other side of the ledger, the surface area available for heat dissipation is reduced. As a consequence, miniaturized equipment is being required to operate at high temperature. Thus, of all the recent trends in capacitor design, perhaps the one of greatest interest is the effect of temperature.

To present data on a variety of capacitors in a comparable manner, characteristics are plotted here against temperature with an abscissa extending from −60 C to 200 C. These limits seem to set about the widest realistic temperature range over which contemporary electronic equipment can normally be relied upon.

Plastic Dielectrics

Such new resins as the silicones, styrene-polyesters and epoxies were developed to meet the need for high-temperature operation. The silicones are finding greatest use in capacitors as sealants because they retain their low surface leakage even at high humidity. Styrene-polyesters are used for supports.

One of the significant advances in capacitor design is the development of a polyester dielectric film. Produced by E. I. du Pont de Nemours & Co. under the name Mylar, this film retains its high insulating properties from −65 C to 125 C. In addition, the film has high mechanical strength, long-term resistance to heat and chemical inertness if hermetically sealed and dry; the film can be vacuum-metalized with aluminum and thereby used in capacitors that are free of internal voids.

Mylar (polyethylene terephthalate) is used alone or as a laminate with paper for capacitors.

In thin films, Mylar is impregnated with polystyrene, silicone or mineral oil to fill pinholes. Alternatively, several thin films are laminated to cover pinholes. It may well rival paper for use as a general-purpose dielectric where insulation resistance, temperature coefficient of capacitance and operating temperature range are dominant factors.

Some of the characteristics of Mylar are shown in Fig. 1. The dissipation factor is a minimum at about 80 C at 1,000 cps and at 1 mc. At frequencies above 1 mc, the dissipation factor is relatively independent of temperature. The dielectric constant is in the order of 3 and is relatively constant with frequency; although the temperature coefficient of capacitance rises rapidly above 80 C, at normal operating temperatures it is lower than most commonly used dielectrics. (A dielectric constant of 5 is common in chlorinated-diphenyl paper capacitors.)

The dielectric strength, which decreases with increase in temperature, is a function of the thickness of the film. For instance, a 0.25-mil film exhibits a dielectric strength of around 750 volts per mil; a 7-mil film withstands an instantaneous voltage equivalent to 2,800 volts per mil. However, dielectric fatigue results from operation under appreciable internal a-c corona. The film is attacked in air to some extent by corona at 300 to 400 volts rms. The film is, therefore, used in sealed capacitors.

For operation at high potentials, the film should be impregnated with oil or varnished. Capacitors can be operated to temperatures of 125 C with no voltage derating. One such precision capacitor, marketed by Southern Electronics of Burbank, Calif. under the trade name of Mycon in capacitances up to 10 μf and tolerances down to 1 percent, has rated voltages as high as 25,000 volts d-c for a temperature range of −65 C to 125 C. The insulation resistance at 25 C is 100,000 megohms in this capacitance range; at 125 C it is 3 megohms. The dissipation factor of these capacitors is in the vicinity of 0.03 percent.

A growing application for the new film is in low-voltage units for use with transistors. Because transistors are normally limited to temperatures below 75 C, the advantage of the dielectric is chiefly in reducing size; toward this objective, the producer is experimenting with 0.1-mil film.

Considerable saving in space and weight is made possible by a plastic dielectric. The particular unit pictured uses a cellulose-acetate dielectric impregnated and filled with silicone in a tubular construction. The glass housing provides a long leakage path, enabling such units to operate at as high as 60,000 volts; the glass housing hermetically seals to the metallic ends.

Paper Dielectric

A conventional dielectric for fixed capacitors has been paper. The paper serves as a carrier for various

COMPONENT DESIGN TRENDS

- **Impregnating thin Mylar films with polystyrene, silicone or mineral oil to fill pinholes**
- **Metallizing Mylar films in vacuum with aluminum**
- **Using glass housings for high-voltage sealed capacitors**
- **Impregnating paper with a solid resinous material such as Permafil to boost temperature limits and reduce size**
- **Improving temperature ratings of metallized paper capacitors by using a chemically inert copolymer as impregnant**
- **Forming electrolytics at high current density to improve energy storage performance**

types of impregnants which by themselves may lack mechanical stability, especially at high temperatures. Among the more common impregnants are vegetable oil, mineral oil and synthetic insulating liquids. A more recent impregnant, known by the GE trade name Permafil, is a solid resinous material that retains its electrical characteristics at temperatures as high as 125 C ambient rating. Because of this characteristic, capacitors made with Permafil are appreciably smaller than equivalent paper-dielectric capacitors.

A comparison of operating voltages for paper capacitors with oil-impregnated and Permafil-impregnated capacitors is shown in Fig. 2. Where alternating voltage is present in addition to direct voltage, the operating voltage determined from the curves applies to the sum of the direct voltage and the peak alternating voltage. However, the peak alternating voltage should not exceed 20 percent of the direct voltage at 60 cps or 1 percent at 10,000 cps. That is, such units are engineered for use primarily as decoupling and blocking capacitors. In low-frequency RC oscillators and related predominantly a-c applications paper capacitors are used conservatively.

Because leakage current is of great importance in many electronic applications, this characteristic of capacitors is frequently used as a measure of the quality of a capacitor. Paper-dielectric capacitors impregnated with Permafil have a leakage of over 4,000 megohm-microfarads at 25 C, over 100 megohm-microfarads at 85 C and over 8 megohm-microfarads at 125 C. The variation in capacitance of these capacitors with temperature is also shown in Fig. 2.

Where high-temperature operation is not required, Pyranol capacitors can be used. Pyranol is a liquid impregnant with high dielectric constant that makes possible smaller paper-type capacitors. At −55 C, these capacitors lose no more than 15 percent of their 25 C capacitance. Thus, such capacitors have much the same characteristics as wax-filled capacitors of identical size but permit operation of equipment to lower temperatures.

For protection against humidity, especially where equipment operates through a wide temperature cycle and is thereby made to breathe appreciably, capacitors are hermetically sealed. A silicone bushing provides a rugged and permanent liquid-tight seal with generous air strike and creepage distance that is resistant to vibration and shock. The silicone bushing permits operation at rated voltage under severe humidity and high altitudes (50,000 feet). Because the hermetic seal also prevents the entrance of potting compound, capacitors so sealed can be used in potted circuits provided the pour temperature does not exceed the peak operating temperature for the capacitor.

Impregnated paper capacitors should be applied with caution when either the a-c or d-c voltage is less than about 10 volts, because some pressure contacts require appreciable current to maintain their low resistance. Some low-voltage capacitors are made with an extended foil or a webbed-flag tab in which a metal strip is welded to the tab to increase the area of contact with the foil as much as ten times.

As with plastic-dielectric capacitors, the reliability of paper capacitors depends greatly on moisture-tight seals at seams and terminals, impregnants and other materials that are chemically inert toward each other and mechanical stability.

Metallized Paper

In the late '40s, metallized paper capacitors attracted widespread interest because of their compactness and because, when electrically punctured, the electrodes quickly evaporated in the vicinity and thereby prevented the formation of a short. Experience soon indicated, however, that such capacitors were limited to rather low temperatures (below 65 C), partly because of deterioration of the impregnant in the vicinity of a point of failure.

Considerable improvement has resulted from the use of Aerolene as an impregnant; it is a copolymer of a polyester and a styrene-monomer that can be polymerized without producing water and is considerably more inert chemically than conventional impregnants, which is especially important in metallized capacitors. Capacitors made with Aerolene can be operated from −55 C to 100 C without derating and up to 125 C if derated 25 percent. Their capacitance increases about 0.1 percent per deg C. Insulation resistance falls from some 2,000 megohm-microfarads at 25 C to about 2 megohm-microfarads at 125 C.

Electrolytic Capacitors

Electrolytic capacitors, used heretofore chiefly for low-frequency, low-impedance, bypass and storage functions, now find use in applications that require high pulse energy storage. Examples are photoflash and pulsed circuits. To provide such capacitors with reduced power factor and leakage current, development in Europe is directed toward reducing impurities in the aluminum used for roughened electrodes.

Two principal limitations to aluminum electrolytic capacitors are the formation of a secondary stratum of aluminum oxide dielectric, which is somewhat soluble in acids, and the presence of needle-like crystals of iron oxide semiconductor projecting from the surface of the aluminum anode and occasionally extending through the aluminum oxide dielectric. The soluble secondary stratum of aluminum oxide can be kept to a minimum by forming a capacitor at high current density; the iron oxide crystals can be minimized by using high-purity aluminum. Such capacitors have a representative rating of 500 μf at 500 v, a space requirement of about 0.8 cu cm per μf, a power factor less than 5 percent, and a leakage current less than 0.4 ma. They use electrolytes of high conductivity with the addition of colloids to increase their breakdown potential. A particular advantage of this type capacitor in pulsed circuits is the stability of the cathode so that, in the event of a sudden discharge, there is less likelihood of the cathode being formed.

The widespread use of selenium rectifiers has placed a further requirement on electrolytic capacitors. Because of their low forward resistance, selenium rectifiers subject the first filter capacitor of a rectifier-filter network to very high surges and ripple voltages, which would be limited by the internal resistance of vacuum-tube rectifiers. Also, because the reverse impedance of selenium rectifiers tends to decrease during periods of idleness, high reverse current reaches the capacitor immediately after power is applied to a selenium rectifier and continues until the barrier layer is reformed. For both these reasons, a current-limiting resistor is often placed between a selenium rectifier and a first filter capacitor.

In the presence of high ripple voltages, plain cathode foil capacitors tend to develop an oxide deposit during the negative slope of the ripple voltage. In time this cathode formation, by producing a second capacitor in series with the original anode-dielectric capacitor, will reduce the total effective capacitance of the unit; this loss in capacitance is most pronounced at lower direct voltages. For such operation, it is preferable to use electrolytic capacitors in which both the cathode and the anode foils are etched and formed; that is, nonpolarized a-c electrolytic capacitors.

Tantalum Electrolytics

For units that have high capacitance and are required to operate under severe environmental conditions including a temperature range of −55 C to 200 C, tantalum electrolytic capacitors are commercially available. Figure 3 presents representative characteristics. Tantalum electrolytics are about two-thirds the size of equivalent aluminum electrolytics.

Unlike aluminum electrolytic capacitors, tantalum capacitors are affected very little by idle storage without bias voltage. Such capacitors are conservatively expected to have a shelf life well in excess of ten years, and may even be stored for considerable time at temperatures as high as 85 C, although such storage results in a slightly longer recovery to normal d-c leakage current when the units are first placed in service. Long service life is also expected.

Accelerated life tests being conducted by P. R. Mallory at 125 C ambient and full rated voltage show that tantalum electrolytics on test for two full years are still within the final-inspection electrical limits for new units.

For low-voltage direct-current applications, such as in transistor circuits, a line of microminiature Tantalytic capacitors (trade name used by GE) have capacitances as high as 8 μf and are available in ratings up to 20 v in a case about the size of the head of a wooden match. As an example, a unit 5/16 inch long and 1/8 inch in diameter provides 4 μf at 4 dcwv. These capacitors employ a tantalum anode, stably oxidized to the voltage rating, enclosed in a silvered case and impregnated with a nonacid solution to provide a stable electrolyte. A synthetic plug in the end of the case is roll-crimped into place and a solderable tin-coated nickel lead is lap-welded externally to the projecting tantalum anode lead. The tin-coated copper case is the cathode or negative terminal. The unit is thus hermetically sealed.

Superimposed a-c voltages on tantalum capacitors should be small compared to the d-c voltages, just as for aluminum electrolytic capacitors. Initial power factor of these miniature units is about 20 percent; the capacitance is highest in the

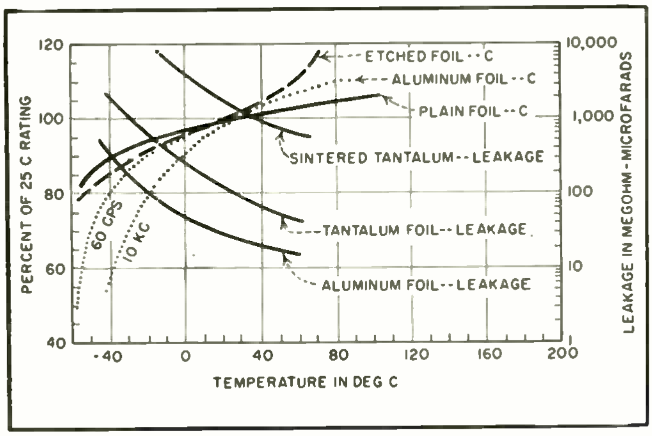


FIG. 3—Comparison of characteristics of aluminum and tantalum electrolytics. Leakage curves are for 30-minute electrification

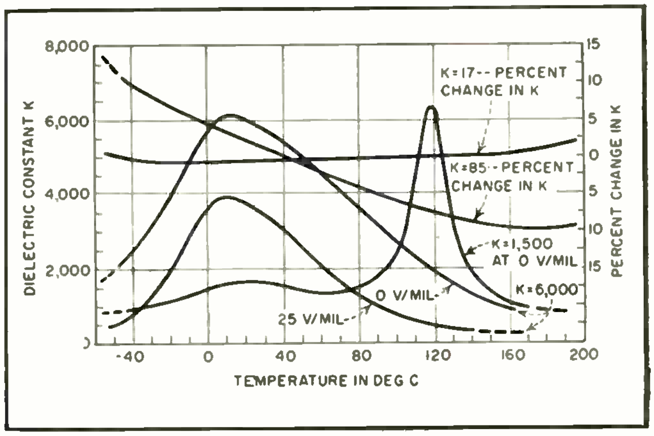


FIG. 4—Temperature characteristics of titanate-base ceramic capacitors, from Glenco Corp. data for representative units

- Developing temperature-stable ceramic mixes using barium titanate
- Using bentonite clay derivative as dielectric in high-voltage capacitors
- Fabricating high-temperature units in monolithic blocks of vitrified porcelain or glass
- Using synthetic dielectrics to get longer time constants than with mica

vicinity of 25 C. Leakage current at 25 C is about 0.2 μa per μf per volt. These units are rated for operation over a temperature range of −20 C to 50 C, although operation is possible at lower temperatures with a decrease in capacitance.

Ceramic Dielectrics

The characteristics of ceramic dielectrics can be varied over wide ranges, although individual characteristics cannot readily be varied independently of others; even so, capacitors using ceramic dielectrics have been tailored to a wide variety of applications. Some ceramics have very high dielectric constants at room temperature. In general, however, the higher the dielectric constant, the more temperature-sensitive is the dielectric. Practically all ceramic dielectrics contain a large portion of barium titanate, the dielectric constant of which is voltage-sensitive.

For circuits in which the angular velocity or time constant must remain constant within narrow limits despite wide temperature fluctuations, small fixed capacitors consisting essentially of a ceramic dielectric with silver electrodes fired on at a very high temperature are used. The composition of the dielectric material is varied so that a wide range of temperature characteristics is obtained. One series of ceramic dielectrics includes temperature coefficients of dielectric constants having any predetermined nominal value from +100 to −1,400 parts per million per degree C. These capacitors display a temperature coefficient of capacitance that is definite and entirely reproducible under normal operating conditions. With the silver electrodes in intimate contact with the surface of the dielectric, air spaces or wax-filled pockets between the electrodes and the dielectric are avoided. The curves for $K = 17$ and $K = 85$ in Fig. 4 are indicative of the temperature-compensating characteristics available in such capacitors.

For bypassing functions where a capacitor is required only to present a low a-c impedance, ceramic capacitors are usually used that have the highest possible dielectric constant, even though this may mean considerable variation in capacitance with temperature and voltage as indicated by curves for $K = 1{,}500$ and $K = 6{,}000$ in Fig. 4. This type of capacitor is available in a variety of mechanical configurations to facilitate use in very high frequency circuits.

Where it is necessary to protect ceramic capacitors from humidity or other adverse atmospheres, they are sometimes molded and insulated in low-loss phenolic jackets. The safe upper temperature of operation of such capacitors is limited as much by the behavior of the jacket at high temperature as by the loss in capacitance.

Because of the considerable dependence of dielectric constant on temperature in high-K capacitors, research at Solar Manufacturing Co. and at Erie Resistor Corp. is currently directed toward the development of temperature-stable ceramics. This work has resulted in commercial capacitors having a maximum change in capacitance of 10 percent from −55 C to 85 C, compared to a change of 25 percent heretofore.

By precise control of the manufacture of the ceramic dielectric, starting with raw materials of high purity, stable capacitors with a dielectric constant approaching 1,500 are produced. Such capacitors display a maximum change in capacitance of 5 percent from −55 C to 105 C and no more than a 10 percent change from −55 C to 125 C. Insulation resistance is 10,000 megohms minimum; at 1 kc their power factor is 1.5 percent maximum. Although a principal constituent of these capacitors is barium titanate, they have negligible piezoelectric effect in this application.

A bentonite clay derivative, developed by Aircraft-Marine Products as a possible mica substitute, is thermally stable from −60 C to 200 C. Because of its high dielectric strength (5,000 volts per mil in 1-mil samples), it is used in high-voltage capacitors.

Monolithic Structures

For operation at higher temperatures, capacitances up to 6,800 μμf are fabricated as a monolithic rock-like block composed of vitrified porcelain or high-temperature glass in which silver electrodes are immersed. Although the geometry of the capacitor is orthodox, the intimate bond between the conducting and dielectric materials improves its environmental independence. Figure 5 presents representative data for monolithic capacitors.

An inert porcelain body in this type capacitor results in unusually stable electrical characteristics under varying temperature conditions. The temperature coefficient of capacitance is +120± 5 ppm per deg C. Total change in capacitance from −55 C to 200 C is about 5 percent. The intimate bond between the silver and porcelain does not disturb the thermal expansion properties of the porcelain. Therefore, the capacitor bodies behave thermally as would a block of porcelain having high thermal conductivity. The body expands and contracts as a unit and no physical creep occurs between portions of the structure, so that the physical and electrical properties of the capacitor retrace their characteristic curves essentially in an absolute fashion. Such capacitors are stable over temperature ranges exceeding

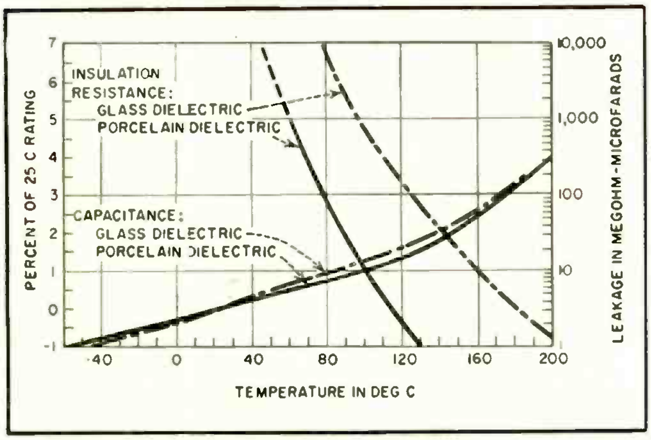


FIG. 5—Comparison of temperature characteristics of monolithic capacitors of glass (Corning) and of vitrified porcelain (Vitramon)

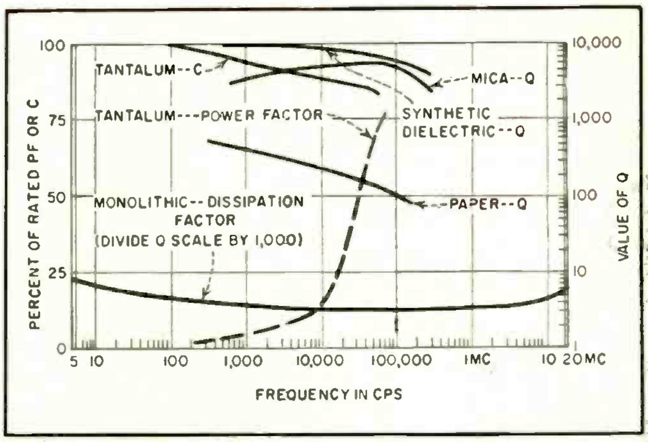


FIG. 6—Frequency characteristics of representative capacitor types using various dielectric materials

the limits of −55 C to 200 C.

Because the silver electrodes of monolithic capacitors are completely immersed in the dielectric, corona starting voltage is considerably above that of units of other constructions and equivalent volume. All corona must be within the dielectric itself since no molecular incompatible materials exist in the structure. Dielectric strengths are also entirely a function of the properties of the insulating materials.

The dissipation factor of 0.0003 at 1 mc for the porcelain is maintained through quality control of the dielectric material. The porcelains used in these capacitors have a loss characteristic which displays interfacial polarizations similar to that of mica. Therefore, some increase in loss occurs at very low frequencies, accompanied by a corresponding increase in capacitance.

The self-resonance of a typical monolithic capacitor is comparable to the inductance of a bar of copper with the same geometry as the capacitor body.

The vitrified block of porcelain is not porous, hence these capacitors are immune to atmospheric effects just as are capacitors with glass or porcelain hermetic seals. Furthermore, the entire body is homogeneous, and no change is brought about by chipping off a corner or an edge of a capacitor as long as the chip does not penetrate to the electrode structure. Even so, surface treatments to repel outer surface contamination are commonly used.

The porcelain capacitor withstands unusually high accelerations (units fired in projectiles with accelerations of over 40,000 g have remained undamaged). No change occurs in electrical properties until the unit physically breaks.

For continuous operation at high temperature, glass monolithic capacitors are also used. Structurally they are much like the monolithic porcelain capacitor in that the electrodes are imbedded in the glass body which serves both as dielectric and as cover. In miniaturized circuits these capacitors provide a relatively high capacitance-to-volume ratio; for example, a 500-volt, 150-μμf capacitor has a volume of about 0.005 cubic inch.

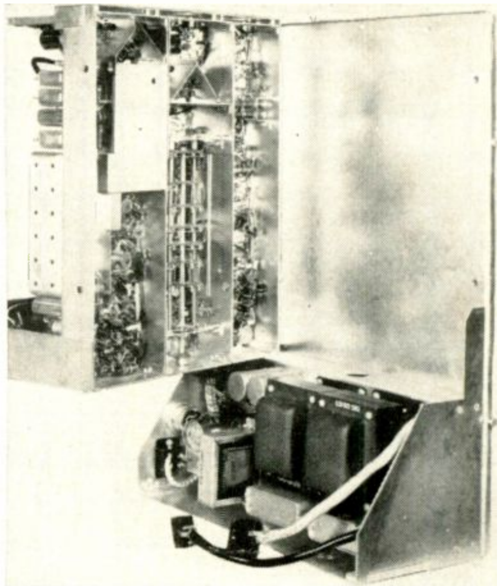
The Q of glass capacitors is especially constant. It does not decrease markedly at low capacitances because the case is of the same glass as the dielectric, nor at high capacitances because the direct connection to the foils results in low inductance.

Precision Capacitors

For the stability required in a precision calibrated capacitor, natural mica is still a preferred dielectric material. For greater stability the mica is silvered to eliminate voids between the plates of the capacitor and the dielectric. One such capacitor, manufactured by Leeds & Northrup Co. for use in its decade capacitance boxes, is hermetically sealed, has a maximum safe operating voltage of 500 volts, a maximum insulation resistance exceeding 5,000 megohms and a dissipation factor less than 0.0001. The phase angle, as mounted in a decade box, of units having a capacitance in the order of 0.1 μf and 0.01 μf is less than 20 seconds; the phase angle of units having capacitances in the order of 0.001 μf is less than 40 seconds. Maximum safe current is 1 ampere rms. The temperature coefficient of capacitance is less than about +0.016 percent per degree C at normal ambient temperatures.

Capacitors using synthetic dielectrics can, by sacrificing temperature stability somewhat, provide other characteristics that in some cases are superior to those of mica. For example, Industrial Condenser Corp. markets under the trade name of Stabelex D a series of capacitors that, for pulse operation, have a dielectric absorption which is 1/25 that of commercial mica capacitors. For a 10-μf capacitor of this type maintained at normal room temperature and humidity, a time constant as long as 200 days has been measured. These units are hermetically sealed in a lead-coated steel case and have glass standoff terminals. Units are available with capacitances ranging from 0.05 μf to about 10 μf at 600 dcwv. They are manufactured to tolerances of ±10 percent and as accurate as ±1 percent on special order. Normal operating temperature range is from −80 C to 75 C. The insulation resistance at 25 C is 10^6 megohm-microfarads, or approximately ten times that of commercial oil capacitors.

Figure 6 compares the Q of several types of capacitors as a function of frequency.



Equipment designed for nontechnical personnel (left) swings out on hinges for quick servicing in port (right)

Multichannel F-M Aids Marine Communications

New communications plan for Great Lakes shipping eliminates medium-frequency interference problems by using carriers between 156.3 and 161.9 mc. Specialized mobile equipment for shipborne use includes 8-channel switching arrangement

MARINE RADIOTELEPHONE communication is now carried out principally on medium and high-frequency channels between 1.5 and 9 mc. The congestion on these channels has increased to the point where in some areas only a fraction of the desired communication load can be accommodated. This is particularly true on the Great Lakes and on the Canadian west coast. Although the greatest part of such ship-to-ship and ship-to-shore traffic is carried out over distances of less than 50 miles the propagation characteristics of these frequencies is such that interference is regularly experienced from ships hundreds and even thousands of miles away.

A solution to this problem lies in the use of channels assigned to the vhf marine service. These channels, particularly when frequency modulation is employed, have the advantage of providing dependable, noise-free communication over ranges of 50 to 100 miles without interference from cochannel equipments located appreciably beyond line-of-sight range.

Frequencies Available

Present channel assignments are based on a joint agreement between the Canadian and United States governments and are allocated on the following basis:

(1) Frequencies from 156.3 through 157.4 mc and 161.9 through 162.0 mc have been made available for vhf marine service.

(2) Channel spacing at the present is on a 100-kc basis with the center of the first channel being 156.3 mc.

(3) Frequency tolerance is 0.01 percent.

Table I lists the 14 vhf channels available for marine service[1,2] as well as the proposed functions of each channel.

Equipment designed for the vhf marine service must meet a number of requirements not normally encountered in vhf land mobile service. These basic requirements can be enumerated as follows:

(1) Equipment must be capable of operation on a number of alternative channels, a minimum of four being generally accepted as a reasonable compromise between flexibility and cost.

(2) It must be possible to change channels by means of a

Small vessel typical of Great Lakes and Canadian west coast maritime activities requires only small antenna atop mast

By **WILLIAM ORNSTEIN**
and PETER CAHN

Canadian Marconi Co.
Montreal, Canada

simple switching operation without retuning.

(3) Equipment should be designed to operate with the various primary power sources encountered on ship board. This includes 110 volts a-c, 220 v, 110 v, 32 v and 12 v d-c.

Equipment described below fulfills the needs of this maritime service.

Transmitter

Since all transmitter frequencies are in the range 156.3 mc to 157.4 mc, the transmitter is designed to operate over a bandwidth of 1.1 mc without retuning. Channel switching on transmit therefore requires switching of the transmitter crystals only, as indicated in Fig. 1.

The transmitter is phase-modulated, employing a frequency multiplication of 36. A 5894/AX9903 twin tetrode in the output stage gives a power output of 25 watts over the band. Peak deviation is limited to ±15 kc by a symmetrical clipping circuit. High-frequency pre-emphasis before clipping and de-emphasis after clipping applies modulation limiting mainly to the higher-frequency audio components. In a phase modulation system these components are largely responsible for frequency excursions beyond

Table I—Great Lakes VHF Supplemental Radiotelephone System

Channel	Frequency in Mc	Function
1	156.8	Safety Calling
2	156.3	General Intership
5	157.0	Second Intership (large vessels)
6	156.7	Third Intership (small vessels)
3	157.2	Coast Guard Working
4	156.6	Port Operations
X	156.5	Large Vessel Operational
7	157.3–162.0	Public Correspondence—duplex
8	157.4–161.9	Public Correspondence—duplex
W	156.9	Tug Dispatch
Y	156.4	Ferries, etc

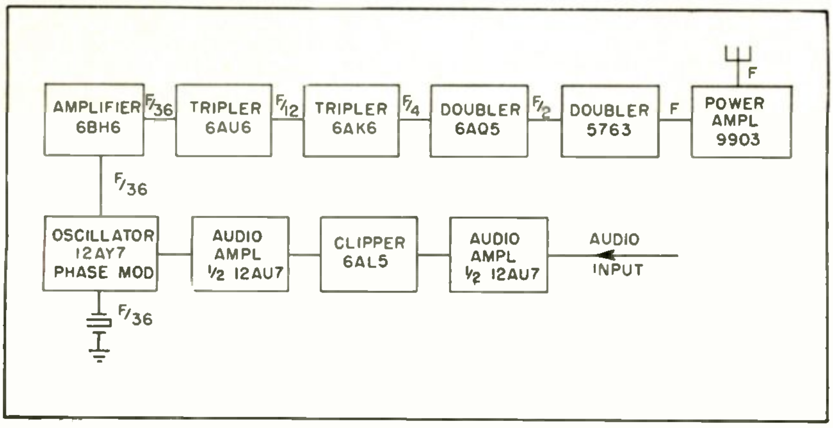


FIG. 1—Block diagram of 25-watt transmitter used in vhf communications

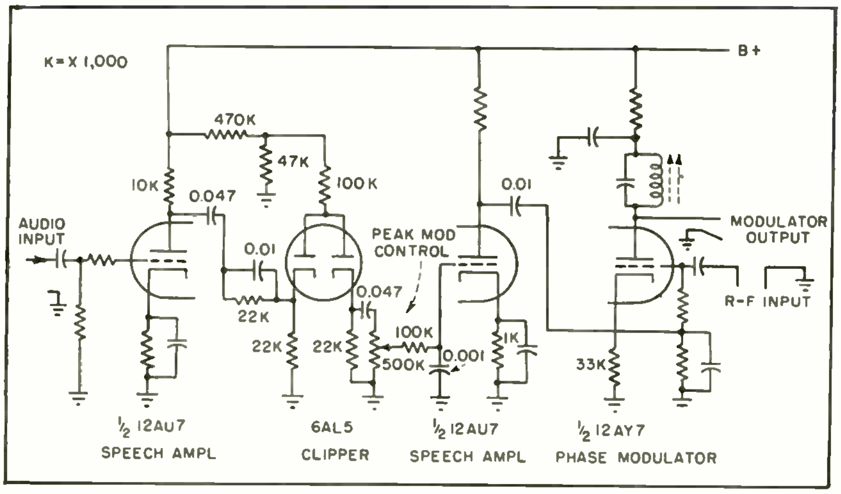
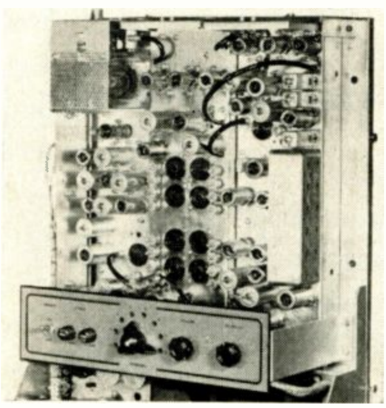


FIG. 2—Detail of speech amplifier and phase modulator

rated maximum channel value.

Figure 2 illustrates the circuit employed in the clipper and phas-modulator stages. The use of three double-tuned circuits in the transmitter as well as a Faraday shield in the output circuit result in all harmonic and spurious emissions being attenuated by more than 60 db below carrier level.



Removal of dust cover provides access to one side of hinged unit

Receiver channels, unlike those of the transmitter, lie in two bands —156.3 to 157.4 mc and 161.9 to 162.0 mc. The receiver shown in the block diagram of Fig. 3 is a double-conversion superheterodyne with two r-f stages and five tuned circuits at signal frequency before the first mixer. An oscillator-multiplier chain, which supplies an injection signal to the first mixer, contains another four tuned circuits that are signal-frequency dependent.

Receiver Controls

To accommodate the two widely separated frequency bands the first three receiver stages as well as the first oscillator-multiplier chain located on the receiver chassis are duplicated on a frequency control unit chassis. Which of the two receiver r-f heads is actually used is determined by the setting of the channel change switch on the control frequency unit. This switch also controls the operation of a relay that connects the receiving antenna to the receiver r-f head in actual use. From the first i-f stage onward the remainder of the receiver circuitry is common to all channels and is located on the receiver chassis.

The overall receiver selectivity is mainly determined by the lumped i-f filter that follows the second mixer. A minimum of gain is employed prior to the filter to reduce spurious response and ensure against desensitization of the early stages by strong interfering signals on adjacent channels. The principle followed is that of lumping the main selectivity at one point in the circuit at a reasonably low frequency and concentrating the gain of the receiver after this point so that minimum amplification is given to undesired signals. This approach has proved effective.

Tuned Filter

The i-f filter is built into an aluminum casting and employs twelve tuned circuits. Figure 4 shows the circuit arrangement of the filter components and Fig. 5 is a curve of the filter passband with 6-db points at least ±17 kc and 90-db points less than ±40 kc from the carrier frequency. A high-gain broadband i-f amplifier with three amplifier and two limiter stages follows the filter and feeds the discriminator stage, which recovers the original modulation.

The satisfactory performance of this receiver under conditions of weak and fluctuating signal results in large part from careful design of the limiter stages. The limiter circuit shown in Fig. 6 employs two cascaded 6BN6 gated-beam tubes, the second stage being saturated by receiver noise when no signal is received.

Frequency Control Unit

The crystals required for both receiver and transmitter operation are located on the frequency-control unit chassis. When all eight channels are employed, a total of sixteen crystals is required. Each crystal oven is capable of accommodating two crystals so that a maximum of eight ovens may be needed. A small trimmer capacitor is connected

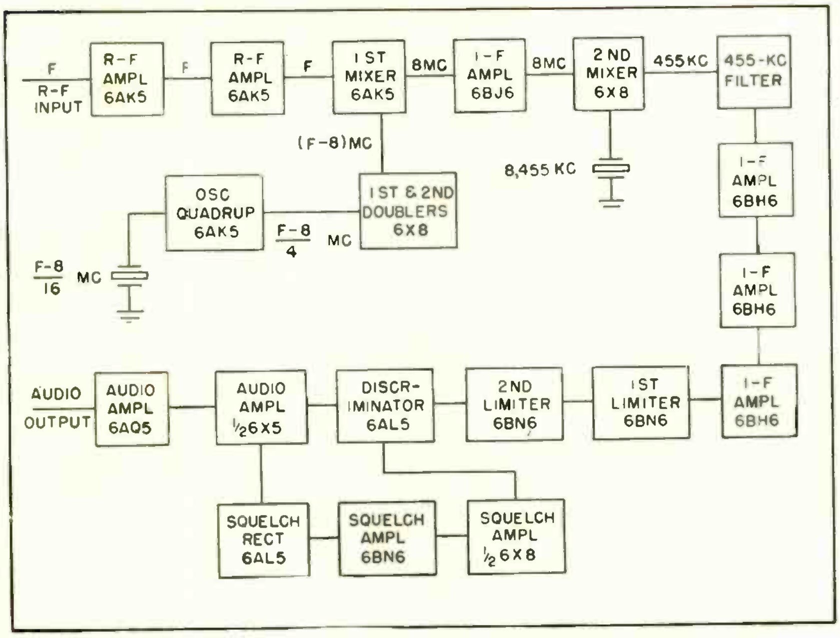


FIG. 3—Block diagram of double-conversion receiver with i-f filter

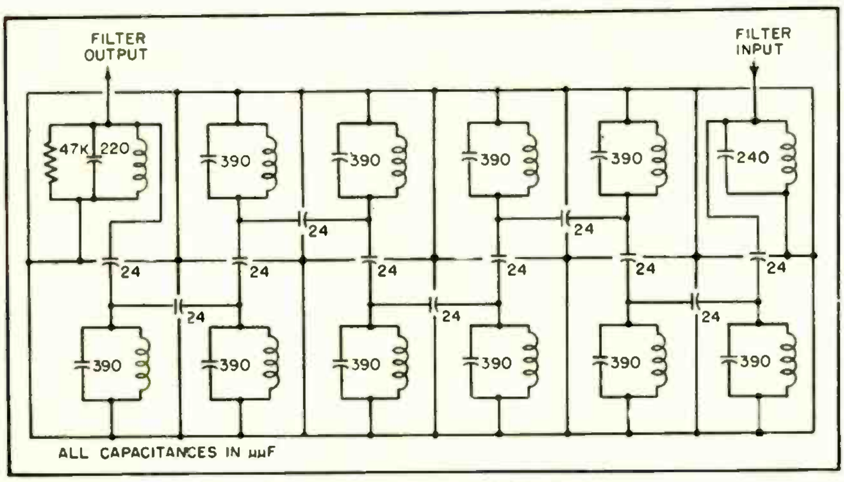


FIG. 4—Lumped i-f filter follows second detector of vhf receiver

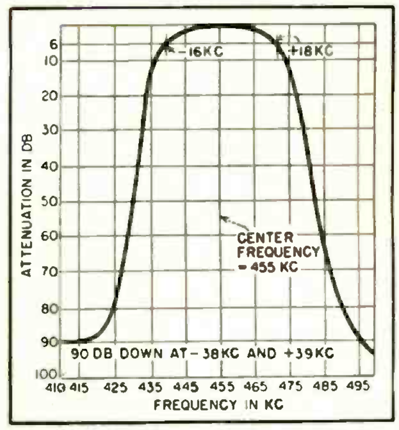


FIG. 5—Selectivity curve of twelve constant-k filter sections

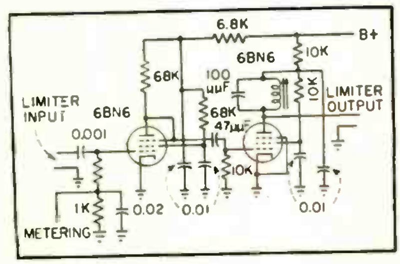


FIG. 6—Receiver limiter stages contribute to better reception

across each crystal for vernier frequency adjustment.

This control allows for field adjustment of each transmitter channel to the exact system frequency and of each receiver channel to the exact center of the receiver passband. Frequency stability of ±0.0005 percent from −30 to +60 C ambient temperature ensures maintenance of this frequency adjustment.

The chassis also accommodates the receiver, first local oscillator and the transmitter local oscillator, as well as a complete duplicate receiver r-f head. A multisection wafer switch running two-thirds the length of the chassis performs all channel-change functions including crystal switching.

While the 110-volt a-c power supply is conventional in design, the two vibrator-operated power suppiles designed for 12-volt and 32-volt d-c sources embody a number of interesting features. Heavy-duty interrupter-type vibrators are employed having two tandem sets of interrupting contacts driven by a common reed. To ensure even division of load current between the pairs of contacts, two bifilar wound primaries are provided on the vibrator transformer.

Dry-Disk Rectifiers

High-temperature selenium rectifiers connected in conventional bridge circuits replace the vacuum tube rectifiers in all the high-voltage secondary circuits. The filament strings in both 12-volt and 32-volt d-c models are wired directly across the primary power source with neither side connected to chassis ground, therefore leaving the mains supply floating.

Vibrator life has been good with no vibrator failures in the field. Numerous laboratory tests at 50-percent transmit duty cycle have indicated a life expectancy of several thousand hours. Good efficiency of the vibrator coupled with its satisfactory life expectancy led to the eventual use of the vibrator as a standard item.

Battery drain is of vital importance to owners and operators of small vessels. For this reason a standby-operate switch is provided on the control panel. In the standby position only the receiver and frequency-control-unit tube filaments are heated while in the operate position all heaters are energized. Crystal ovens operate in both positions of the switch.

REFERENCES

(1) "Communication Functions Provided for by the Great Lakes VHF-FM Supplemental Radiotelephone System." Feb. 5, 1954.

(2) Communication from Controller of Telecommunications, Department of Transport, Ottawa, Ontario, Canada.

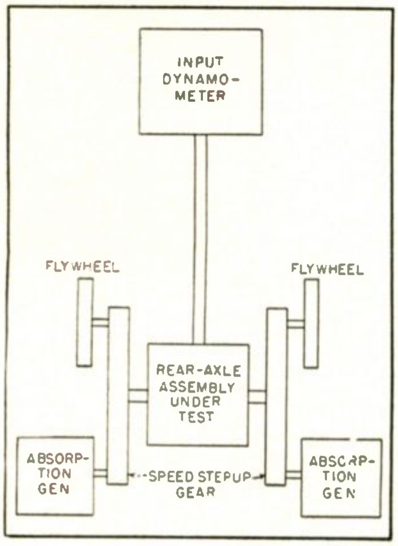
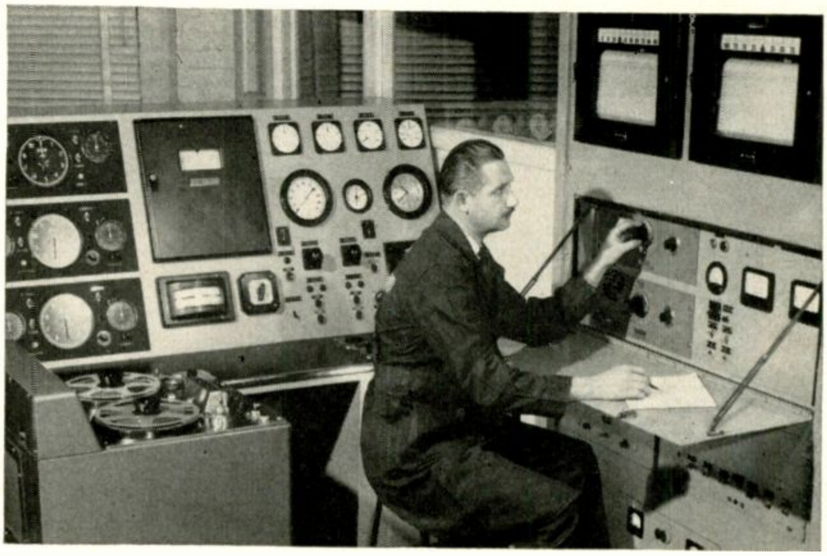


FIG. 1—Arrangement of dynamometers in axle testing setup



Control oscillators at desk are used to set up torque and speed data on f-m tape recorder. Loads corresponding to oscillator signals are shown on chart recorder

Tape Recorder Cycles

Dynamometer control system applies torque and speed loads to truck axle simulating road operation. Frequency-modulated tape carries information for four-hour cycle to control dynamometers through amplidyne system

DYNAMOMETER testing of truck rear axles permits study of axle breakdowns under conditions simulating normal truck operation.

In earlier dynamometer testing systems, cam-actuated switches have been used to add or remove resistance in the dynamometer control circuits to simulate changes in torque and speed. These systems permit only a few steps of control.

To duplicate more closely actual road-test conditions a tape-recorder controlled system has been developed and is now in use at the testing laboratories of the Timken Detroit Axle Division of the Rockwell Spring and Axle Co. Speed and torque data obtained from actual road tests are used to make an f-m tape recording.

In making the recording run, the running speed of the axle is plotted on chart paper against time and the torque values are plotted in a similar manner. These marked charts are placed in chart recorders and allowed to run as normal. The operator follows the recorded lines by varying the frequencies of two oscillators in the tape recorder input. Once recorded, the tape can be used to repeat the four-hour test cycle until axle breakdown occurs.

Dynamometers

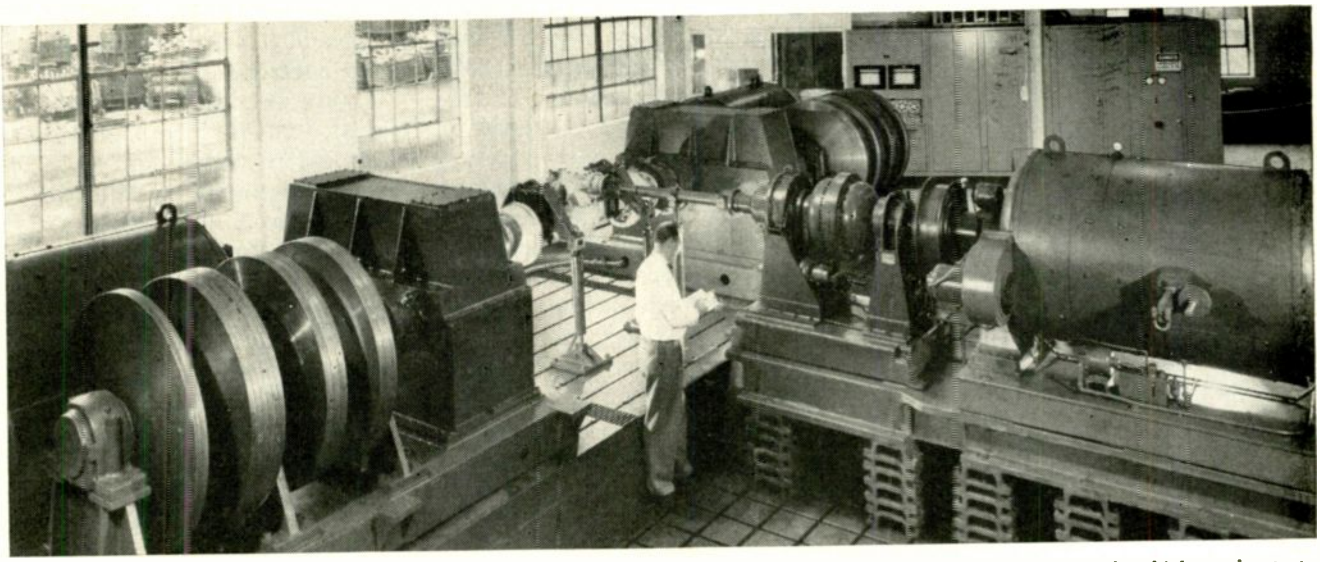
A dynamometer connected to the input of the rear axle assembly acts as the engine and transmission. Two output dynamometers, each connected to an axle shaft, represent loads that may be encountered on the road. Adjustable flywheels, also connected to the axle shafts simulate the inertia of a vehicle. The setup is shown in Fig. 1.

The input and two output dynamometers are direct-current machines capable of motoring or generating as required. Their armatures are connected in series with that of a d-c generator driven by a synchronous motor. Since the dynamometers are connected together both electrically and mechanically in pumpback, the generator only supplies the losses of the system and provides for acceleration and deceleration. Figure 2 shows the electrical arrangement.

Because of the series connection, armature currents in all machines are the same. Therefore, the only control required is for the dynamometer fields so long as armature current is regulated. Armature current is held constant at a preselected value by a regulator acting on the field of the generator.

Each dynamometer is excited by an amplidyne. The amplidyne is used rather than thyratrons because forcing in both directions is necessary. This would require two sets of thyratrons.

Two of the control fields of the amplidyne are connected in buck-boost fashion in the plate circuits of the two output tubes of a preamplifier used to excite the amplidyne. This permits forcing the



Axle-test dynamometer with rear axle assembly in place. Large flywheels on both axle shafts simulate inertia of vehicle under test. One of the tape recorder controls is in background

Truck Axle Tester

By R. P. WASHBURN AND E. B. STAVELY

General Engineering Laboratory
General Electric Co.
Schenectady, N. Y.

Applications Engineer
General Electric Co.
Detroit, Mich.

dynamometer fields in both directions. Also on the amplidyne are two other fields, a suicide field to force the voltage of the machine to zero and an anti-hunt field for stabilizing the control system.

The input dynamometer sets the speed of the system. Speed is regulated directly in a closed-cycle system. The voltage of a d-c tachometer generator belted to the shaft of the input dynamometer is compared with a reference voltage set at the desired value. The error signal is fed to the preamplifier to raise or lower the field current of the dynamometer.

Torque on the test axle is controlled by the two output dynamometers. Here, again, an amplidyne is used in conjunction with a preamplifier. However, torque is not regulated directly. Since armature current is held constant by the main generator, field current is a measure of torque.

In this case the voltage across a resistor in series with the dynamometer field is a measure of field current and is compared with a reference voltage to obtain an error signal.

The cycling control furnishes two varying reference signals to the amplidyne preamplifiers, one to control the input dynamometer speed and the other to control the total torque being transmitted by the axle assembly under test.

Recording Medium

The first item considered in the design of the cycling control was the recording medium. Several requirements were placed on the equipment that made standard techniques and equipment not directly applicable. The time of one cycle was to be four hours and the run was to be repeated without interruption an indefinite number of times until the axle showed signs of failure. The ability of the cycling control to repeat the initial program was not stated but it was felt an error of ±5 percent of the maximum value should be adequate. The type of conditions encountered during a run and the frequency of a change in condition during a run would be variable and would be made the worst possible to test the axle thoroughly. These requirements practically eliminated all but magnetic tape as a recording medium.

Amplitude recording was found the most common system in use. The variables encountered that would tend to cause drift or errors during playback with amplitude recording are tape nonuniformity, playback-head wear, tube aging, speed irregularities and magnetization of the tape head. A rough figure of repeatability for such a system is 20 percent, which is considerably above the limit set for the test equipment. In the best magnetic tapes available, amplitude-variations reproduced are guaran-

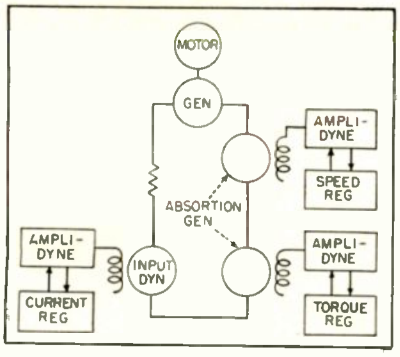


FIG. 2—Closed-loop dynamometer system showing amplidyne controls

teed only to plus or minus one-half decibel, or about six percent.

To avoid the defects of amplitude recording, the frequency-modulation method was chosen. The simplest system, and the one used in the cycling control, consists of a laboratory-type audio oscillator, tape recorder and a discriminator.

A frequency-recorded test program is made by turning the main dial of an audio oscillator and recording the excursions of frequency about a selected value. Upon playback this signal is applied to a discriminator to produce a d-c signal proportional to the extent of the frequency excursion.

The discriminator output voltage is unaffected by tape amplitude variations. The output is affected, however, by changes in tape speed. In a good commercial recorder all these speed variations are very small. Thus, the reproduction error on such equipment is much smaller than the amplitude method and repetition of signals over long playback periods is a measure of discriminator drift rather than recording errors. A total error for such a system should be on the order of one percent of the maximum signal.

The complete cycling control consists of the tape recorder and two variable audio oscillators, one fixed oscillator, two strip chart recorders, a discriminator chassis and one power supply mounted in a standard control cabinet. The electrical arrangement of the units is shown in Fig. 3. The oscillators are used only to make a recording for a test run and the reversal oscillator is used only at reversal points. The four summing resistors supply a half-volt signal to the recorder.

The magnetic-tape recorder is a modification of an Ampex 300 broadcast and transcription recorder. The modifications consisted of a reversing unit to detect reversal signals, a mechanism to change tape direction and relays for selection of recording and playback heads.

To avoid the possibility of a sudden jar to the axle during the tape reversal on playback, the signals at the ends of the tape are returned to a steady condition of minimum torque and speed before reversal. A relay in the discriminator holds the output constant during the time of reversal when the output of the recorder goes to zero.

The main playback amplifier can be energized from the record preamplifier or from either of the two playback pickup heads. During recording the latter arrangement is advantageous since the amplidyne signal is derived directly from the tape as it is in repeated playback. This assures that the record is really on the tape and that repeated playback will be exactly the same as during the recorded run.

The output of the playback amplifier is fed to a high-fidelity audio amplifier to produce a low source impedance with sufficient power for driving the discriminators.

Discriminators

The discriminator unit consists of two similar circuits and one common bias supply. The circuit controlling dynamometer speed will be considered first. The function of this circuit is to receive variable frequency signals in the 3,000 to 6,000 cycle range and convert them into a d-c voltage ranging from zero to −105 volts. The range and polarity was required to match the range and polarity of the amplidyne speed control.

Figure 4 shows the discriminator circuit. Tubes V_1 through V_5 form the speed control circuit. The discriminator input is filtered for signals above 2,500 cycles by a high-pass filter. Resistor R_1 and potentiometer R_2 form the impedance matching terminations for proper filter operation and a gain adjustment. The sine-wave signal is then doubly amplified and clipped into square-wave pulses by tube V_1. Its output is coupled to V_2 which is a conventional bistable multivibrator. The output is a square wave which is differentiated by C_1 and R_4. Resistor R_4 is returned to B+ instead of ground.

Only the negative pulses of the differentiated wave will be passed by tube V_{4A}. This starts the plate of V_{3A} downward and starts to cut off conduction of V_{3B}. This causes the cathode current to decrease, lowering the bias on V_{3A} and causing that half to increase in conduction, further decreasing its plate voltage. The coupling action of C_2 makes this change drive itself to completion and gives a steep positive pulse output. This leaves V_{3A} fully conducting and V_{3B} cut off.

Upon termination of the above change and its starting pulse, the grid of V_{3B} starts increasing its potential through the 2-megohm resistor returned to B+. Capacitor C_2 is also charged through this resistor. These determine the time constant for the off time of tube V_{3B}.

When the potential of the grid reaches cutoff for the particular cathode voltage, V_{3B} starts conducting. This increases cathode cur-

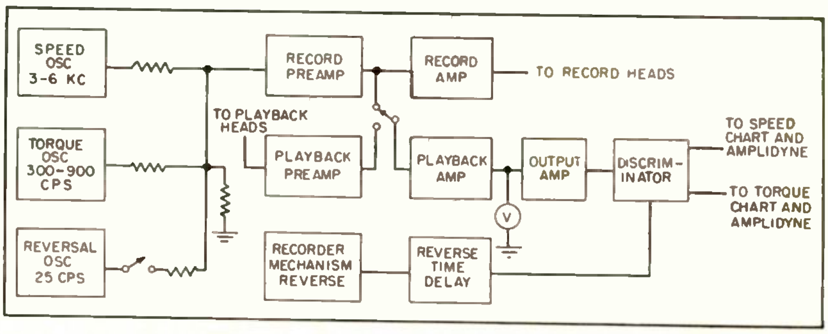


FIG. 3—Manually controlled oscillators supply speed and torque information to tape recorder. Discriminator separates signals on playback to control dynamometer

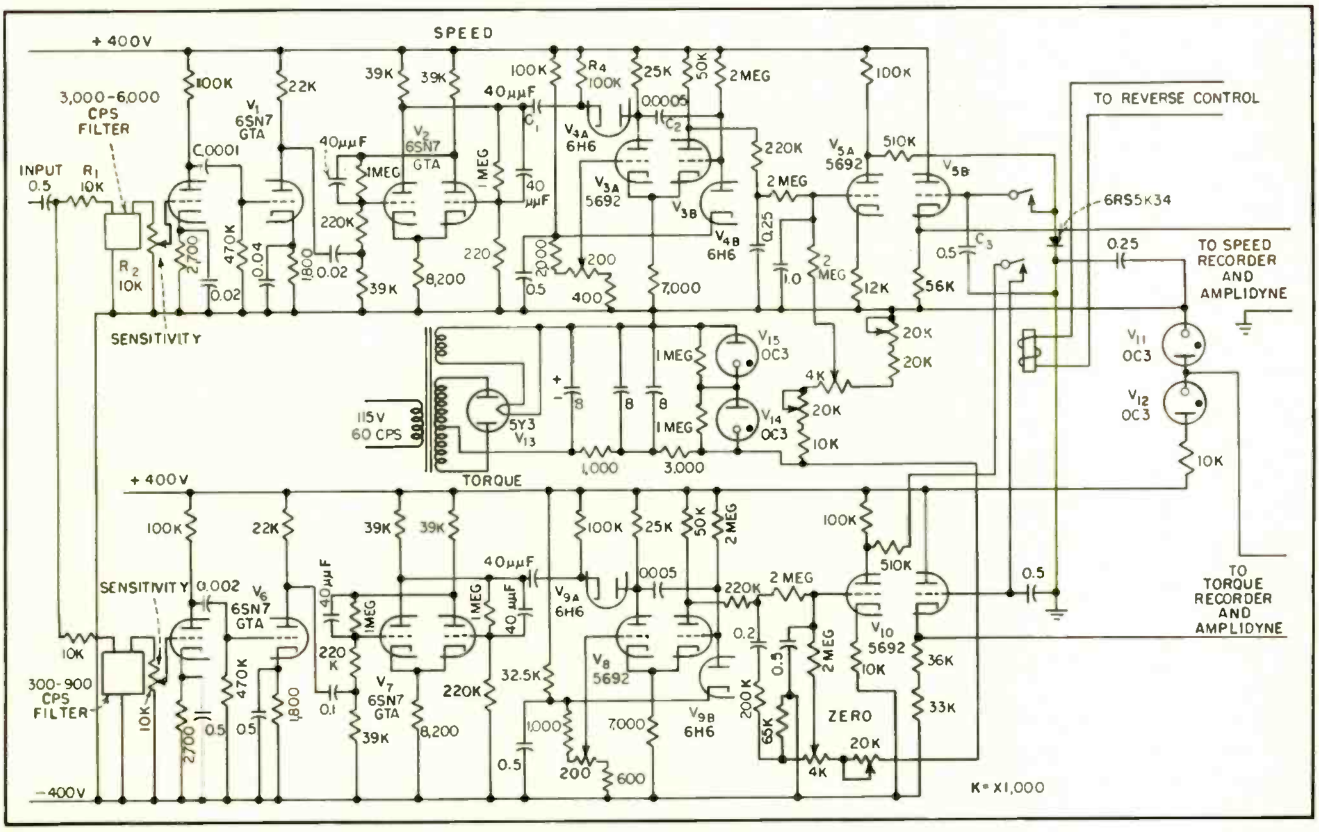


FIG. 4—Discriminator uses two similar circuits with bandpass filters to separate low-frequency torque information from speed information recorded at a higher frequency

rent and starts cutting off V_{3A}.

Another suicide action occurs whereby the grid of V_{3B} is driven more positive and the previous steady-state condition has been resumed. The voltage excursion is limited by the action of V_{4B}. This limits the upper voltage of the grid of V_{3B} and thus the lowest plate voltage or output voltage.

The output pulse width is determined by the potential of the grid of V_{3A} and is controlled by a potentiometer. This control sets the cathode potential of V_{3A} and determines the critical grid voltage.

Thus, each time a full sine wave is passed by the filter unit, there is an output pulse. The output pulses of constant width and amplitude are averaged and amplified by V_{5A}. This d-c voltage is thus proportional to frequency. A separate negative power supply increases stage gain and provides a zero control.

The output of the speed-control section must be a negative voltage to ground, and full speed corresponds to −105 volts to match the manual control. Thus, the output should be of low impedance, and be capable of negative to ground operation. This was accomplished by placing the B− of the power supply −210-volts negative to ground by means of two glow tubes. Thus B+ is +190 when the power supply is adjusted to 400 volts. The d-c amplifier, V_{5A}, is directly coupled to the cathode-follower output, V_{5B}, through a relay.

Reversal

The relay operates from the reverser unit and disconnects the cathode-follower grid from the amplifier tube upon tape reversal. The grid voltage is held constant by capacitor C_3 until the relay picks up ten seconds after tape reversal and full control signals.

Since the signal levels are held constant just before and after reversals, there is no switching surge to jar the dynamometer equipment. A small, high-voltage, selenium rectifier is connected from the cathode-follower grid to ground to prevent positive excursions of this grid relative to ground, which would cause a speed reversal.

In the torque channel the torque signal is treated identically with the speed signal. Here the frequency range is greater, 300 to 900 cycles, than the 2-to-1 speed ratio since output voltage must be twice the range, −105 to +105 volts relative to ground. The additional gain is obtained in the d-c amplifier. No rectifier is used since positive voltage to ground is required.

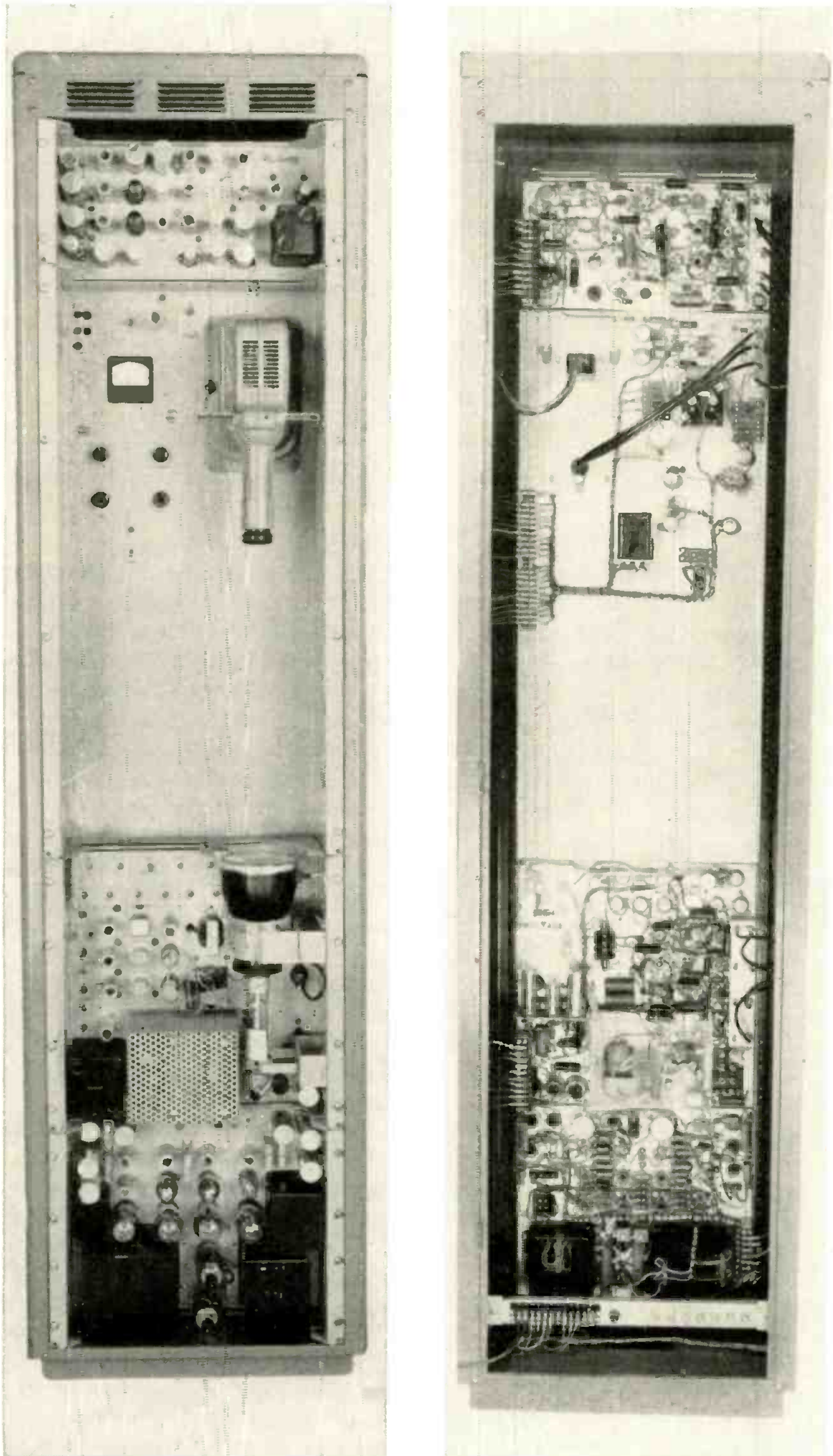
The output of the playback amplifier is connected to a twin-T network set to reject all frequencies outside the 24 to 26-cycle region. Upon receipt of a 25-cycle tone, the signal is passed on and fires a small thyratron tube that actuates a plate relay causing reversal of the capstan motor and the selection of the opposite pair of recording and playback heads.

An additional time-delay unit has been added to the control to prolong the few seconds delay already built in the reverser. This was necessary to allow a longer time for the discriminator to establish the steady value existing prior to reversal.

The over-all accuracy of reproduction of the recorded values is on the order of one percent of full-scale values. Drift in the power supply and discriminator seems to account for most of the error.

Television Flying-Spot

Picture source has resolving power in excess of 600 lines with a signal-to-noise ratio of 35 db or more. Operation may be changed from positive to negative slides by means of a switch in the clamp circuit. Gamma correction compensates for crt nonlinearity



Front and rear views of flying-spot scanner employing 5-inch projection crt

FUNDAMENTAL need in a tv broadcasting station is for a simple, low-cost source of picture signal for test pattern, station identification and general station maintenance. The television development laboratory and receiver factory also need a source of high-quality picture signal. Ability to vary the picture content, such as by use of different slides, is very important.

Study has shown that the opaque scanner has an advantage over the slide scanner in that sometimes the material is easier to prepare. On the other hand, the slide scanner has many advantages. There is no problem keeping glass-mounted slides clean, easily stored and in ready-reference file. The slide scanner requires only one phototube instead of at least two for the opaque scanner.

The slide scanner has two to three times the efficiency of the opaque scanner and as a result the cathode-ray tube voltage in the opaque scanner must be two to three times the 20 kilovolts required in the slide scanner. The optics can be of high quality without incurring the expense required in the opaque scanner.

The flying-spot scanner, although somewhat more expensive than the monoscope, compensates for this by its ability to provide a variety of picture signals limited only by the number of different slides available. The monoscope invariably is a single-signal source.

Operation

In the block diagram of Fig. 1, the cathode-ray-tube beam operating at 20 to 25 kilovolts scans a rectangular raster determined by the horizontal and vertical scanning currents derived from the deflection and high-voltage unit.

Slide Scanner

By A. J. BARACKET
Federal Telecommunication Laboratories
Nutley, New Jersey

Negative blanking pulses applied to the crt grid cut off the beam during horizontal and vertical retrace times.

The flying spot of light is focused by means of the objective lens onto the test pattern or other film slide. The spot of light, modulated by the content of the film, is collected through a condensing lens into a multiplier phototube. The photocathode current, of the order of 0.1 microamperes in the highlights, is amplified to 100 microamperes at the multiplier-phototube anode. The signal voltage at the anode load is then amplified by normal video-amplifier techniques. In the process gamma correction is applied to compensate for the monitor or tv receiver picture-tube black compression.

Phosphor Persistence

The projection flying-spot cathode-ray tube phosphor has an extremely short persistence amounting to 1.4 microseconds for a 50-percent response. As short as this persistence is, it must be compensated for

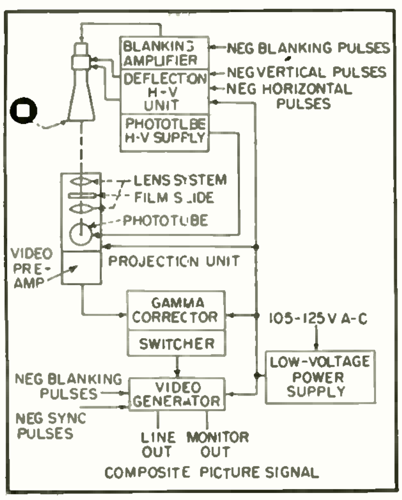


FIG. 1—Flying-spot scanner crt beam operates at 20 to 25 kilovolts

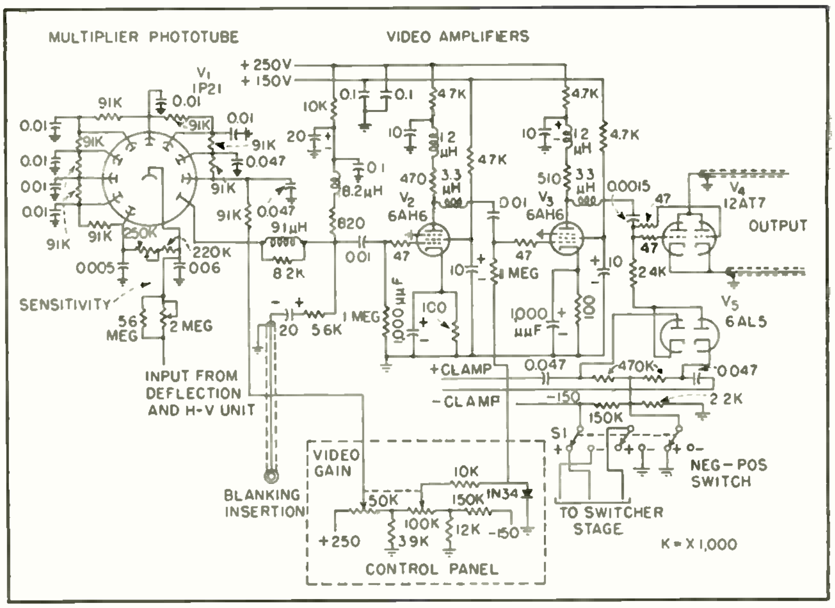


FIG. 2—Projection unit of monochrome scanner uses video amplifiers having a response of less than 3 db down at 12 mc. Black level is set by clamp, V_5, prior to gamma correction in the control panel circuits

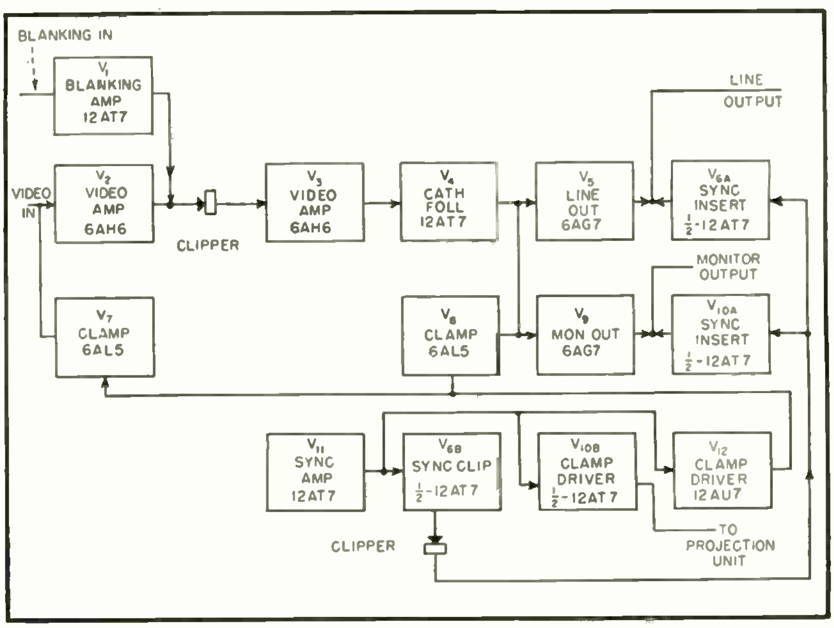


FIG. 3—Video generator uses sync insertion at output to make room for video. Control panel video output is fed into and amplified by 6AH6 tubes V_2 and V_3. Tube V_1 amplifies blanking signal to proper level for insertion into plate circuit of V_2

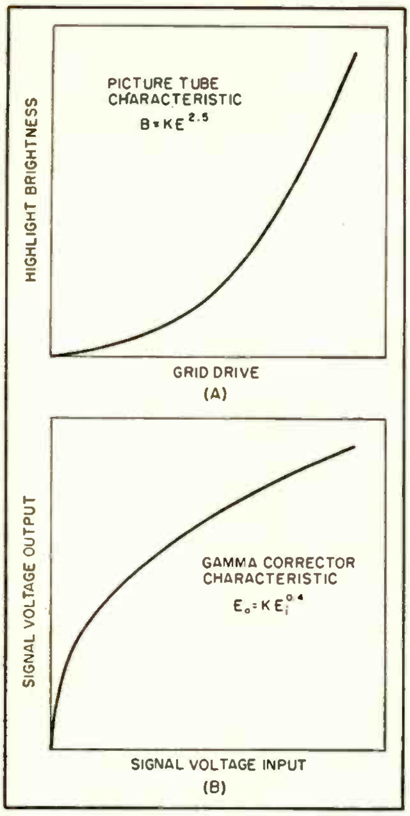


FIG. 4—Nonlinearity of picture tube characteristic (A) and compensated curve obtained by using germanium diode in control-panel circuit (B)

to prevent excessive picture streaking. The compensation consists of a high-pass filter network effectively the inverse of the low-pass filter representing the phosphor decay.

To provide maximum convenience and accessibility in this equipment, the scanner is cabinet mounted. Other scanners intended more for program operation than for maintenance and test-pattern signal are console mounted.

Video Amplification

The overall amplitude-frequency characteristic of the video amplifier yields a response of less than 3 db down at 12 mc. The fall-off is purposely made slow to give a good phase characteristic and transient repsonse.

Figure 2 shows the simplified schematic of the projection unit. Tube V_1 is the 1P21 multiplier phototube selected for its inherent low-noise and high-sensitivity characteristics. Tubes V_2 and V_3 are wideband video amplifiers ahead of the clamped output stage. The clamp V_5 sets black level prior to gamma correction in the control panel circuits.

The video output of the control panel is amplified by V_2 and V_3 in the video generator, Fig. 3. A clamp at V_2 grid sets black level for blanking insertion, in the plate circuit of V_2. A cathode follower V_4 drives the grids of the line-out and monitor-out stages V_5 and V_9. Tube V_1 amplifies the blanking signal to a level where it can be inserted in the plate circuit of V_2 and clipped by the crystal diode.

The grids of both the line output and monitor output tubes are clamped to limit the operating range on the grid base of these tubes. To further provide room for the video, sync is inserted in the output stages, V_{6A} and V_{10A}. Tubes V_{11} and V_{6B} are sync-amplifier stages and V_{12} is a clamp-pulse amplifier and driver.

Gamma Correction

The light-input versus signal-current output of the 1P21 phototube is linear over the range used. The amplifiers have a good amplitude-linearity characteristic. The cathode-ray tube in a picture monitor or television receiver, however, has a nonlinear characteristic of highlight brightness versus grid drive as shown in Fig. 4A. Therefore, if a signal from a linear device such as a flying-spot scanner were to be displayed without any compensation, the picture would be contrasty with very few tone separations in the dark gray region. This is due to the extreme curvature of the picture-tube characteristic near black level.

Figure 4B shows the compensation required to overcome the picture tube nonlinearity. Use is made of the nonlinearity of a germanium diode in the control-panel circuit of Fig. 5A to expand the blacks and dark grays according to the curve of Fig. 4B. This yields a gamma of 0.4 in the scanner to compensate for the picture-tube gamma of 2.5.

Phosphor Lag Compensation

The resolution deterioration due to phosphor decay is equivalent to that caused by a low-pass filter. For compensation, a high-pass filter is needed. This is obtained by use of

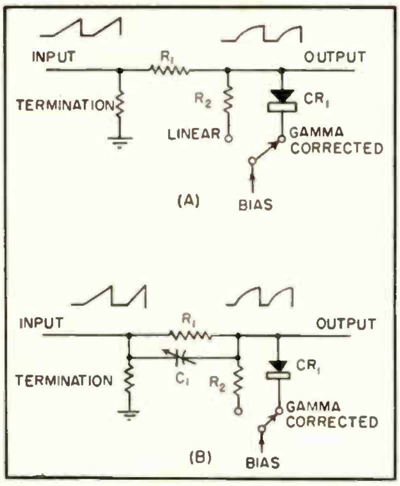


FIG. 5—Gamma correction circuit (A) and gamma corrector and phosphor lag compensator (B)

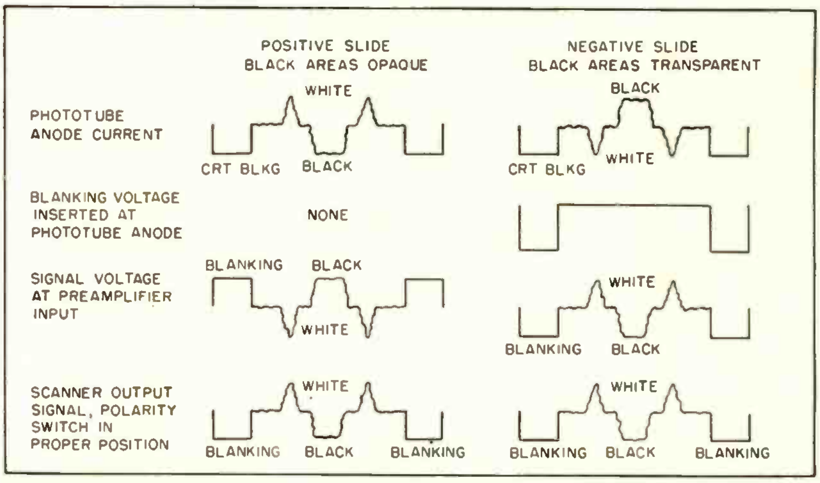
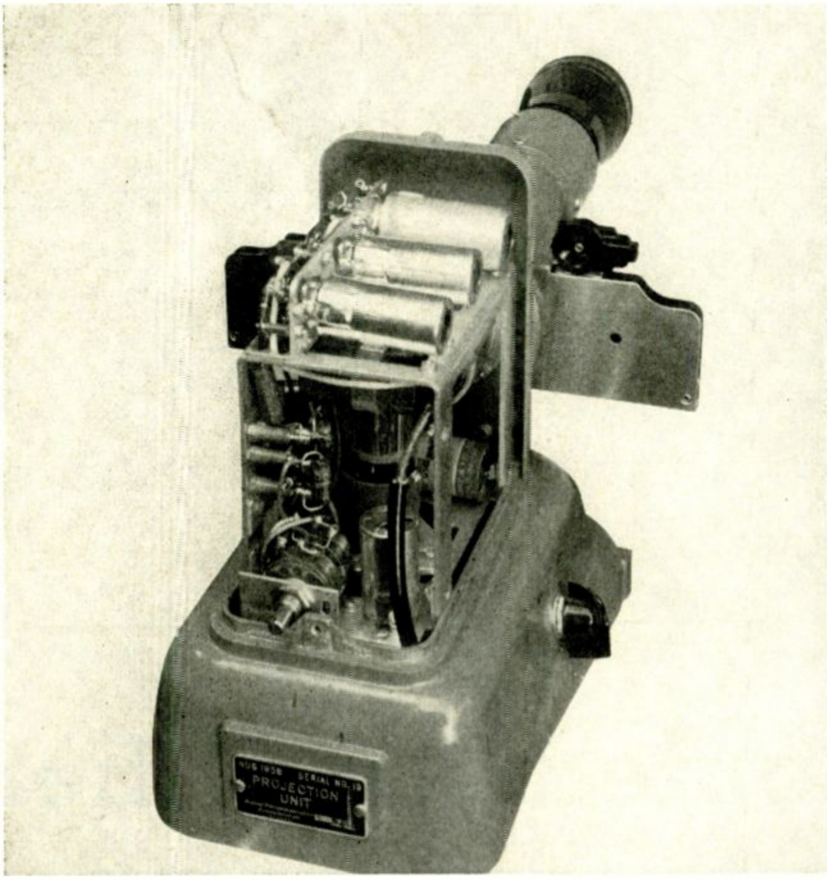


FIG. 6—Blanking inserted for negative slide operation before and after compensation. Scanner circuits automatically compensate for departure of blanking from black level



Inner view of projection unit showing video preamplifiers. Unit contains 1P21 multiplier phototube having a photocathode current of the order of 0.1 microamperes in the highlights

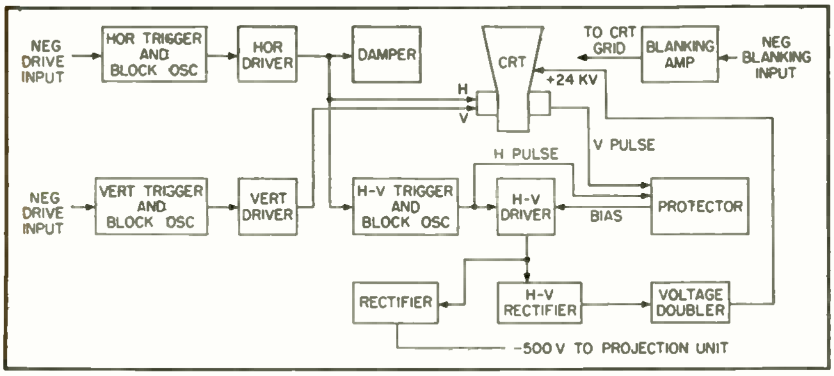


FIG. 7—Deflection and high-voltage unit uses output of a 1B3 rectifier to supply 24 kv to cathode-ray tube

an RCR compensator circuit consisting of C_1, R_1 and either R_2 or diode CR_1 in Fig. 5B.

In this circuit, the individual losses normally caused by gamma correction and phosphor lag compensation are avoided, resulting in only one loss.

Signal-to-Noise Ratio

The source of noise in flying-spot scanners is primarily shot noise in the photocathode signal current. Techniques have been described for optimizing the signal-to-noise ratio.[1] These have been used with good success.

Positive and Negative Slides

Many of the station identification and commercial slides are positive slides. However, a very convenient source of programming material is the readily available 35-mm double frame negative. Use of negatives is provided for in this scanner by means of a switch in the clamp circuit. This feature is made convenient by use of circuits that automatically compensate for the departure of blanking from black level in a negative slide. Figure 6 shows the scanner signal from a negative slide before and after compensation.

Beam Voltage Effect

The greater the light output of the projection crt the better is the signal-to-noise ratio. Resolution is also favorably affected by an increase in high voltage due to the resultant smaller spot size. With the high efficiency of the transparent-slide scanner it is not necessary to go beyond 20 to 25 kilovolts for 600-line resolution and 35-db signal-to-noise ratio. At 20 to 25 kilovolts d-c operation in the scanner, the x-ray radiation is negligible and was measured to be far below minimum average dosage. At much higher beam voltages there is a more difficult situation with respect to high-voltage insulation and the prevention of corona and breakdown.

In the scanner, high voltage is obtained independently in a pulse circuit located in the deflection unit as shown in the block diagram of Fig. 7.

The flying-spot scanner for 2 by 2-in. slides has the following characteristics: beyond 600-line resolution; over 20-to-1 contrast ratio; signal-to-noise ratio beyond 35 db; gamma correction to compensate for the monitor or receiver cathode-ray tube; ability to handle both positive and negative slides; adequate phosphor-lag compensation; convenient rack cabinet mounting; excellent stability, partially due to regulated high and low-voltage supplies.

Achnowledgment is due to work of T. M. Maxwell, Jr., and S. DeMars on circuits and E. Galuska and F. Numrich for chassis arrangements.

REFERENCE

(1) A. J. Baraeket, Signal-to-Noise Ratio in Flying-Spot Scanners, *Tele-Tech* Dec. 1951.

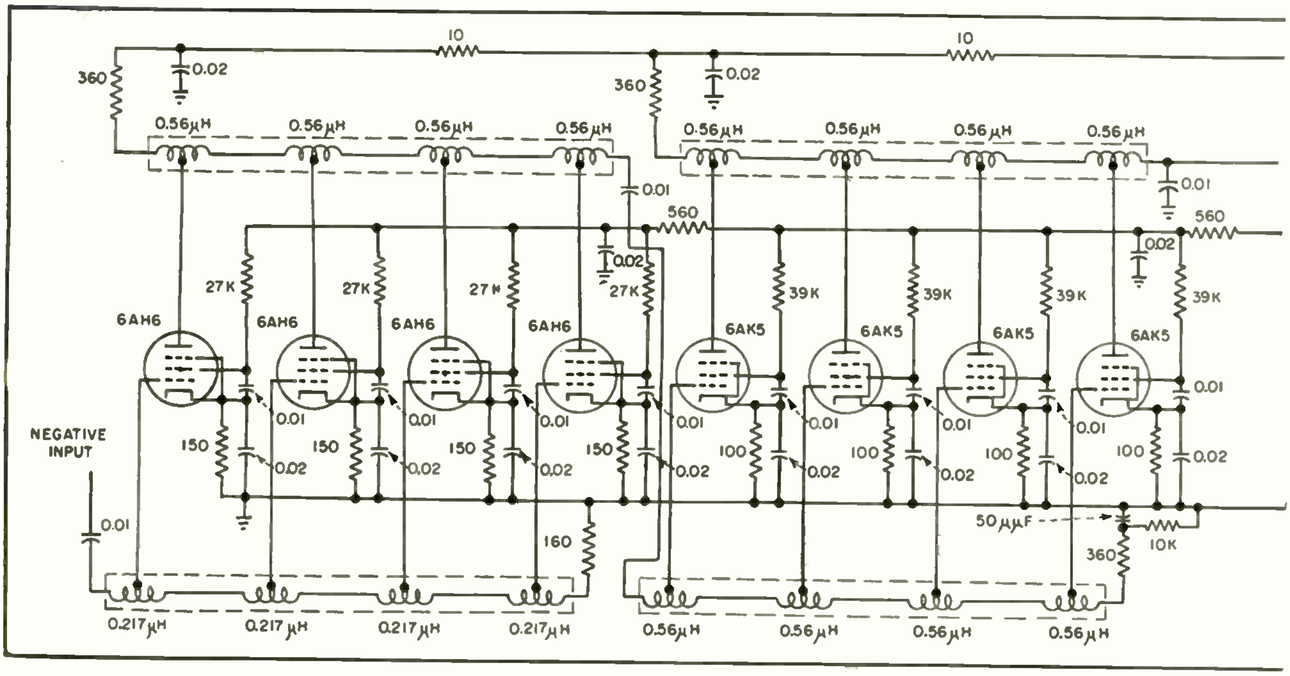


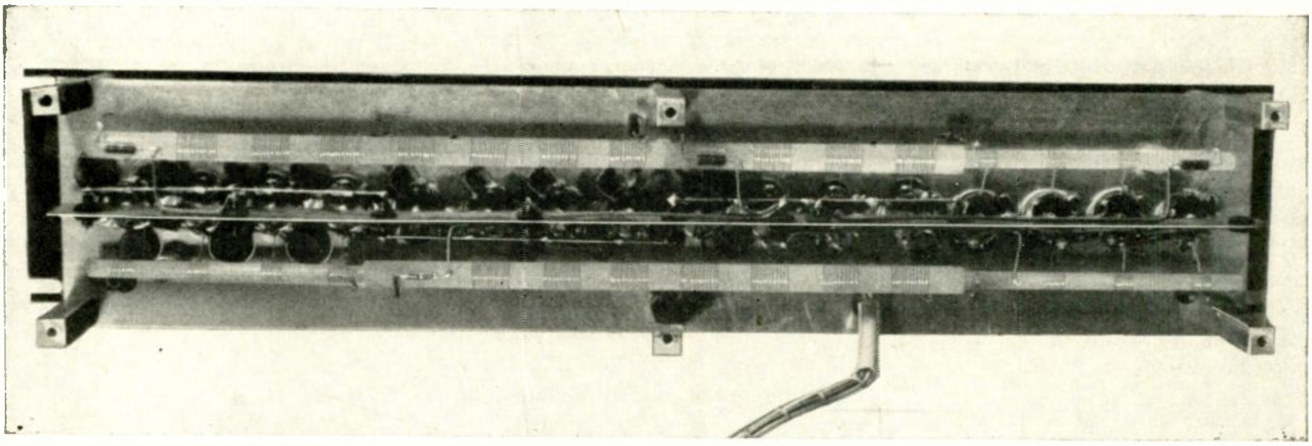
FIG. 1—Schematic of distributed amplifier. Delay-line coils are wound on threaded polystyrene rods with No. 28 wire: 0.56-μh coils have

Distributed Amplifier

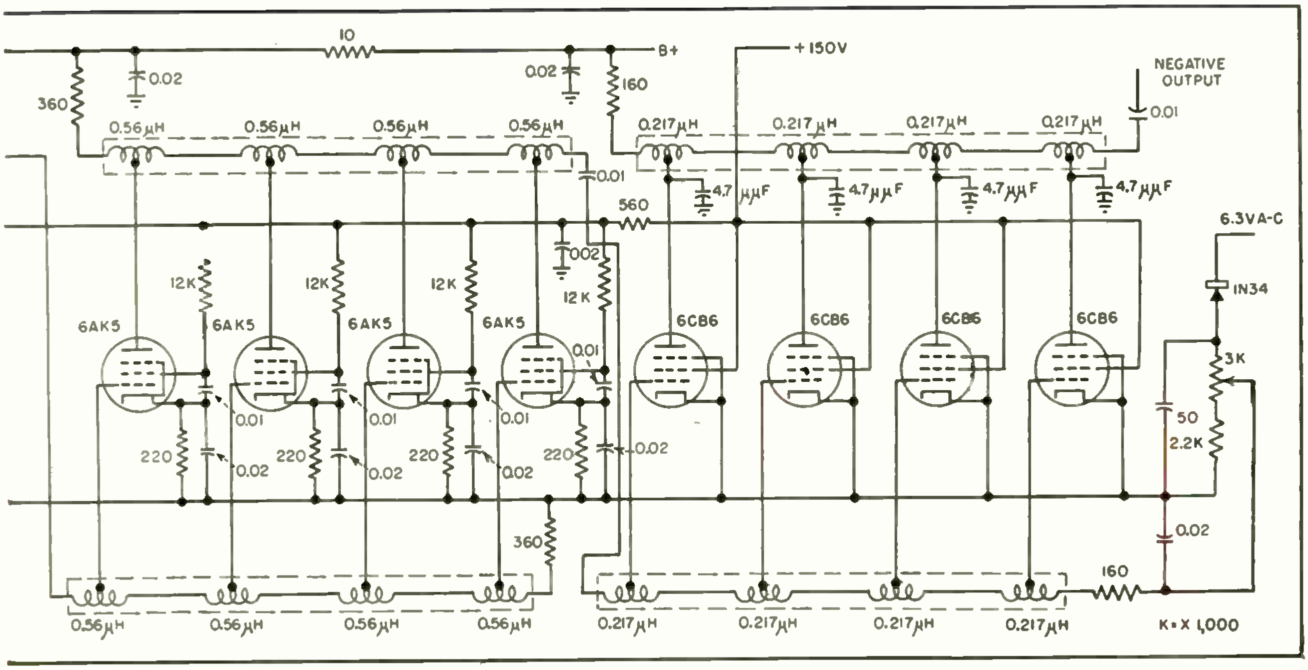
Wide-band amplifier uses traveling-wave principle to obtain gain of 50 to 60 db over a range of 5 to 100 mc. Pulses with rise times as short as 4.2×10^{-9} second are faithfully reproduced. Unit has up to 8-volt output with good linearity.

SCINTILLATION counters, which are used in nuclear-physics research for detection and energy measurement of particles, usually do not have sufficient output to operate scalers and coincidence circuits directly and require an intermediate stage of amplification. Due to the short rise time of the signal and the high attenuation imposed by the associated cabling, a high-gain, wide-band amplifier is necessary.

In many laboratories, the distance between the scintillation counters proper and the amplifiers, and between the amplifiers and the coincidence and scaling circuits is considerable. In the present application, this distance is approximately 350 feet. To transmit pulses of 5 ×



Bottom view of amplifier showing delay lines. Shield between the output and input lines serves as a ground plane to which bypass capacitors, cathode resistors etc are grounded.



13 turns on ⅜-in. o.c. rod with 24 thd per in.; 0.217-μh coils have 9 turns on ¼-in. o.d. rod with 32 thd per in.

for Nuclear Research

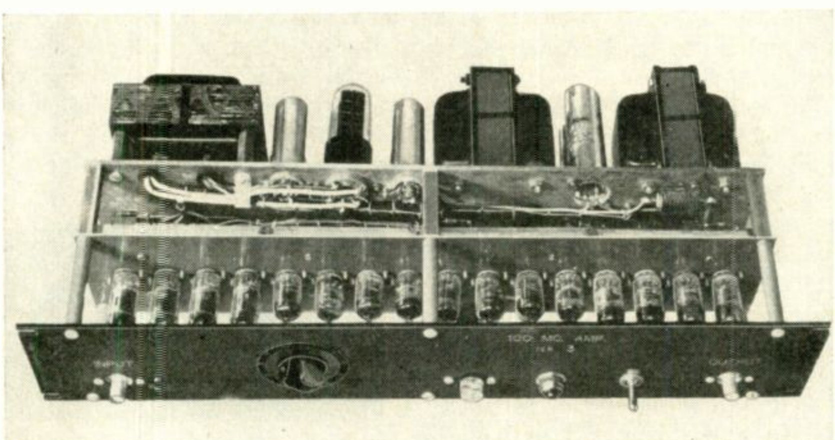
By KURT ENSLEIN
University of Rochester
Rochester, N. Y.

10^{-9} sec rise time over such distances, one of the few practical methods is to use properly terminated coaxial cables. From the standpoint of obtaining signals of fairly large amplitude with a minimum of tube current, it is desirable to use cable with the highest possible characteristic impedance while simultaneously satisfying the attenuation criteria.

Though cables of large diameter are available with 250 ohms impedance, this installation uses 160-ohm cable for short runs and RG/62-U cable of 100 ohms characteristic impedance for long runs. Even the 100-ohm cable has substantial attenuation for runs of this length. Therefore, it is not uncommon to have all the computing circuits close together, with only slow information being transmitted over long cables.

Since 160 ohms is the highest practical cable impedance for our purposes, a distributed amplifier with input and output impedances of 160 ohms was designed to work between two such cables. Since the signal from the counter multiplier phototube anode is a negative pulse and coincidence circuits and scalers often work on negative inputs, the amplifier must be noninverting. This dictates an even number of stages, if grounded cathode circuits are used.

Finally, the questions of gain



Amplifier with cover removed. Unit's power supply is mounted at rear. Tubes are free of obstructions permitting ample air circulation and maximum output amplitude remain. The output from scintillation counter multiplier phototubes varies over wide ranges. In this case, however, the quantity of interest is the minimum amplitude for the speed of response indicated earlier. A good value for this is 0.05 to 0.1 volt peak. Coincidence circuits usually require inputs in the order of 3 to 5 volts. This fixes the value of gain between 50 and 60 for the amplifier. The maximum output signal should not be less than about 5 volts peak.

The bandwidth criteria were derived from the rise time and maximum duration of pulses that are expected to be passed by this amplifier.

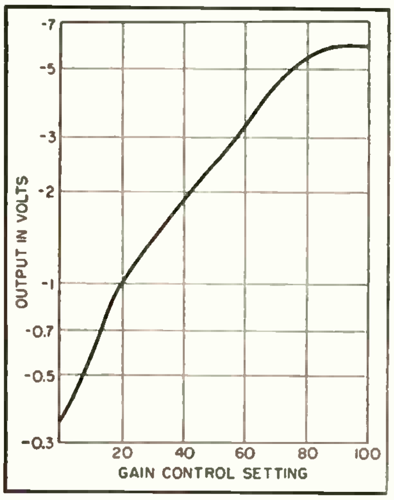


FIG. 2—Amplifier output voltage against gain-control setting for —0.1-v, 0.06-μsec input pulse

Design Data

The schematic of the amplifier is shown in Fig. 1. Design principles for distributed amplifiers have been developed in the literature.[1,2] It has been shown that minimum number of tubes is achieved for a given gain and a given bandwidth when the gain per stage is 2.72. This criterion is completely valid only when each stage consists of the same tube type, the tubes are operated at their maximum gain-bandwidth product and the gain per stage is equal for all stages. Measurements have shown that since the overall bandwidth of the amplifier is only 100 mc, no serious difficulty will be encountered from input impedance and cathode resonance problems for the tubes used.

The amplifier was designed so that the average gain per stage would be approximately 2.72. From the design objectives, the number of stages in this amplifier must be even. For two stages, gain $= 2.72^2 = 7.4$, which is too low. Four stages give $2.72^4 = 54.9$, which is a practical number for this purpose.

The original design was based on the use of constant-K lines. It was found, however, that these lines were unduly susceptible to stray effects such as changes in tubes and slight errors in inductances. Since it was desired to keep the number of adjustments to an absolute minimum, a design based upon M-derived lines was developed. While these lines are considerably more difficult to construct initially, experience has shown that distributed amplifiers constructed with them are tolerant of large changes in L and C.

It was found in the amplifier under discussion, that no change in rise time or reflections could be observed if an entirely different set of tubes was inserted. As constructed, the amplifiers have no alignment adjustments and none of the ten built to date have exhibited any real departure from the characteristics shown.

Only two types of artificial transmission lines have been used, 160 ohms and 360 ohms. While a greater gain-bandwidth product could have been obtained by using a greater variety of lines, the additional design time was not felt justified, since the amplifier exceeds the specifications as it is.

Impedance Matching

No great care has been taken in the amplifier to match capacitances exactly.

For example, the output capacitance of the 6AH6 is 2 μμf and the input capacitance of the 6AK5 is 4μμf. Yet both the plate line of the first stage and the grid line of the second stage are of the same characteristic impedance. One or the other, or both, of the lines must be mismatched. Yet, from the practical standpoint, the effect is negligible as long as the velocity of propagation in respective grid and plate lines is identical and one of the lines is properly terminated.

Suppose the plate line of the first stage is of characteristic impedance 360 ohms and therefore properly terminated. No adverse effects occur until the first section of the grid line of the second stage is encountered. A reflection is produced at this point. This reflection travels down the plate line of the first stage. Since this line is properly terminated, the signal is absorbed by the termination. The same thing happens on the second and other grids. Here, however, a difficulty is encountered. Suppose a reflection is created at the fourth grid of the second stage. This reflection will travel towards the left and will be of opposite polarity than the input signal. Since it travels towards the left, it is amplified by all the tubes of the second stage only towards the left and therefore ends in the reverse termination of the plate line of the second stage. The signal components that went towards the right in the plate line of the second stage will be out of phase and will appear at the grids of the third stage as separate pulses of much smaller amplitude than the desired signal and of opposite polarity.

The same sort of effect will occur between the plate line of stage 2 and the grid line of stage 3. By a judicious experimental choice of mismatches, it is possible to cancel the effects of the various misterminations, resulting in a clean signal.

The termination of the plate line of the third stage is 360 ohms and the termination of the grid line of the fourth stage is 160 ohms. These respective lines are of the nominal impedances represented by their terminations. It is to be expected, however, that a considerable reflection will occur at the junction of the two lines. This reflection will promptly be absorbed by the reverse termination of the system,

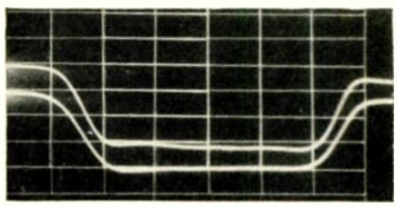


FIG. 3—Input waveform to amplifier with 10^{-9} sec rise time and output waveform (bottom) with maximum gain

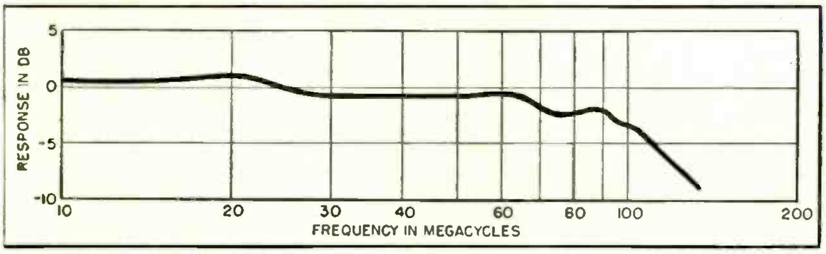


FIG. 4—Frequency characteristic of amplifier in the range of 10 to 200 mc

namely the left termination for the plate line. This is much like a tapered line and the advantage of greater net gain into the load holds here also.[1]

Tube Types

Three types of tubes are used, the 6AH6, 6AK5 and 6CB6. Type 6AH6 is used as input tube because of its high g_m/I_p ratio for the absolute value of g_m used. A high value of g_m is needed since the first stage operates with negative-going signals and g_m therefore decreases with the signal. The high input capacitance of the 6AH6 was no objection in this case, due to the nominal 160-ohm input impedance of the system. The low cathode resonant frequency is no objection either, since the maximum frequency of interest is approximately 120 mc.

Since the 6AH6 has an output capacitance of 2 $\mu\mu$f, it was desired to follow it by a stage with comparable input capacitance. The 6AK5 fits this situation best. Since its output capacitance is not much different from its input capacitance, the third stage is an iteration of the second stage.

The problem for the last stage was to use a tube with greater current-handling capability than the 6AK5 to develop at least 5 volts across 80 ohms, or approximately 63 ma of peak current. It was not desirable that this tube have as large an input capacitance as the 6AH6 and the 6CB6 seemed a satisfactory compromise.

By working the tubes well below their ratings, and with the alternatively low and high biases needed in the system, the choice of tubes indicated above led to approximately 4 tubes per stage. This number simplified construction of the artificial transmission lines and was not too high to exclude lining up the tubes in a single row approximately 17-in. long, which is the maximum length that can be fitted into a 19-in. rack.

The various tubes are operated far below their maximum ratings. Because of this, it was found unnecessary to select tubes for any of the amplifiers constructed. A modification of the amplifier, decreasing cathode bias and increasing screen voltages, was made to run the tubes harder. The amplifier gain was thereby increased from 36 db to 40 db.

Gain Control

To provide control over the total gain of the amplifier, the last stage is operated at a variable grid bias. Figure 2 shows that the gain can be varied over a range of approximately 24 db by this method. This type of control is more desirable than the type which attenuates the signal by a potentiometer, since the signal is not varied, but rather, the gain of the amplifier tubes.

While it was anticipated that the amplifiers would be operated from a-c lines having a regulation of better than 0.1 percent, additional protection was provided by regulating the screens of the tubes by a glow-discharge tube. The large cathode resistors also help.

Low-frequency compensation is provided by the R-C combination in the grid line of the second stage. This is a more desirable method than that of providing larger coupling capacitors between lines, or by connecting grids individually by capacitors to the grid delay lines.

Power Supply

The amplifiers are operated from a regulated a-c line, the plate supply is therefore left unregulated and consists of a simple choke-input rectifier. A small amount of decoupling between stages was found to be desirable, especially in the high-gain versions of this amplifier.

The pulse performance of the amplifier as observed on a wide-band oscilloscope is shown in Fig. 3. The upper trace is the input to the amplifier and the lower trace the output at maximum gain. The output waveform was taken with an attenuator between the amplifier and the oscilloscope. The input pulse for these photographs was derived from a mercury switch pulser, with a rise time of the order of 10^{-9} sec. The oscilloscope did not have as good a rise time as this and the input pulse is therefore smeared out. The sweep speed for these pictures is 10^{-8} sec per division. The measured rise time of the amplifier, from these pictures, is 4.3×10^{-9} sec.

Figure 4 shows the frequency re-

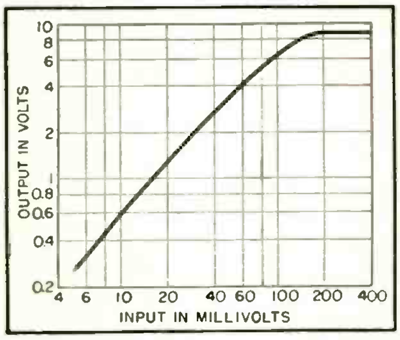


FIG. 5—Linearity curve of amplifier

sponse of the amplifier in the range of 10 to 200 mc. Several small discontinuities will be noticed, but these are relatively immaterial insofar as the pulse response of the amplifier is concerned.

Figure 5, a plot of input vs output amplitude, shows that the linearity of the unit is quite good up to an output of approximately 8 volts. This is more than adequate for operating scalers and coincidence circuits.

This work would not have been possible without the diligence and experimental design efforts of Anatol Adveenko, nor without the support of the AEC.

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Stabilizing Color Carrier

Self-balancing phase detector achieves stability by combining time gate and synchronous detector with bipolar detector to minimize factory alignment as well as field servicing of color reference oscillator. Circuit also includes color-kill output for monochrome reception

By E. G. CLARK

Philco Corp.
Philadelphia, Pa.

SYNCHRONOUS DETECTORS used for high-sensitivity phase detection have suffered in past applications from phase instability produced either by supply-voltage or gating-voltage variations. Although conventional balanced-diode phase detectors have desirable characteristics, their usable sensitivity depends upon exactness of balance and level of input signal.

The self-balancing phase detector described below has proved successful in prototype color television receivers wherein it serves to maintain the color reference oscillator to a tolerance better than that required by perception of the ordinary viewer.

Balanced Diode Detector

The principal advantage of a balanced form of phase detector in a high-quality automatic phase-control system lies in the immunity it provides to amplitude variations in the comparison signals. To better understand the ultimate circuit development the parameters controlling balance and the effects of unbalance in the familiar dual-diode phase detector are reviewed briefly.

Figure 1 illustrates a conventional circuit in which the oscillator output is applied in parallel across the diodes and the higher-amplitude gated burst is applied in push-pull. In order that the output be maintained at zero at phase center, the d-c voltages produced by each diode must be equal over the required range of signal variations.

This condition requires that the opposite polarity burst signals be of equal amplitudes and source impedance, the diodes be of equal efficiency as peak detectors and that the oscillator signal have peak voltage symmetry about the average level. These requirements can be most conveniently met with a series of balancing controls. If an exactly balanced burst transformer proves too expensive or too low in impedance, adjustment of the relative inductance of the two halves of the secondary can assure a balanced burst input. With the input signal effectively balanced, final balance is provided by adjustment of the relative resistance of the diode leaks.

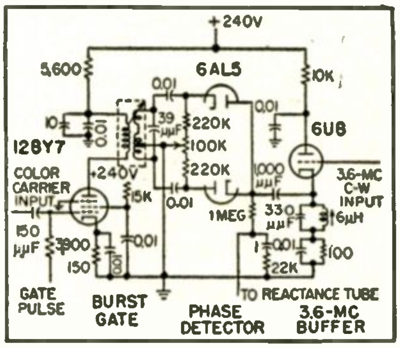

FIG. 1—Conventional circuit with inputs in parallel and push-pull

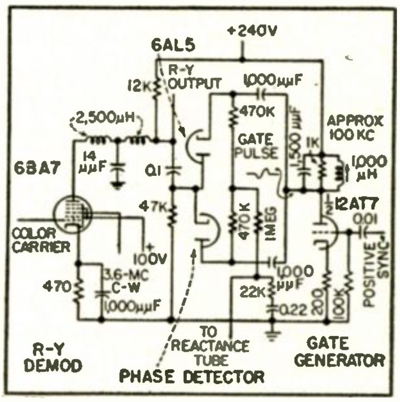

FIG. 2—Error voltage with time gating and d-c reinsertion

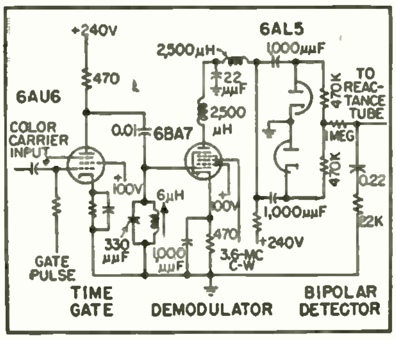

FIG. 3—Bidirectional control voltage unaffected by supply variation

Unbalance Conditions

Unbalance in the phase detector will introduce a steady-state phase error variation with burst or oscillator-voltage amplitude changes, produce asymmetrical pull-in and impair the noise-rejection of the system. Unbalance also restricts the maximum usable loop gain and hence to a large degree determines the overall system performance. In addition to the quality of balance, another important limitation to the upper sensitivity of this form of phase detector is in the available amplitude of input signals.

If the desired loop gain indicates a phase detector sensitivity of 20 volts per radian, for example, an oscillator signal of 40 volts peak-to-peak and a substantially greater burst signal will be required. Obtaining such high-amplitude signals becomes a problem since it must be accomplished without raising the resonant impedance of the 3.58-mc circuits through the use of dangerously high Q's. Because of the substantial heat rise of a color receiver, phase errors introduced by thermal drift in these circuits must be minimized through the use of low Q as well as temperature stabilization.

This condition is particularly

Reinsertion Oscillator

true when a typical system employing this form of phase detector may have as many as five tuned circuits outside the apc loop. The shielding and layout problems are also made more difficult at high levels of color-carrier frequency signals.

Synchronous Detectors

Employing a synchronous detector for phase detection has certain philosophical advantages besides offering the possibility of simplification. The use of a circuit similar to the color demodulator, but with a d-c plate load, provides a substantial reduction in the number of independent 3.58-mc tuned elements, improves noise performance at fractional signal-to-noise ratios, solves most of the a-c balance problems and makes it possible to achieve burst separation by direct time-gating of the detector. With the exception of the last item, these are generic advantages of synchronous detectors discussed below.

While direct coupling is a convenient technique in several respects, it introduces a stability problem. In such a system, variations in supply voltages, static tube characteristics, component values or gate pulse amplitude will generate a d-c output and contribute to a steady-state phase error. Further complication is introduced because the output is referenced to the plate supply voltage instead of ground. While systems of this type have been employed, it is felt that their long-term stability must be improved before they can be commercially successful.

Use of a color demodulator as a phase detector is worthy of consideration since such a system retains many of the advantages of synchronous detectors and likewise includes the *R-Y* demodulator in the apc loop. Like the direct-coupled system, however, the practical difficulties are severe. To separate the demodulated burst from the color difference signal, an a-c coupled time gate appears mandatory. The a-c coupling provides freedom from the sources of drift previously outlined, but introduces the requirement for re-establishing the phase center reference voltage independently of color-carrier modulation.

A circuit that combines generation of a bidirectional error voltage with time gating and d-c reinsertion is illustrated in Fig. 2. The gating waveform is a single sinusoid generated by the ringing circuit tuned to a line-frequency harmonic and driven by horizontal sync. The diodes will then conduct in sequence at blanking and burst times and read the relative voltage difference independently of modulation. The diode and gate pulse balance characteristics therefore control the performance and stability. The circuit has balance problems analogous to those of the conventional balanced diode circuit translated to a lower frequency but with additional complications involving color killing, burst suppression and the location of contrast and chroma controls.

Self-Balancing System

The basic circuit of the self-balancing phase detector system contains three functional blocks: a time gate, a synchronous detector and bipolar detector. The time gate, or burst separator, is a coincidence gate enabled during burst time. Its output is coupled to the synchronous detector through a filter that removes the gating frequencies. The plate load of the synchronous detector is a low-pass filter of sufficient bandwidth to produce a reasonable replica of the demodulated burst envelope. By a-c coupling to a bipolar detector, the required bidirectional control voltage is generated with complete freedom from supply voltage variations. This configuration is illustrated by a typical circuit in Fig. 3.

Operation is based on the recovery of the burst envelope at the synchronous detector plate. This envelope will be zero when the burst and reference voltages are in quadrature, but will assume a polarity determined by the direction of any phase deviation from quadrature and an amplitude determined by the magnitude of this deviation. The bipolar detector consists of two oppositely poled peak detectors whose outputs are combined through isolating resistors.

Bipolar Output

For a given phase deviation, the diodes read the difference between the positive and negative peaks of the pulse train and produce a d-c output equal to half the difference, with the loss resulting from the required isolation. Because of the short duty cycle of the demodulated burst, the bipolar detector efficiency comes close to the theoretical maximum of 50 percent. Because the a-c input to the bipolar detector vanishes at phase center, zero d-c output is assured without requiring a balance of tube characteristics, signals or supply voltages.

In addition to providing inherent static (synchronous) balance, this configuration allows utilization of many of the practical advantages of the synchronous detector. These include the immunity provided the demodulated burst for a wide range of variation in amplitude and harmonic content of the reference c-w and makes it feasible to provide an electron-coupled oscillator to drive the *R-Y* demodulator and the burst demodulator in parallel.

Inclusion of the *R-Y* demodulator drive in the apc loop improves overall stability and use of the eco simplifies the system through the elimination of any buffer requirement. Because the gain in the system is at burst-envelope frequencies, stability is further enhanced through the substantial reduction in burst level and the number of color-carrier-frequency tuned elements. This characteristic is also important since it makes possible achievement of extremely high sensitivities by inserting additional amplification between the synchronous and the bipolar detectors.

It is shown that amplifiers with particular characteristics can be employed to control the performance of the entire system. The sensitivity of the simple system of Fig. 3 is comparable to the balanced-diode system although dependent on burst amplitude.

Dynamic (asynchronous) balance is not inherent with this system and precautions must be taken in the design to assure acceptable dynamic characteristics. Symmetrical pull-in and elimination of noise cross-modulation are achieved without special requirements for diode balance if the synchronous detector is sufficiently linear. The linearity requirements established for the color demodulators are more than adequate for the burst demodulator.

Sensitivity

Figure 4A is a block diagram of a self-balancing phase detector system employing a linear voltage amplifier between the synchronous and bipolar detectors, with waveforms indicated for asynchronous or open-loop operation. The output of the synchronous detector is a series of pulses whose tips describe the sinusoidal beat note between the burst and reference c-w signals. This signal is amplified before the beat frequency is recovered by the bipolar detector and attenuated in the filter by the amount m, which is the ratio of a-c to d-c transmission of the filter. The sensitivity μ of the phase detector system is given by

$$\mu = \partial E/\partial\phi \text{ volts per radian.}$$

This is the slope at phase center of the open-circuit bipolar detector a-c output waveform or d-c output characteristic, the two being identical in the absence of the filter. If the bipolar detector has an efficiency of 50 percent, the following relation can be written in terms of E, the input beat note in peak-to-peak volts.

$$\mu = (E/4) \sin\phi \text{ at } \phi = 90 \text{ deg, phase center} = E/4 \text{ volts per radian}$$

Phase detector sensitivity is therefore a direct function of the amplitude of beat note supplied to the bipolar detector. Sensitivity can be increased with equal reliability by either increasing the conversion gain of the synchronous detector or by the addition of amplification to follow it.

Cascode Demodulator

In the course of the work on a higher-gain demodulator, a twin-triode circuit was developed that has characteristics particularly suited for this application. The circuit is an adaptation of a signal multiplier having a configuration resembling the cascode amplifier.

Briefly, it consists of two triodes connected in a-c series, that is, with the plate of the first driving the cathode of the second and with color-carrier and reference carrier applied to the first and second grids respectively. Typical circuits have delivered up to 100 volts peak-to-peak of linear demodulated output with a burst input of about 6 volts.

An important feature of this configuration is the use of two series elements with a frequency-selective intrastage coupling. This makes it possible to employ time gating of the burst in the first section and remove the gating frequency by the intrastage selectivity before demodulation is performed in the second section. Such an operation is impractical in conventional pentode or heptode demodulators because of the difficulty in removing gating frequencies from the space current once introduced at the first grid.

To justify the usefulness of even greater phase-detector sensitivity, it is necessary to examine its role in determining the loop performance. The following expression can be written for the d-c loop gain f_c

$$f_c = \mu\beta \text{ cycles per second}$$

where μ is the phase detector sensitivity in volts per radian and β is the reactance tube sensitivity in cycles per volt. Gain f_c has the dimensions of frequency and is also the expression for the maximum possible frequency deviation from which the system could pull in were it not for the gated nature of the input. Higher values of μ make possible a design choice between a higher loop gain or redistribution of reactance tube and phase-detector sensitivities for a given loop gain.

The latter is of importance in determining the stability of the complete system. Direct-current degeneration in the reactance tube produces a substantial improvement in stability by increasing its immunity to tube and supply voltage changes, but is permissible only to the degree that the loss in loop gain can be regained through the use of a higher phase-detector sensitivity. A sensitive, inherently balanced phase detector system can therefore contribute to the stability of the complete system in a twofold manner.

Phase Error

The primary function of the apc system is to hold the phase difference between the locally generated c-w reference signal and the synchronizing burst within a prescribed amount. The steady-state phase difference θ_{ss} is determined by the open-loop frequency deviation Δf between the burst and reference c-w and the d-c loop gain of the system

$$-\sin\phi_{ss} = \frac{\Delta f}{f_c}$$

Although the phase error will continue to decrease as the loop gain is increased, the point of diminishing returns is reached when the resulting hue distortion falls below the perceptible level. While a reduction in the close tolerances to which certain components outside the apc loop must be held may indicate the usefulness of higher d-c loop gains than usually provided, exceedingly high loop gains are not generally necessary to meet the phase accuracy requirements of a typical color television receiver. In some monitoring or laboratory equipment the high sensitivity may be useful for precision applications.

A second important performance characteristic of the apc loop is the degree of random phase fluctuation produced in the output by the presence of thermal noise in the burst. The effective integration of the detected phase fluctuations by the phase detector filter is modified by the a-c loop gain. It is conventional to express the effect of the loop on noise in terms of the bandwidth f_{nn} of the rectangular filter that will pass the same noise power. Richman[1] has shown this to be

$$f_{nn} = \frac{\pi}{2} (mf_c + f_2)$$

where f_2 is the frequency at which the attenuation of the filter is 3 db less than the infinite frequency attenuation. To minimize the subjective effect of random phase fluctuations produced by noise, it is necessary to limit f_{nn} to a value where video noise will mask these disturbances. If the noise bandwidth is assigned a maximum value and f_2 chosen for an optimum passband shape, the a-c loop gain mf_c must be held constant. Accordingly, increasing the d-c loop gain will have an adverse effect on noise performance unless the a-c gain is restored to its original value by decreasing the ratio of a-c to d-c transmission of the filter.

Pull-In Time

When the synchronous characteristics of the apc loop are designed for minimum phase error from all sources, the system performance is limited by the asynchronous characteristics, principally pull-in time. The additional parameter, K, which helps determine pull-in time can be expressed in terms of a-c loop gain and the time constant, xRC, of the shunt arm of the apc filter.

$$K \cong \frac{\pi}{2} (mf_c \times xRC)$$

$$\cong 0.25(mf_c/f_2)$$

The noise bandwidth expression can now be rewritten as

$$f_{nn} = \frac{\pi}{2} \left(mf_c + \frac{mf_c}{4K} \right)$$

$$= \frac{\pi}{2} mf_c \left(\frac{K + 0.25}{K} \right)$$

The following expression has been developed[1] for pull-in time T_f in terms of these parameters

$$T_f = \left(\frac{\pi}{2K} \Delta f \right)^2 \left(\frac{K + 0.25}{f_{nn}} \right) > 4 \frac{\Delta f^2}{f_{nn}^3}$$

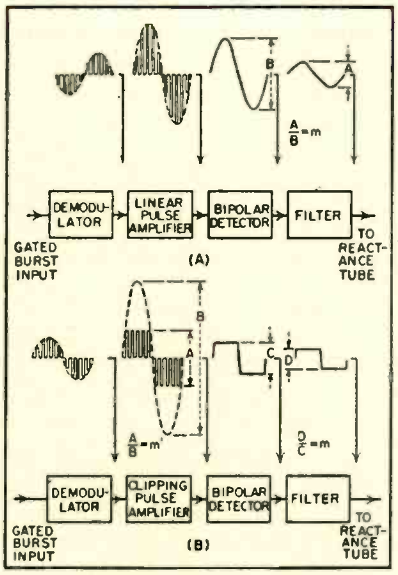

FIG. 4—Self-balancing phase detector (A) using clipping amplifier (B)

This expression has been used to determine the optimum value of K and to demonstrate that the limit on minimum T_f for large values of Δf is approached as the d-c loop gain is increased, provided mf_c is constant. It is the increase in pull-in range for a given pull-in time that constitutes one of the important reasons for seeking higher d-c loop gains.

Clipping Amplifier

The maximum limit on sensitivity of the systems so far described is set by the simple expression $\mu = E/4$ volts per radian where, in order to preserve asynchronous balance, the peak-to-peak beat note E must be linear. The maximum limit on beat note amplitude is less than the B-supply of the receiver. Figure 4B is a block diagram of a system that can achieve virtually unlimited sensitivity by substituting a symmetrically clipping amplifier for the linear amplifier driving the bipolar detector. The dynamic balance requirements can be met as long as the beat note waveform generated by the bipolar detector is symmetrical, with no d-c component. The sensitivity is directly proportional to the amplification that precedes the symmetrical clipping and is not limited by beat note amplitude. The waveforms of Fig. 4B illustrate another important characteristic of this system, the difference in a-c and d-c gains.

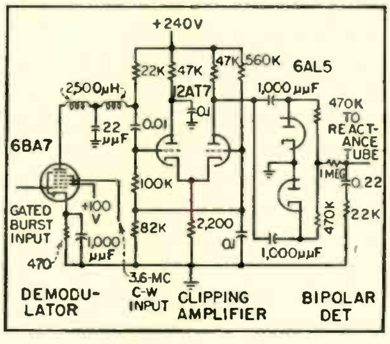

FIG. 5—Cathode-coupled twin-triode clipper has gain of twenty

The d-c sensitivity, as before, is given by the slope at phase center of the open-circuit bipolar detector a-c waveform or d-c characteristic. Over a restricted phase range this slope increases with amplification independently of the clipping action. The a-c or asynchronous gain is determined not by the slope but by the amplitude of the beat note and therefore by clipping level. As shown in Fig. 4B, the a-c to d-c gain ratio m' of the system can be taken as approximately the ratio of the amplitudes of the actual amplifier output to the unlimited output as given by the product of the input amplitude and the small-signal amplification.

The error introduced by the differences in area for a given amplitude of limited and unlimited beat note is in the direction to increase m', but is sufficiently small to be unimportant. In determining the a-c loop gain of the system, the cascaded effects of m and m' must be considered, although some complication is introduced by the variation of m' with level of input signal.

A typical circuit embodying the clipping beat-note amplifier is illustrated in Fig. 5. A 12AT7 tube is employed as a cathode-coupled twin-triode clipper with a small-signal gain of approximately twenty times. The sensitivity of this phase detector system is approximately 150 volts per radian with an m' of 0.16. This circuit, employed in a prototype color receiver, required no phase adjustment during transportation and experiments over a period of two and a half months. At the end of this time, the phase error was checked and found to be within the accuracy to which it had been originally adjusted to optimum.

While the synchronous characteristics of this system can be regarded as excellent, the improvement in asynchronous performance is subject to two limitations. First, the actual improvement in pull-in time over low-gain systems is somewhat less than 50 percent. Second, the values of d-c loop gain employed require an a-c to d-c gain ratio of approximately 0.001 for the system. Although no disadvantage in itself, the high a-c attenuation accentuates the difficulty in maintaining symmetrical pull-in characteristics through reduction of the tolerable d-c component generated by imperfect clipping symmetry. The point of diminishing returns is reached rapidly when improvement in overall system performance is sought by very high d-c gain.

Two-Mode Systems

The d-c component generated by asymmetry in the clipping beat-note amplifier has been shown to be a limiting factor in determining maximum usable d-c gain. It can be turned to useful application in one of the simpler forms of a two-mode apc system. Two-mode systems are of interest since they represent a practical means for achieving very high system performance. Several forms of two-mode systems are particularly suited for use with the self-balancing phase detector.

One of the techniques for achieving different modes of operation for the synchronous and asynchronous operation is to employ a nonlinear filter. Such action can be produced by modifying the clipping beat-note amplifier to have a deliberate asymmetry (nonlinearity) at a given amplitude level. If this level lies between the amplitudes of the thermal noise fluctuations and the beat note a large d-c component will be generated whenever beat note is present. This d-c component is unidirectional and will speed oscillator pull-in in one direction only, so a prerequesite for this form of two-mode device is offset frequency operation. Offsetting the free-running oscillator frequency will assure the required unidirectional frequency difference but will also generate a steady-state phase error. The high d-c gain requirement is retained by such a system merely to maintain this phase error within acceptable limits. Another limitation is the ambiguity that can exist between noise and beat-note amplitudes at low signal-noise ratios.

Frequency Detection

An elegant form of two-mode device is one that employs a phase servo to control sysnchronous performance and a frequency servo to control asynchronous performance. Such a system can be designed around an apc loop supplemented by the form of beat-frequency discriminator that Richman[2] has called the quadricorrelator. The form of quadricorrelator having maximum number of degrees of freedom and hence the highest performance employs two synchronous detectors operating in quadrature. The presence in the self-balancing phase detector system of many of the elements required for the quadricorrelator makes the combination appear particularly attractive.

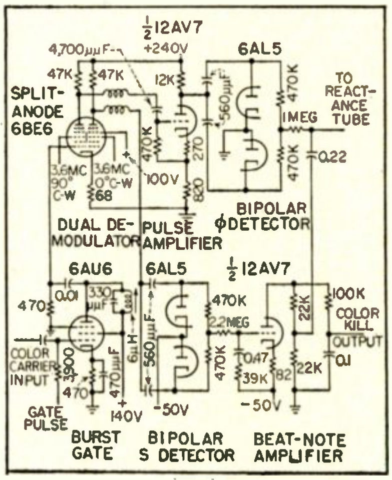

FIG. 6—Ultimate two-mode phase detector with variable a-c gain and color kill

A complete quadricorrelator circuit was designed to obtain an evaluation against other forms of two-mode systems. The circuit was simplified by substituting a passive filter and a dual-diode sum-and-difference detector for the summing synchronous detector. The performance advantages and mode of operation of the resulting circuit are closely analogous to those of the self-balancing phase detector. Further simplification was made possible by developing an experimental dual demodulator tube that can, in one envelope, perform the functions of the two quadrature synchronous detectors. Employment of this circuit is deferred in preference to another described below, which provides the advantage of automatic color killing.

Synchronization Detection

Two synchronous detectors in quadrature can be utilized in a circuit named the d-c quadricorrelator and described[2] in the literature. The so-called S detector operating in quadrature with the phase detector will produce a maximum d-c output when the system is in synchronization and zero d-c output when synchronization is lost. This change in d-c voltage can be utilized to switch off and on an amplifier that provides a shunt path for the beat note around the phase-detector filter.

The effect is to produce a variable a-c gain, which is maximum for the asynchronous condition facilitating rapid pull-in and minimum for the synchronous condition, producing minimum noise bandwidth. A narrow-band filter on the output of the S detector increases the noise immunity of the switching voltage. Since the d-c output of the S detector requires the presence of burst, this voltage may be used to provide automatic color killing.

Figure 6 is the schematic of a two-mode phase-detector system employing variable a-c gain and automatic color killing. The experimental dual demodulator tube is employed to provide the quadrature burst demodulation. Two dual diodes comprise the bipolar S and ϕ detectors. A linear pulse amplifier provides a high d-c sensitivity. The beat-note amplifier also serves the additional function of amplifying the color-killing voltage before application to the chroma amplifier. Relative complexity of the phase-detector system is partially offset by elimination of special buffer requirements for the oscillator.

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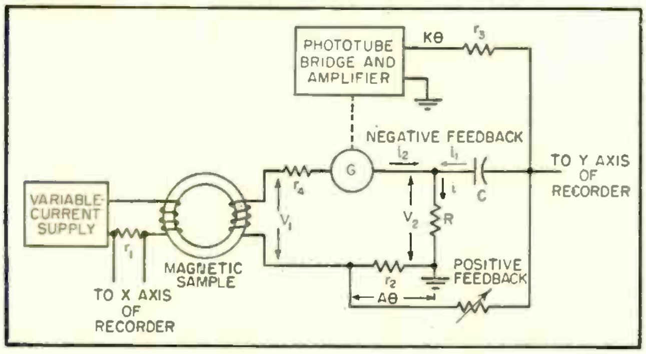


FIG. 1—Simplified circuit of fluxmeter showing feedback paths

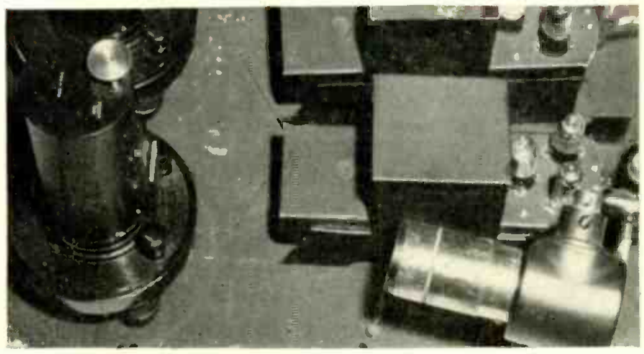


FIG. 2—Galvanometer deflects light to phototubes in shielded box

Recording Fluxmeter

High-sensitivity instrument plots B-H curve of magnetic materials in few minutes. Ease of operation enables unskilled operators to obtain accurate results. Overall error in measurement is 0.5 percent ± 25 flux interlinkages per minute

By RALPH I. BERGE and CHARLES A. GUDERJAHN

Aeronautical Research Laboratory
Wright Air Development Center
Dayton, Ohio

DEVELOPMENT of a recording fluxmeter for tracing d-c magnetization curves outmodes use of ballistic galvanometers for obtaining hysteresis loops of magnetic materials.

The fluxmeter described in this article is similar to that developed by Cioffi[1], which employs one or two integrators and a two-axis recorder for tracing B-H curves directly on standard coordinate paper. The search coil wound on the sample requires only a few turns of wire because of the sensitivity of the instrument.

Theory of Operation

The principle of operation of the fluxmeter may best be understood by reference to Fig. 1. Two coils are wound on a ring sample of magnetic material. The primary is excited with slowly varying direct current which causes a voltage drop across r_1. The movement of the recorder pen in the X direction is thus proportional to the current in the primary coil and consequently the magnetizing force.

As shown in Fig. 1, any change of magnetic flux in the sample will induce a voltage in the secondary coil causing a deflection in the galvanometer. The mirror of the galvanometer, which had previously illuminated two phototubes equally, will then direct more light on one phototube than on the other generating an error voltage in the bridge circuit of which the phototubes form a part. This error voltage is amplified and fed back into the galvanometer circuit through the capacitor to reduce the galvanometer deflection. The output of the amplifier, which is the integral of the voltage induced in the secondary coil and thus proportional to the flux in the sample, is applied to the Y axis of the recorder. The behavior of the galvanometer coil is described by

$$I\frac{d^2\theta}{dt^2} + b\frac{d\theta}{dt} + k = ge \qquad (1)$$

where θ is the angular deflection of the galvanometer coil, I is the moment of inertia of the coil, b is the total mechanical and electromagnetic damping torque, k is the torque due to the suspension and ge is the torque due to the voltage e appearing across the galvanometer.

The voltage e is given by

$$e = v_1 - v_2 + A\theta \qquad (2)$$

where v_1 is the voltage generated in the secondary by a change in flux in the sample, v_2 is the voltage across R and $A\theta$ is a positive feedback voltage appearing across r_2.

If the total stray capacitance loading the phototubes is small, for small deflections of the galvanometer the output voltage of the amplifier is $K\theta$, where K is the overall gain of the phototubes and electronic amplifier. The output impedance of the amplifier is represented by r_3.

If the currents are as marked in Fig. 1

$$K\theta = i_1 r_3 + \frac{1}{C}\int i_1\,dt + v_2 \qquad (3)$$

$$K\theta = \frac{r_3}{R} v_2 - \frac{r_3}{r_4} e + \frac{1}{RC} \int v_2 \, dt - \frac{1}{r_4 C} \int e \, dt + v_2 \quad (4)$$

where r_4 is the internal galvanometer resistance.

Differentiating and rearranging

$$v_2 + C(R + r_3) \frac{dv_2}{dt} = RCK \frac{d\theta}{dt} + \frac{RCr_3}{r_4} \frac{de}{dt} + \frac{R}{r_4} e \quad (5)$$

The voltage output of the search coil is given by

$$v_1 = N 10^{-8} \, d\theta/dt \quad (6)$$

Substituting Eq. 2 and 6 in 1 and rearranging

$$v_2 = -\frac{I}{g} \frac{d^2\theta}{dt^2} - \frac{b}{g} \frac{d\theta}{dt} - \frac{k}{g} \theta + N 10^{-8} \frac{d\phi}{dt} + A\theta \quad (7)$$

Differentiating Eq. 7

$$\frac{dv_2}{dt} = -\frac{I}{g} \frac{d^3\theta}{dt^3} - \frac{b}{g} \frac{d^2\theta}{dt^2} - \frac{k}{g} \frac{d\theta}{dt} + N \, 10^{-8} \frac{d^2\phi}{dt^2} + A \frac{d\theta}{dt} \quad (8)$$

Substitution of Eq. 7 and 8 in 5 gives

$$\left[\frac{RCr_3}{r_4} + C(R + r_3)\right] \frac{I}{g} \frac{d^3\theta}{dt^3} + \left\{\left[\frac{RCr_3}{r_4} + C(R + r_3)\right] \frac{b}{g} + \left(\frac{R}{r_4} + 1\right) \frac{I}{g}\right\} \frac{d^2\theta}{dt^2} + \left\{\left[\frac{RCr_3}{r_4} + C(R + r_3)\right] \frac{k}{g} + \left(\frac{R}{r_4} + 1\right) \frac{b}{g} - C(R+r_3)A + RCK\right\} \frac{d\theta}{dt} + \left[\left(\frac{R}{r_4} + 1\right) \frac{k}{g} - A\right] \theta = N 10^{-8} \frac{d\phi}{dt} + C(R + r_3) N 10^{-8} \frac{d^2\phi}{d^2t} \quad (9)$$

The measured values of the constants are: $I/g = 1.9 \times 10^{-4}$; $b/g = 1.3 \times 10^{-3}$; $k/g = 1.4 \times 10^{-4}$; $K = 4 \times 10^4$; $r_3 = 200$ ohms (approx.); $C = 10^{-6}$ farad; $R = 12$ ohms; $r_4 = 26$ ohms.

The amount of positive of feedback is so chosen that

$$(R/r_4 + 1)k/g - A = 0 \quad (10)$$

With this condition fulfilled, Eq. 9 is integrated and after substitution of the numerical values of the constants

$$6\times10^{-8} \frac{d^2\theta}{dt^2} + 3\times10^{-4} \frac{d\theta}{dt} + 0.5\theta = N 10^{-8}\phi + 2\times10^{-12} N \frac{d\phi}{dt} + L \quad (11)$$

where L is the constant of integration.

The first term in Eq. 11 is negligible and the time constant of the system is $3 \times 10^{-4}/0.5 = 6 \times 10^{-4}$ second, therefore the steady state solution is

$$\phi = \frac{K\theta}{N} 10^8 \left[RC + \left(\frac{R}{r_4} + 1\right) \frac{b}{gK}\right] + L \quad (12)$$

The amplifier output voltage $K\theta$ is applied to the recorder. Thus the pen of the recorder moves proportionally to the amount of flux θ in the sample. The constant of integration L is of no importance since just the length of the pen trace is measured.

Electro-Optical System

The arrangement of the galvanometer and optical system is shown in Fig. 2. When the galvanometer is at balance, an equal amount of light is focused on two closely spaced high-vacuum phototubes. A prism is not used to split the light beam. The light source is a filament heated by direct current to avoid inducing 60-cycle hum into the system.

Provision is made for two integrators. The second is for use with a magnetic potentiometer.

The galvanometer has a 7.1 mm/µv sensitivity, critical damping resistance of 120 ohms, period of 7.4 seconds and coil resistance of 26 ohms.

In order to minimize thermal currents in the galvanometer circuit, all connections are made of clean copper lightly coated with grease to reduce oxidation. Also, the galvanometer and other connections are thermally insulated in copper boxes packed with cotton batting.

Amplifier

The schematic diagram of the galvanometer and amplifier is shown in Fig. 3.

The phototubes are arranged in a bridge circuit with the output of the phototube bridge near ground potential.

The 1U4 preamplifier tube was selected because of its low interelectrode capacitance and filament voltage to avoid capacitative loading of the phototubes. A relay operated by turning on the power supply controls the filament current.

For the servomechanical system to have a small time constant, it is necessary that the output of the amplifier to the capacitor C have a low impedance and r_3 be small. This condition is achieved while employing miniature components by using a type 6AH6 tube operating in its high-transconductance region. The range of control in the high-transconductance region is extended by using a constant-current load tube, also a 6AH6, and by operating the screen at a constant 150 volts above the cathode potential.

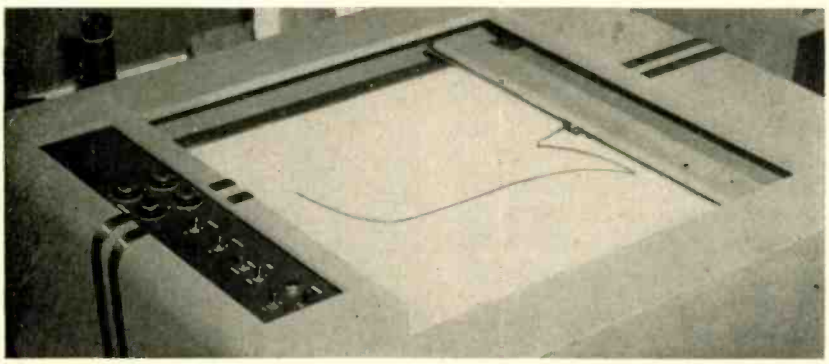
A low-leakage capacitor is used instead of a mutual inductance to oppose the interlinkages of the search coil since high-quality computing-type capacitors are readily available and less power output from the amplifier is required.

Calibration

The total flux in the sample at any moment is given by Eq. 12. Neglecting the constant of integration

$$\phi = 1/N(JK\theta) \text{ gauss} \quad (13)$$

where $K\theta$ is the output voltage of



Fluxmeter output is applied to electronic plotting board (above) to record B-H curve of magnetic sample under test

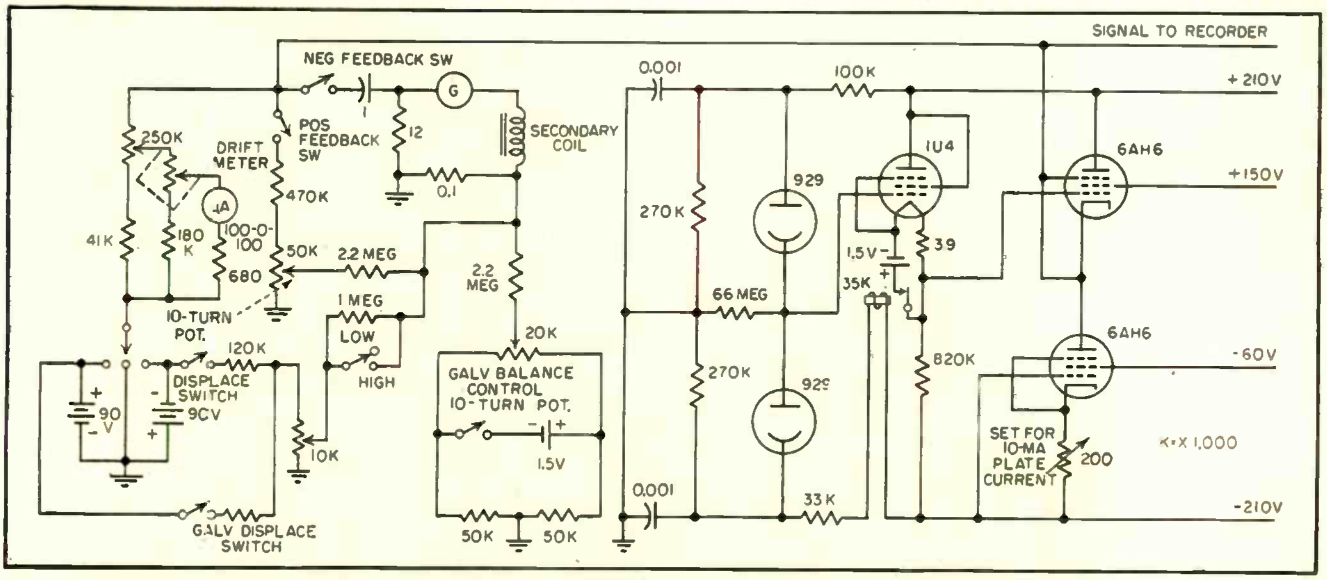


FIG. 3—Load capacitances and leakage currents are kept to a minimum by mounting the photocells and amplifier on the same chassis

the amplifier and J is the calibration constant

$$J = 10^8[RC + (R/r_4 + 1)(b/g)K] \quad (14)$$

The last term in the calibration constant is about 0.5 percent of the first, therefore a change in the gain of the amplifier will affect J only slightly. The values of b, g and K may easily be determined experimentally and J = 1,205.

The recorder also has a variable scale factor of G cm/volt. An external source of voltage is used to adjust G so that GJ is some convenient number adapted to the scale of the graph paper used. Then

$$\phi = (1/N)(GJ)(K\theta) \times \text{(length of trace on paper)} \quad (15)$$

The H axis of the recorder is calibrated in a similar manner.

Operation

The galvanometer and optical system must be adjusted so that the amplifier output voltage is zero without either positive or negative feedback. Coarse adjustment is made by turning the galvanometer suspension or by moving the phototube chassis while the output-drift meter is at low sensitivity. The galvanometer control potentiometer is then adjusted so that the output-drift meter reads an average of zero at high sensitivity.

The intensity of the galvanometer light is first decreased and then the negative feedback switch is closed. Otherwise, a high transient current will flow at the instant the switch is closed, permanently altering the galvanometer suspension.

The positive-feedback potentiometer is adjusted by displacing the galvanometer to either side of zero using the displacement switches, then adjusting the positive-feedback potentiometer so there is minimum galvanometer drift as indicated on the output-drift meter. The amount of positive feedback required may be different for displacements on opposite sides of zero because of possible mismatching of phototubes. An average of the positive-feedback potentiometer settings on either side of zero is set on the potentiometer.

Considerable galvanometer drift will result if there is a large difference in the amount of positive feedback required when the galvanometer is displaced on either side of zero. In this case, to minimize drift, one of the photocells should be shaded, or both replaced by a more evenly matched pair. If the system goes into oscillation, as may be ascertained by viewing the output of the amplifier on an oscilloscope, the positive-feedback potentiometer is not properly adjusted.

The recorder is then calibrated and the hysteresis curve is traced so slowly that a further decrease in tracing speed does not affect the shape of the curve. Small discontinuities may appear in the recorded hysteresis loop due to rough control of the magnetizing current. A satisfactory source of current is an autotransformer used with a full-wave rectifier and several stages of filtering.

Before switching off the fluxmeter, the negative feedback switch is opened to prevent a heavy transient current from flowing in the galvanometer suspension at the moment of switching.

Accuracy

The degree of accuracy of the fluxmeter depends on the accuracies of the calibration constant, the external calibration voltage and the recorder. In addition, the slow drift of the system due to changing thermal currents and other factors must be considered.

The value of the calibration constant may be obtained within 0.3 percent and the calibration voltage source within 0.1 percent. The static error of the recorder is given as 0.1 percent of full scale. By carefully balancing the fluxmeter, the drift can be restricted to less than 25 flux interlinkages minute. The overall error is then 0.5 percent ±25 flux interlinkages minute.

The sensitivity of the system is easily controlled by adjusting the gain of the recorder. This sensitivity may be increased to such a high degree that the drift error, normally negligible, becomes an objectionable part of the total flux change.

Reference

(1) Coiffi, Recording Fluxmeter of High Accuracy and Sensitivity, *Rev of Sci Inst*, 21, p 624, Jul 50.

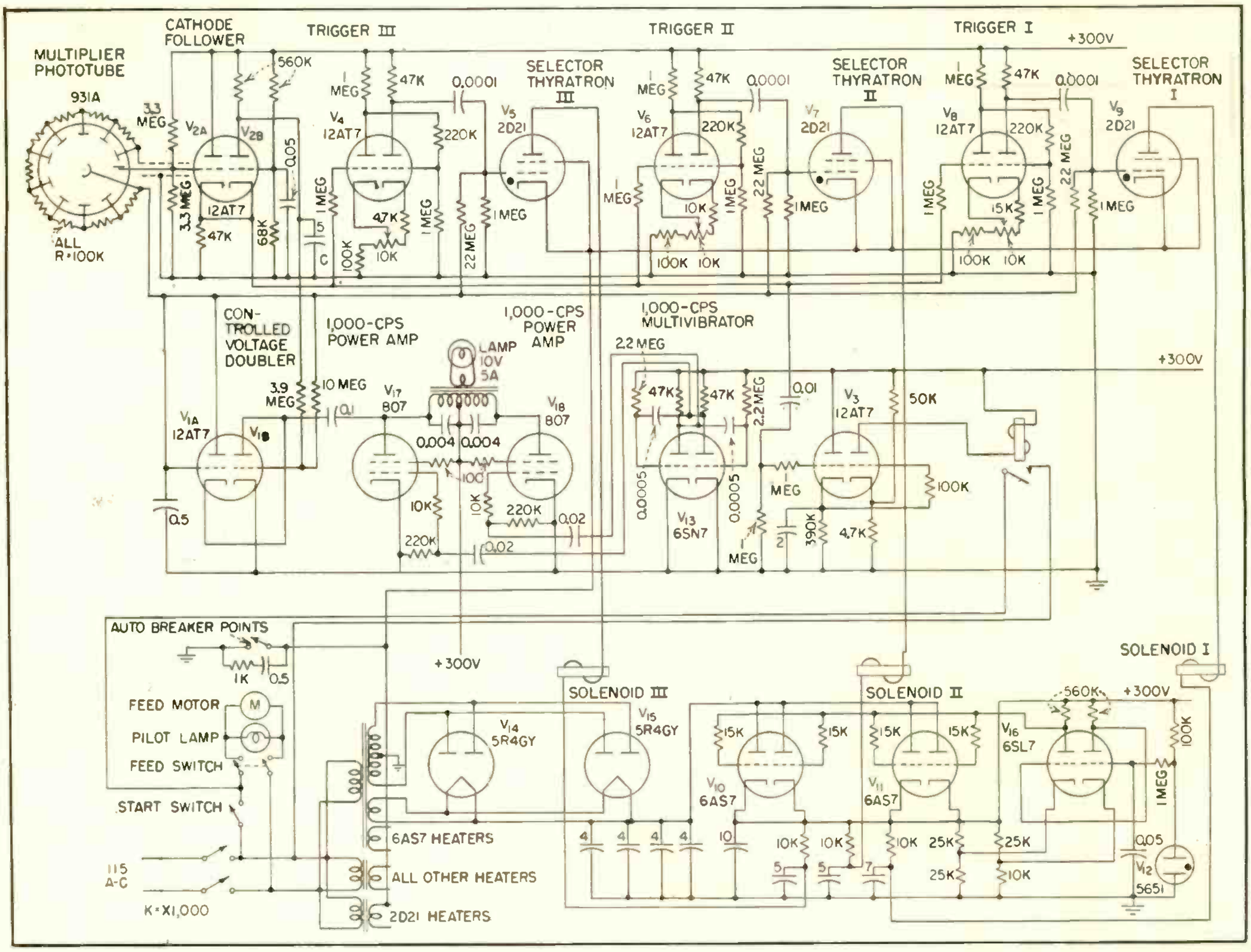


FIG. 1—Complete circuit diagram of electronic pencil lead and crayon sorter. Solenoids operate selector fingers of classification bins. Smallest crayons go past all three solenoids to drop into fourth bin

Photoelectric Gage Sorts

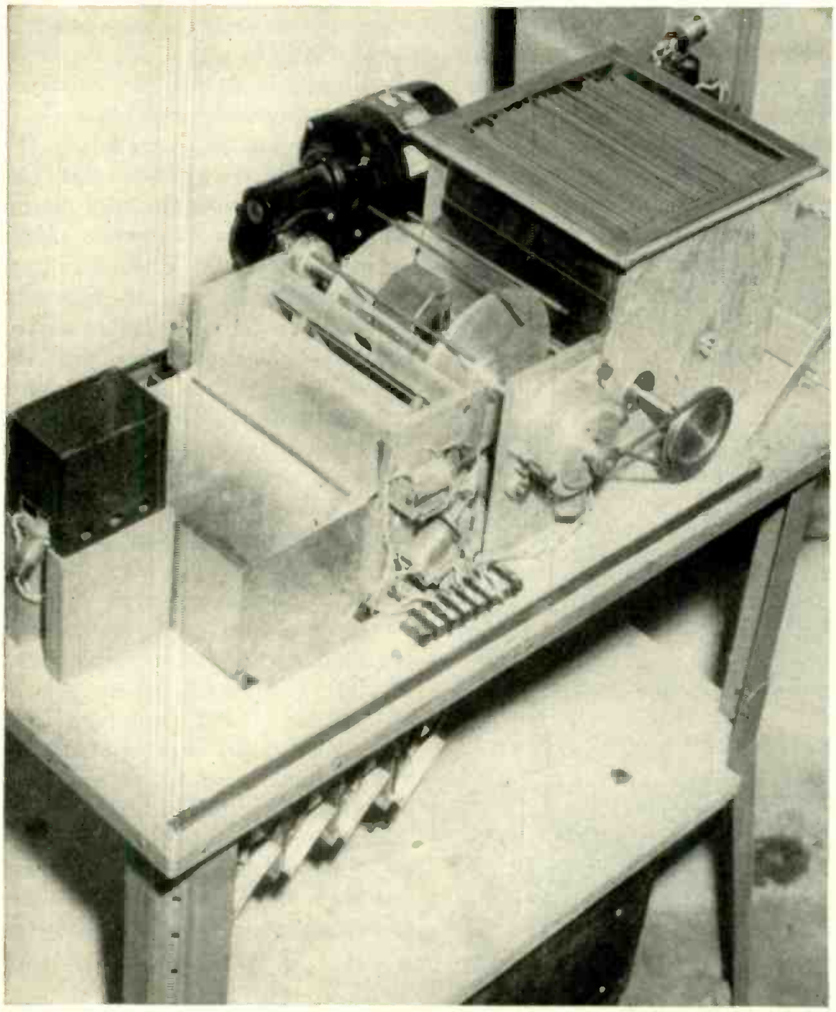
Noncontacting automatic gage measures diameters of fragile pencil leads or crayons as they are whirled through light beam at high speed by motor-driven feed wheel and sorts into four groups differing in diameter by steps of 0.002 inch or even 0.0001 inch

AUTOMATIC GAGING coupled with telemetric controls must rely largely on noncontact measurement because of the time element and the need for long life, trouble-free performance and minimum maintenance.

A pencil sorter is one example of rapid automatic gaging. The problem is to classify pencil crayons or leads according to diameter. These crayons are eventually encased in the usual wooden holder. For proper bond and writing qualities, the insert and holder must have a certain relationship. If the slot in the holder is too large with respect to crayon, the binder may ooze out or may not properly retain the insert; if too small, the crayon may break or be crushed. It is therefore desirable to group the crayons into several sizes and match the appropriate holder to crayon size. The specifications required classifying into four categories differing by 0.002 inch. Several nominal diameters are involved, of which 0.160 inch is typical.

Operation of Sorter

With the automatic sorter, the operator has only to fill the hopper



Machine with cover raised, showing crayon input hopper and feed wheel drive motor at right end of table

Pencil Crayons

By CARL A. VOSSBERG

Chief Engineer
Southeastern Electronic Laboratories
Division of The Electron-Machine Corp.
Umatilla, Florida

with pencil crayons or leads and push the start button. A mechanical agitator keeps the crayons in motion to prevent jamming in the hopper. The crayons, picked up one at a time by a motor-driven feed wheel, pass the measuring position at the rate of better than 200 per minute. While in motion they are individually measured by an optical-electronic noncontacting gage. The information is stored to allow time and space for appropriately classifying into one of four categories by means of extending selector fingers. Tolerance limits are adjustable.

When a particular crayon has traversed the selector positions and dropped into its correct bin, the gage is automatically reset in readiness for measuring the next crayon and the cycle is repeated.

The feed wheel has two sets of eight pickup hooks. These are actually standard stainless steel rivets embedded in narrow wheels with the heads protruding. Normally a crayon is picked up by a pair of these hooks. A short or broken crayon will either drop down unobtrusively through the reject slot, be picked up by one hook and then slide into the reject slot, or be thrown back to a small recirculating pile of crayons for another attempt to get on the feed wheel.

If a crayon gets onto a hook on one side, and a later hook on the other side so that it is crosswise, it is dumped back into the recirculating stack by a deflection plate situated between the feed wheels. Thus all crayons are properly aligned for measurement. The efficiency of feed is high, so that only about 1 percent of the hooks are free of crayons.

Classifying Mechanism

As the crayon or lead approaches the measuring station all selectors are reset and closed. It passes a beam of light for only an instant, but this is sufficient for the electronic gage to determine its size. If it is below the lowest limit, the crayon passes all the selectors and drops into the fourth classification bin. If it is within the next larger classification the third pair of selector fingers is actuated by a solenoid and remains open until the pencil has had time to pass through and on to the bin containing that size. A similar action drops still larger crayons into the appropriate bins for the next two larger sizes.

Resetting of selectors is accomplished by a modified Ford breaker and distributor assembly on the feed wheel shaft, opening the thyratron circuits in the electronic classifier.

When the first crayon reaches the measuring station after start-up, a hold relay is actuated and the machine becomes self-running. Should the feed stop for any reason, the relay opens, thereby stopping the feed motor. As a safety precaution a clutch is used between motor drive and feed wheel.

The removable optical aperture in front of a multiplier phototube comprises two slits centered at the edges of the shadow cast by the smallest crayon. The larger the crayon the less light transmitted to the phototube from a lamp and condensing lens source.

To stabilize the electronic system and allow for aging of lamp, phototube and other components, the signal developed when no crayon blocks the beam is automatically regulated to a reference value. Thus, in effect it is a change in the crayon signal from that reference setting that actuates the controlling elements, independently of the conversion gain. This results in excellent stability, requiring no resetting of controls.

Circuit Operation

The basic circuits are given in Fig. 1. The phototube signal output is fed to the grid of cathode follower V_2, which is an impedance converter. The crayon signal is a positive pulse, the peak value being a function of crayon diameter, which may trigger one or more trigger tubes as V_4, V_6 and V_8. The level at which triggering will occur is determined by the cathode circuit controls of the trigger tubes. Trigger tube V_4 will transmit a pulse to thyratron V_5 thus actuating the selector solenoid in its plate circuit, which in turn opens flippers associated with that solenoid to accept the crayon.

The smallest category of crayon will not develop sufficient signal to trigger any of the discriminators. The next size larger will trigger one discriminator, the next will trigger two stages and the largest diameter will actuate all three discriminators and corresponding thyratrons.

Upon completion of the cycle the breaker will open all thyratrons, releasing the selectors and again closing the circuit in readiness for the next signal. The standard eight-point automobile breaker had to be adjusted for minimum open time, since the entire sequence must take place between two adjacent crayons.

The diameter is measured practically instantaneously. To shorten the operate time for the flipper solenoids, a capacitor in each circuit is charged to full supply voltage and then allowed to discharge through solenoid and thyratron. The value of this capacitor is 5 μf each for two stages and 7 μf for the flipper solenoid nearest the measuring station.

A 1,000-cps generator comprising V_{17}, V_{18} and multivibrator V_{13} supplies power for the lamp to ensure constant unmodulated light. The dynode supply voltage is also derived from this generator. A doubler circuit, employing V_{1A} for rectifying the 1,000-cps signal, supplies the dynodes with a d-c voltage whose value is a function of the impedance of V_{1B}. This in turn depends on its grid bias.

Loading pencil crayons into machine for sorting into four different diameter categories

The signal level with no crayon is a minimum and, if less than the reference positive bias on the grid of V_{2B}, capacitor C will discharge on these negative pulses. The greater the minimum phototube signal, the lower the voltage across C and the more negative the bias on V_{1B}, which lowers the dynode supply voltage to correct for the initial change. The gain of the system is such that the minimum voltage (maximum light signal) level is automatically regulated to a precise degree corresponding to a signal output nearly equal to the reference. Voltage for the dynodes then remains independent of the crayons, being solely governed by the unobstructed light-beam intensity resulting in phototube output. Blocking half of the light beam has no perceptible effect on performance since dynode voltages automatically increase to offset the loss in light signal. All couplings are direct, from phototube output to regulating and control tube.

A start switch, paralleling the contacts of the relay in the plate circuit of V_3, operates the feed motor. As soon as the first crayon passes the measuring station, the a-c signal is detected by V_3 and the resultant d-c positive voltage applied to the relay tube section, operating the relay. The feed then is self-running until a prescribed interval without signals, either because of an empty hopper or improper feeding, allows the developed detected voltage to drop off to open the relay, thus stopping the feed. A pilot lamp is used to indicate such action.

A typical electronic power supply regulator is used, employing two 5R4GY rectifiers, two 6AS7's, a 6SL7 and a 5651 reference tube. Tube heaters are unregulated since the automatic gain control can effectively accommodate relatively slow changes in tube characteristics and the like. Even so, the signal output from the phototube is substantial as compared to possible discriminator variations, the limits being about 20 and 150 volts.

Conclusions

An impressive demonstration is to select pencil crayons according to size, with each classification a different color. Then by filling the hopper with these assorted colored pencils it would appear that the machine is a perfect color separator.

No difficulty was experienced sorting into four categories each differing by only 0.0001 inch. The apparent discrimination can be very much enhanced by narrowing the slits.

Applications for classifying on the fly without contact by using the foregoing principles are numerous. For example, nails, screws, rings, washers, disks, cartridges, shells, flints and even transparent glass rods, vials and syringes are adaptable. The latter, because of optical divergence, are relatively opaque when inspected at a reasonable distance.

The mechanical system was designed by E. D. Haffner.

TV Station Monitor

Picture and waveform oscilloscopes show tv broadcast control operator the condition of output signals from studio or equipment as well as incoming signals from networks. Circuits provide pulse cross with vertical sweep expansion to check sync generator

By H. E. THOMAS and E. STEIN

Federal Telecommunication Laboratories
International Tel. & Tel. Corp.
Nutley, N. J.

TELEVISION MONITORS must be capable of rapidly measuring the video level and picture quality of any signal that may be encountered in the facilities of small or large tv stations. For example, it may be necessary to monitor a video signal that does not contain sync pulses, such as the output of an iconoscope film chain to which sync is added at the master control point.

In addition, rapid pushbutton switching of the signal input, such as may be encountered in preview operation, requires that the tv monitor accept and function rapidly with a minimum of operator control to measure input signals with a wide range of characteristics.

Input signals from which the monitor must be capable of operating include composite video, video and blanking only (without sync) and remote or network signals with degraded sync.

Automatic Sync

In monitoring a composite video signal, it is desirable to use the sync pulse contained therein for synchronizing the monitor sweep circuits, as in a home receiver operating from an off-the-air signal. However, to monitor a signal that does not contain sync information, such as a signal originating at an iconoscope film chain, synchronization at the monitor must be provided by driving pulses from the sync generator, which trigger the deflection circuits.

An electronic switching circuit shown in Fig. 1 selects the mode of synchronization automatically.

In the absence of sync on the input video signal, a pulse-width discriminator circuit functions to gate in cutoff bias on the sync control tube and to permit driving pulses to continue synchronization

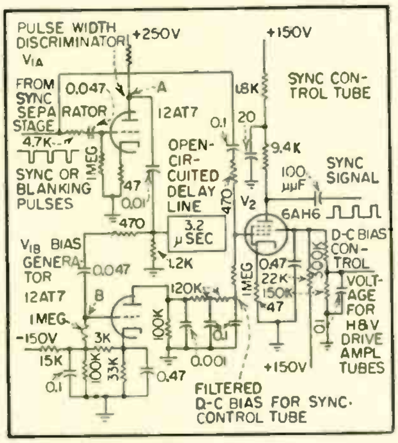


FIG. 1—Automatic sync selector circuit takes composite or camera signals

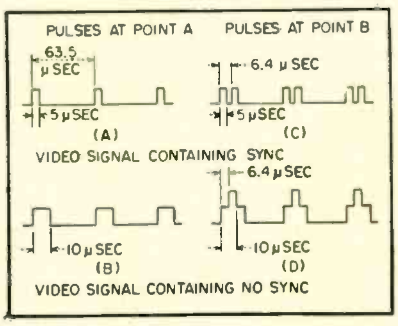


FIG. 2—Waveforms encountered at points *A* and *B* in circuit of Fig. 1

of the monitor deflection circuits. When sync pulses are present in the video signal, the driving pulses, although available, are blocked. When it is desired to synchronize on driving pulses regardless of the character of the input video signal, a manual switch effectively immobilizes the automatic circuit by applying cutoff bias to the grids of appropriate sections of the sync selector stages.

As shown in Fig. 1, the video signal has been passed through a sync separator tube, which clips the tops of the pulse peaks in its grid circuit. When the video signal contains sync, the pulses appearing in the plate of the sync separator stage will have the same width as the sync pulses from which they are derived, approximately 5 microseconds (Fig. 2A). When the video signal contains no sync, the pulses appearing in the plate of the sync separator stage will have the same width as the blanking pulses from which they are derived, approximately 10 microseconds (Fig. 2B). Clipping here takes place in the setup region.

Delay Technique

These pulses are fed to the grid of the pulse width discriminator V_{1A}, which contains a delay line of 3.2 μsec in its plate circuit; the sending end is properly terminated while the receiving end is open-circuited. Pulses arriving at point *A* in Fig. 1 add directly to their echoes that have been delayed 6.4

μsec by virtue of travel to and reflection from the open-circuited receiving end of the delay line.

Resulting waveforms occurring at point B are shown in Fig. 2C for a signal with sync pulses and for a signal without sync pulses in Fig. 2D.

For a narrow 5-microsecond pulse, the reflection appears as a similar pulse delayed 6.4 μsec behind the original. This pulse train, when applied to the grid of bias generator tube, V_{1B}, a grounded plate-negative cathode stage normally biased below cutoff, is of insufficient amplitude to cause plate-current conduction.

Under this condition, the d-c output of the bias generator, which is coupled directly to the control grid of the sync control tube V_2, is substantially zero or ground potential. Thus, sync signals present at this point are amplified by the sync control tube and passed to the deflection synchronizing circuits.

In the case of the wider 10-μsec blanking pulse, the reflected pulse is superimposed upon the initiating pulse as shown in Fig. 2D. The resultant pulse train, with almost twice the peak-to-peak amplitude of that developed by the narrow pulses, causes V_{1B} to conduct and lower its plate voltage. Under this condition, the filtered d-c output of the bias generator is sufficiently negative (about 18 volts) to bias the sync control tube beyond cutoff and prevent the passage of sync information through it to the deflection synchronizing circuits.

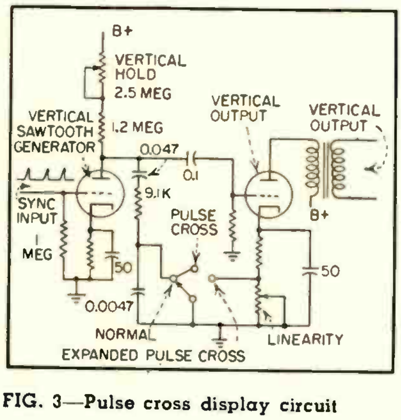


FIG. 3—Pulse cross display circuit

Thus, in the presence of sync pulses on the video signal, the sync control tube passes this sync information, while for a signal without sync pulses, this tube is biased beyond cutoff. In the latter case, it is now necessary to gate in driving pulses to the sync circuits to maintain synchronization.

Generator Sync

Gating action is controlled by sync control tube V_2 through its shift in d-c screen potential under the two conditions of control grid bias. With substantially zero bias when sync is present in the video signal V_2 conducts fully, causing the screen voltage to drop by virtue of the *IR* drop in the screen resistor. This drop is coupled to the control grids of the horizontal and vertical drive amplifier tubes, causing them to be biased beyond cutoff and preventing drive pulses from being passed to the deflection synchronizing circuits.

When there is no sync in the video signal, the sync control tube is biased beyond cutoff, raising its screen potential to the static voltage divider value. The higher screen potential applied to control grids of the drive amplifier tubes causes them to conduct and pass the amplified drive signals to the deflection synchronizing circuits.

A unique feature of the monitor is its ability to check accurately the timing waveforms of the sync generator by means of pulse-cross presentations. Periodic observation and adjustment of the sync generator pulse output is necessary in any tv station. The monitor pulse-cross display permits these measurements to be made accurately and at a moment's notice.

A three-position switch permits selection of normal, pulse-cross and expanded pulse-cross presentations. The regular pulse-cross presentation displays the entire blanking region, both horizontal and vertical.

Pulse-Cross Displays

The expanded pulse cross presentation enlarges the vertical blanking interval about five times, permitting critical and accurate examination of the timing in this region. The relative timing and shape of the front porch, back porch, sync pulse, equalizer pulse, vertical serration, number of equalizer pulses, number of vertical serrations—all these can be readily determined from this display.

In the pulse-cross position, the start of the horizontal sweep is delayed by approximately 66 percent in relation to the horizontal sync pulse in the video signal to permit the observation of all vertical equalizer pulses as well as the horizontal blanking interval. The start of the vertical sweep is delayed by approx-

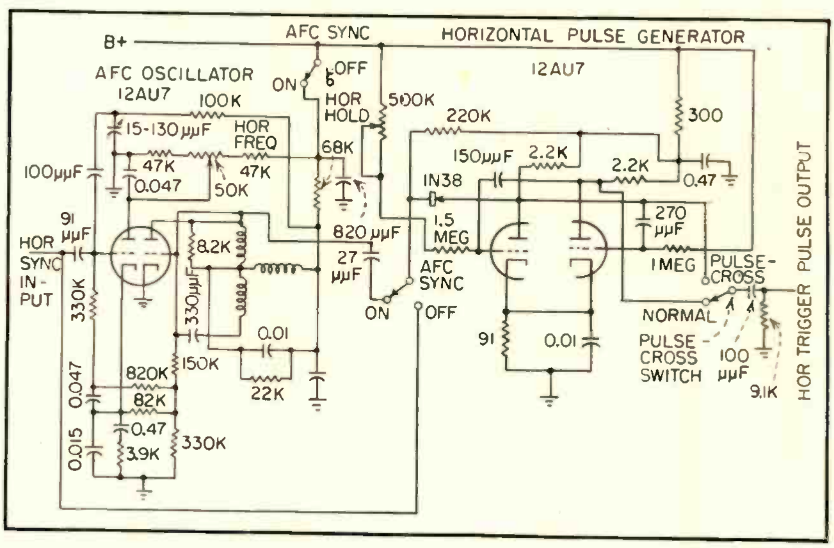
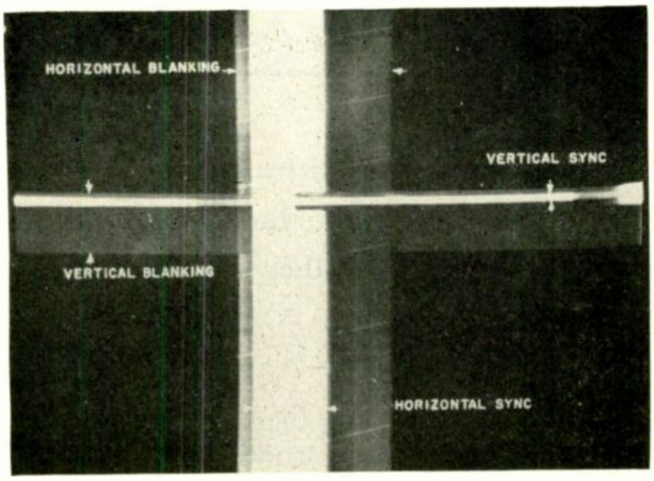
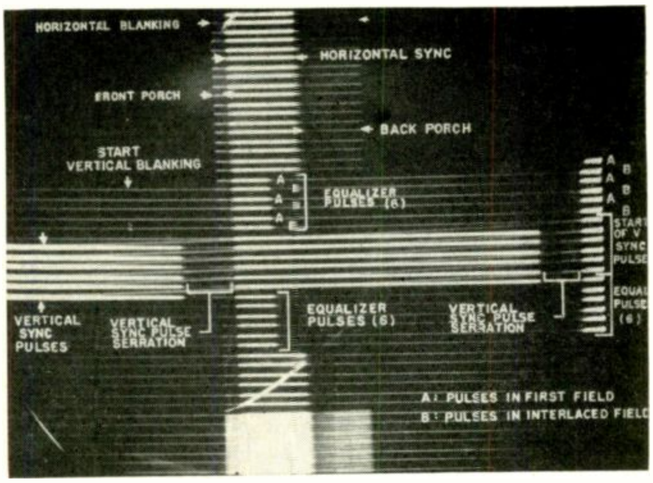


FIG. 4—Flywheel sync control similar to that used in television receivers



Pulse cross display resulting from delayed sync and inverted picture polarity



Expanded pulse cross permits counting significant pulses from sync generator

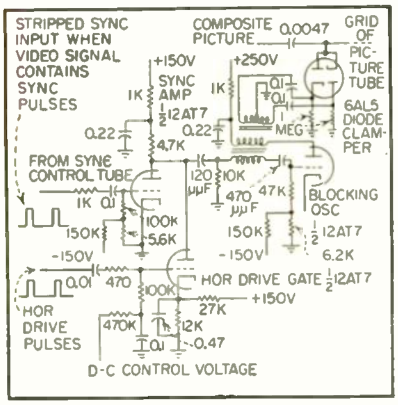


FIG. 5—Back-porch clamping circuit allows switching between composite and camera signals without adjusting black level

imately 50 percent in relation to the vertical sync pulse in the video signal. These delays are achieved by the use of horizontal and vertical multivibrator circuits running synchronously. In order that details in the blanking intervals may be observed with good contrast, the video signal on the grid of the picture tube is inverted. Thus, white represents sync top level, gray represents pedestal level and black represents white level.

Expanded Blanking

Expansion of the vertical blanking interval is accomplished by the circuit shown in Fig. 3. In the expand position, the charging capacitance in the plate circuit of the vertical sawtooth generator is effectively reduced by the addition of a small series capacitor that increases the slope of the generated sawtooth approximately five times. At the same time, the bias of the vertical output stage is reduced by shorting out some of the cathode resistance in order to center the display on the central and linear portion of the vertical scanning cycle.

Flywheel Sync

Greater synchronization stability in the presence of noisy or degraded sync, such as may be present in a remote signal under marginal conditions, is assured by a horizontal flywheel sync circuit. The circuit, which can be switched in, is a modified version of the synchro-guide arrangement widely used in tv receivers. It is shown in Fig. 4.

Black level fixed reference is maintained over wide variations in video signal content and level by line-to-line back-porch clamping. This eliminates the need for frequent adjustment of the brightness control, otherwise necessary with a conventional d-c restorer circuit. Back-porch clamping is ideal in monitor operations where many different video signals may be sampled in rapid succession.

For instance, in going from a composite video signal that contains sync information to a signal containing video and blanking only, the d-c restorer, which restores on sync pulse tips in the one case and to the pedestal level in the other, would give a shift in black level of approximately 30 percent. The back-porch clamper keeps black level fixed for the two signals.

Back-Porch Clamp

The clamp drive pulses are derived from either the trailing edge of the separated sync pulses or the trailing edge of the horizontal drive pulses, depending only on whether or not sync pulses are present in the video input signal. The circuit needs no adjustment and operates automatically for all types of input signals, the only requirement being that the pulse width of horizontal drive be less than the pulse width of horizontal blanking by at least 2 microseconds for satisfactory pedestal clamping of a video signal without sync pulses.

The clamper circuit of Fig. 5 consists of a dual diode driven from the low-impedance center-tapped winding on a blocking oscillator transformer.

The clamp drive pulses, of approximately 2 microseconds width, trigger the blocking oscillator, which operates as a slave circuit normally biased to cutoff.

Trigger pulses are obtained by differentiation and amplification of either sync or horizontal drive pulses as described above. Separate amplifiers gate in either of the two different trigger sources, depending on the bias conditions at the sync control tube.

Four-Channel FSK

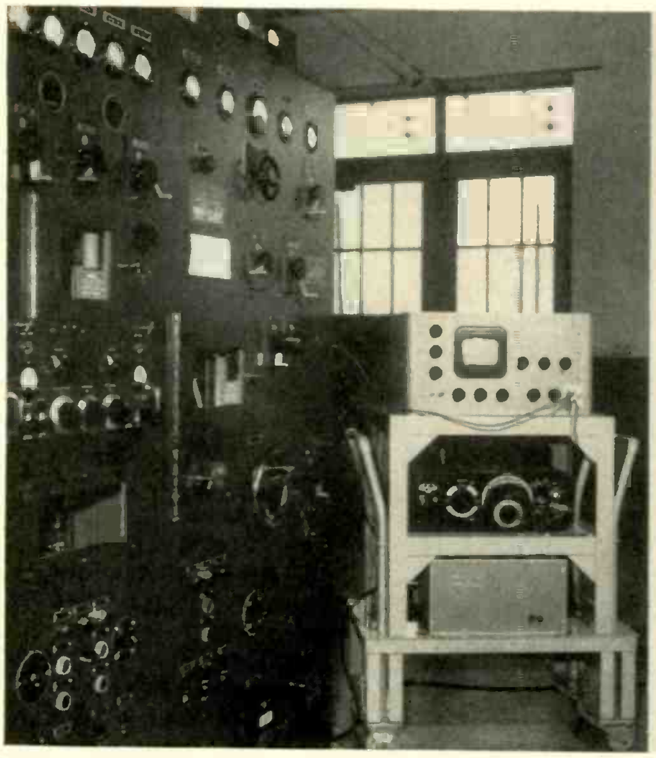
New frequency-shift keyer adapts any class-C radiotelegraph transmitter to multichannel operation. Overall frequency spread of only 3.85 kc provides four channels including keying sidebands. Transmitter driver uses heterodyne system rather than frequency multiplication to select assigned carriers from 4 to 24 mc

FREQUENCY-SHIFT generation of a new form described below allows multiple frequency-shift channels from a single radio transmitter while at the same time permitting an exciter of reduced size and cost. This development was carried out primarily to obtain additional channels by use of two or more frequency-shifted carriers passing through a single linear amplifier. The new type of frequency-shift excitation resulting can be applied to any class-C telegraph transmitter for ordinary single-channel working. The embodiment of the new generation and multichanneling scheme has been given the name Polyplex.

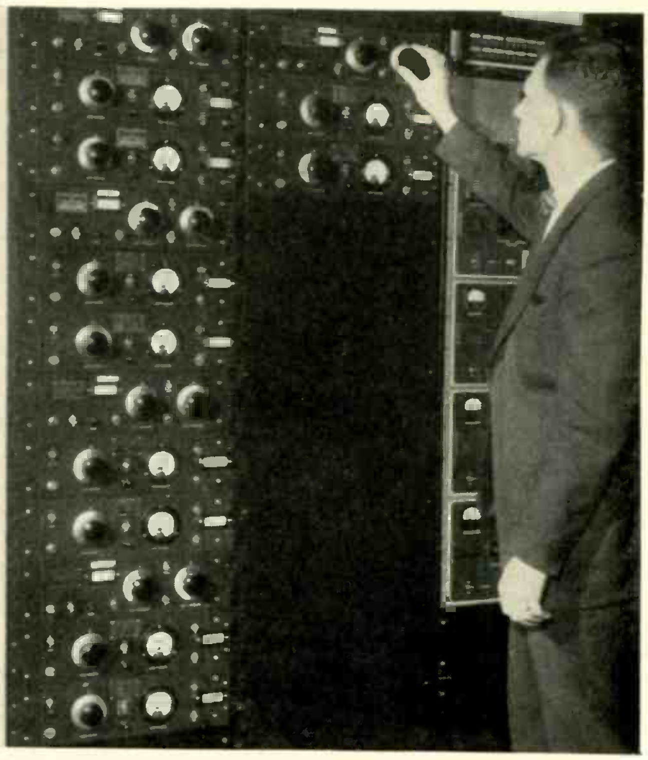
In the Polyplex system delineated in Fig. 1 all component circuits have been reduced to the essentials necessary for maximum stability and overall effectiveness in radiotelegraphy. In effect this system is a composite of single-sideband as well as frequency-shift techniques. Fundamentally, these two methods are the same. Frequency-shift keying is the telegraphic counterpart of single-sideband suppressed-carrier as applied to telephony. At present, four frequency-shifted channels are derived from the system, using standard radiotelegraph transmitters of 7.5-kw and 30-kw class-C rating in which the final and penultimate amplifiers have been converted to linear operation. Terminal equipment associated with these transmitters to produce four channels is less expensive than that formerly required for single-channel frequency-shift keying.

Exciter Unit

Generation of the frequency-shifted carriers is accomplished in exciter units of the type shown in Fig. 2. Carrier shift is obtained by means of reactance-tube frequency-modulation of a 200-kc oscillator of the series-tuned *LC* type. The modulating and oscillating func-



Driver stage is mounted in transmitter (left). Panoramic distortion-measuring equipment on dolly can be wheeled to required location



Group of five exciters (two dials) and combining units (two for each exciter) provides four channels on each of five transmitters

Adds Radio Circuits

By CHRISTOPHER BUFF

Project Engineer
Mackay Radio and Telegraph Co.
International Tel. & Tel. Corp.
New York, N. Y.

tions for each carrier are combined in one tube, a type 6SN7. Considerable effort was expended in obtaining a very pure 200-kc waveform so that two or more oscillators could be combined without producing intermodulation distortion. As a result, total harmonic distortion in each oscillator is less than 1 percent.

A high degree of frequency stability without temperature-controlled ovens is required. The present design shows a maximum drift of about ten cycles for a temperature variation from 20 to 50 deg C over a 24-hour period. Compensating capacitors are employed to offset frequency variations owing to temperature. However, no attempt is made completely to neutralize this effect because this leads to jumpiness in oscillator frequency and nonuniformity in production.

By using a heterodyning process to obtain final output frequencies in the 4 to 26-mc range, rather than the usual frequency multiplication, total drift on 26 mc is essentially the same as on 200 kc, plus the small drift of the associated high-frequency crystals.

Each 200-kc reactance-tube oscillator section is followed by its own class-A triode amplifier and then coupled into a common tuned-plate circuit, which is transformed to a 70-ohm output impedance for feeding a coaxial line to the transmitter at a level of 1 to 2 volts. This source actuates the driver chassis located in the radio transmitter.

The Twinplex[1] method of keying, which permits two channels from each of the two carriers produced by one exciter, is used to obtain a total of four channels. A combiner

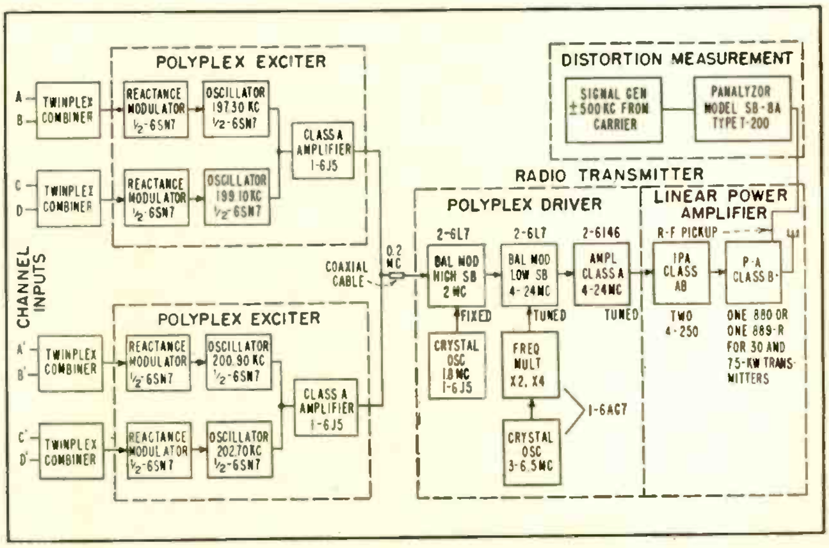


FIG. 1—Block diagram shows interconnections for four-channel Polyplex system used commercially. Eight channels shown can be used if bandwidth permits

circuit is shown in Fig. 3. Bandwidth permitting, it is possible to parallel two exciter outputs on the coaxial line for a total of eight channels.

Figure 4 shows the frequency spectrum for four-channel operation. Using Twinplex keying on each carrier, effective power is doubled over that existing for conventional mark-space keying of separate channels because for the same number of channels the available transmitter power is spread over only half the number of carriers.

For making the equivalent of the two-tone test to check overall transmitter distortion, both oscillators of this exciter are placed on mark-mark condition and this produces two equal-level carriers at the output, 2,150 cycles apart.

Transmitter Driver

As in other types of radiotelegraph transmitters in which crystal oscillator, buffer, keying stage and frequency multipliers are mounted on a single chassis, the Polyplex driver is similarly assembled. The basic driver comprises two bal-

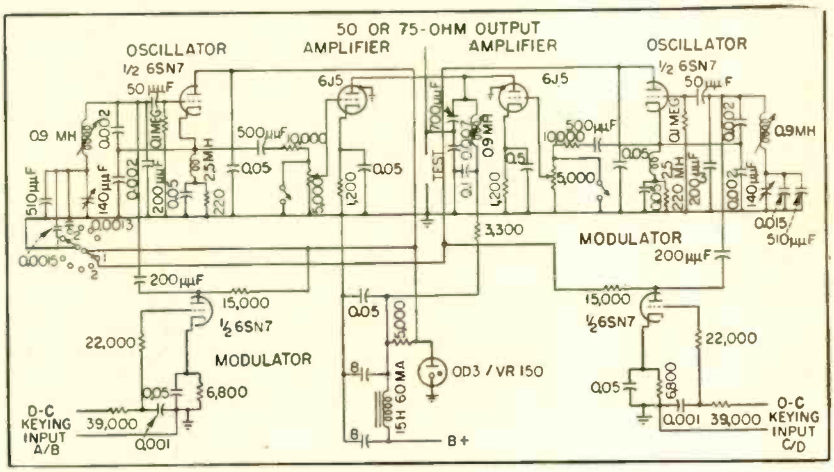
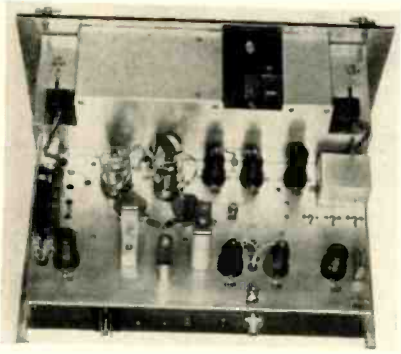


FIG. 2—Exciter combines four inputs to driver



Driver stage transposes 200-kc keying frequencies into range from 4 to 26 mc

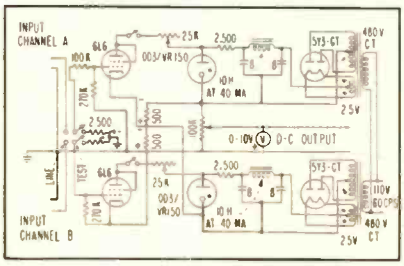


FIG. 3—Twinplex combiner feeds two signals to exciter (Fig. 2)

anced modulators, two crystal oscillators and a linear push-pull output amplifier suitable for driving the type 4-250 penultimate stage of the transmitter. These features are shown in Fig. 5. The first balanced modulator is fixed tuned at 2 mc which is the high-frequency sideband resulting from the mixing of an associated 1,800-kc crystal oscillator and the 200-kc signals coming in on the coaxial line from the exciter.

The 2-mc output is fed in push-pull to the grids of a second balanced modulator that may be switched and tuned over the range from 4 to 24 mc. The low-frequency sideband is chosen throughout this range as the final output frequency. This sideband results from the 2-mc signals mixing with harmonics of a high-frequency crystal oscillator operating on a fundamental range of 3 to 6.5 mc and always utilizing either the second or fourth harmonic of the crystal. A feature of this circuit is the use of double-tuned highly selective circuits in the crystal multiplier output.

This precaution results in at least 50-db attenuation of all but the desired second or fourth harmonic to which the circuit is tuned. A small peaking trimmer is used on the second tuned circuit to permit opti-

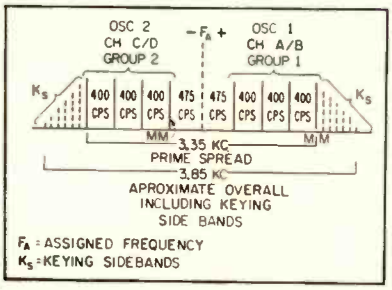


FIG. 4—Four-channel frequency spectrum

mum selectivity throughout the range. The extra tuned circuit eliminates the need for using various odd harmonics of the crystal to prevent spurious outputs from the second balanced modulator. For example, if 14-mc output is desired it should be the resultant of the fourth harmonic of 4-mc minus 2-mc. However, if adequate multiplier selectivity is not provided, 14-mc may also be produced by the third harmonic of 4-mc plus 2-mc. Both 14-mc frequencies would be radiated, one spurious.

Neutralizing Voltage

Following the second balanced modulator is a push-pull linear amplifier utilizing type 6146 tetrodes operating class A. Output from one side is capacitively coupled to the parallel 4-250 stage in the transmitter, which is operated class AB. Output from the other side provides a 180-degree out-of-phase neutralizing voltage for the 4-250's.

In the design of the driver rapid frequency change is provided without introducing distortion. All biases and driver levels are preset to the best possible compromise between distortion and output over the entire range from 4 to 24 mc. A single drive-level control on this unit, which is in the 200-kc input circuit from the coaxial line, serves to adjust the operating output level of the complete transmitter.

The maximum distortion products during a two-tone test are 35-db or more below the main signal at the output of the 6146 stage for a drive level sufficient to operate the transmitter to at least 17-kw peak power output. The transmitter final output shows the distortion 28 to 30 db down.

In the driver all facilities associated with other types of radiotelegraph operation have been incorporated. It is possible to operate on-off keying, with class B or C operation of the transmitter, through the same unit. Likewise, straight frequency-shift with class-C operation may be used. When two carriers are required to provide

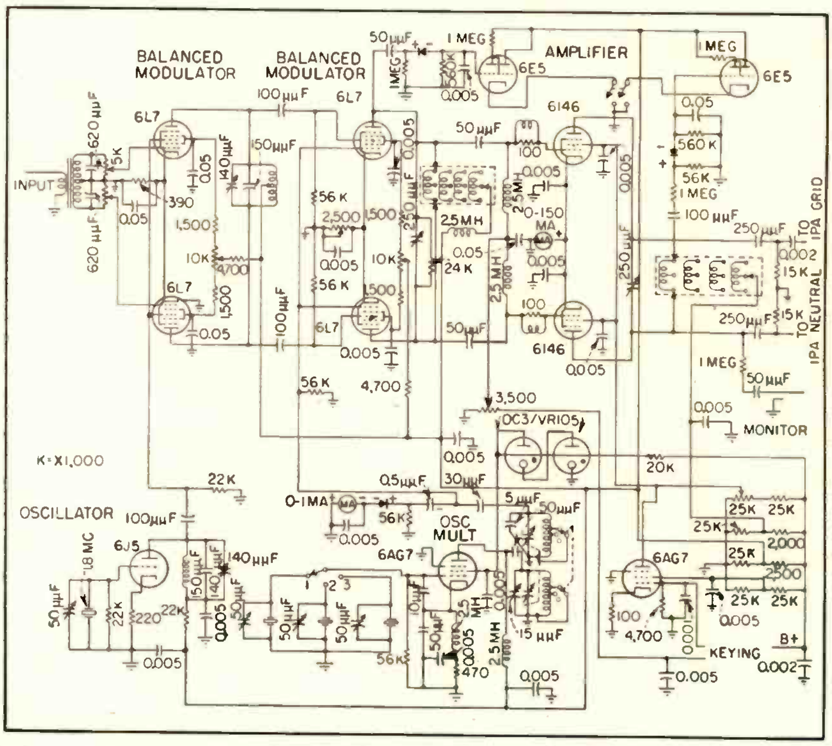


FIG. 5—Driver assembly takes four-channel input and keys transmitter

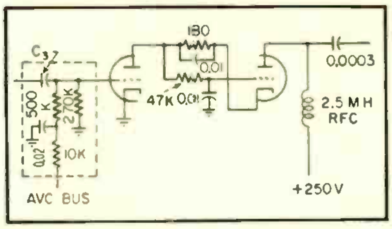


FIG. 6—Cascode stage improves receiver r-f

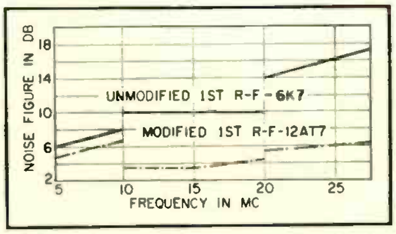


FIG. 7—Improvement in signal-noise for receiver using cascode r-f

additional channels, the drive level to the transmitter is reduced by means of a front-panel control until linear operation results in all stages of the transmitter.

Distortion products under linear operation are observed on a panoramic type presentation so that results are immediately evident. This feature permits rapid tuneup and changeover from class-C to linear operation. The driver characteristics are also suitable for single-sideband telephony when associated with suitable voice frequency terminal equipment.

Receiving Equipment

Multichannel reception is carried out on a dual-diversity basis. For four-channel operation two identical receiver bays are used, one for channels A/B and one for channels C/D. Each pair of radio receivers is controlled by an external high-frequency crystal or variable-frequency oscillator of high stability tuned specifically to receive one of the two pairs of channels. By using separate high-frequency oscillators tuned in this manner, the same audio frequencies result from each pair of receiver outputs and this in turn allows identical filters to be used in the frequency-shift conversion equipment following. This conversion equipment is the same as that previously used for Twinplex operation employing filter center frequencies of 1,950, 2,350, 2,750 and 3,150 cycles.

Radio receivers are Hammarlund SP-400 and SP-600 types especially modified for optimum performance on fsk telegraph operation. In one model the 6K7 first r-f stage has been replaced with a 12AT7 in a cascode circuit (Fig. 6) for improved signal-to-noise ratio over the whole 4 to 26-mc range. Above 20 mc a 10-db improvement over the original circuit is obtained as shown in Fig. 7.

The antenna input is converted to 50-ohm impedance for unbalanced coaxial cable. A broad-band 4 to 26-mc balanced-to-unbalanced transformer couples the low-impedance coaxial line to the antenna feedpoint. These transformers are made for various balanced input impedances such as 1,000, 500, 200, 100 and 50 ohms. The output impedance is 50 ohms unbalanced in each case and the transformer loss is held to within 1-db over the 4 to 26-mc range.

The Polyplex system is closely akin to single-sideband working and precautions must be taken in the receiver as well as in the transmitter to minimize nonlinearity and consequent intermodulation in all stages. The distortion is carefully checked with two-frequency input varied over a wide range of levels—about 60 db—as would normally be encountered in high-frequency propagation. It was found, in the SP-400 receiver, that the main factors in achieving a low value of distortion are the application of the proper amount of avc and cathode bias on the 12AT7 first r-f stage and the injection of a sufficiently strong intermediate oscillator signal at the plate of the third i-f stage.

In the original receiver there was also considerable overdrive, with strong signals, of the third i-f stage, which caused blocking of the second detector and mutilation of the signals. This condition was remedied by changing the third i-f tube from a 6SK7 to a 6SJ7 with considerably reduced plate and screen voltages.

The intermediate-frequency oscillator or bfo acts as the reinserted carrier and for best results it should be at least 10-db above the signal level at the point of mixing. The rather simple expedient of using a 1.8-millihenry peaking coil in series with the bfo signal line to the third i-f mixing point proved effective in raising the injected 467.5-kc bfo voltage from 10 to 50 volts, or about 14-db. This voltage gain is realized through an impedance transformation.

If the local carrier oscillator is not much stronger than the signal the detector output will contain distortion products of importance in the form of difference frequencies between the two or more signal carriers present. When these difference frequency components fall within the desired signaling bands, mutilation of the signals usually results.

When a Polyplex signal is picked up on a communications receiver in which the aforementioned design principles have not been properly applied, spurious frequencies on either side of the main signal may be noticed in the receiver output. The spurious effect will increase as the r-f or, in some cases, the i-f gain is increased. With multichannel operation, as in single-sideband working, the receiver must be given consideration equal to that afforded the transmitter with respect to effects of distortion and intermodulation, especially at maximum gain settings. These are points often overlooked in the design of standard communications receivers.

System Operation

The present Polyplex system was based on the use of existing Twinplex filtering and conversion equipment to reduce obsolescence. Development of a new receiver-converter designed specifically for the system will allow transmitted bandwidth to be cut in half. Further development also continues in the transmitter proper towards greatly increased power output under linear operation with the same number of stages.

The Mackay radio circuit between New York and Tangier has been operated on a Polyplex basis for more than a year. A four-channel multiplex may be operated on each of these four Polyplex channels in the future.

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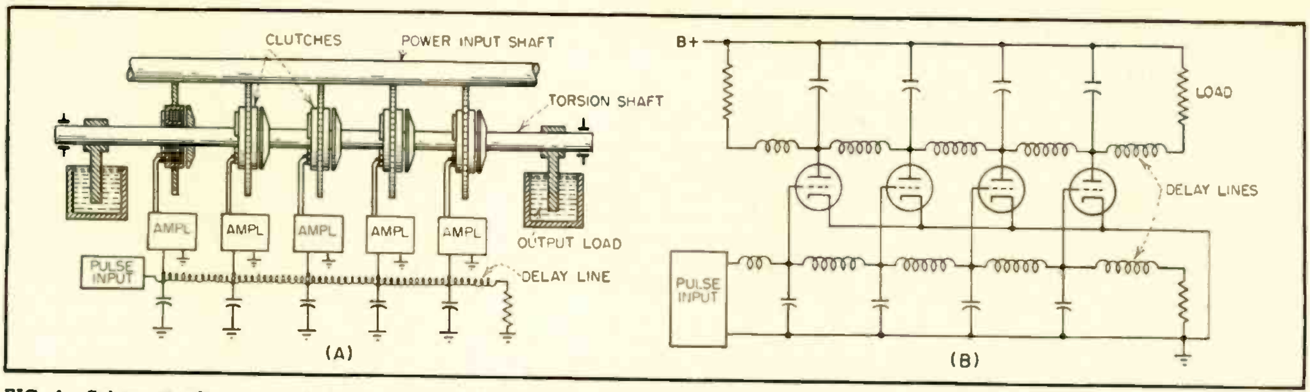

FIG. 1—Schematic diagrams of clutch-actuated distributed transducer (A) and analogous distributed amplifier (B)

Distributed Transducer

Nonresonant magnetostrictive device sets up high-energy traveling waves at ultrasonic frequencies. Possible applications include study of elastic properties of materials, frequency-modulated sonar and ultrasonic cutting tools

TRAVELING WAVES of ultrasonic energy can be set up in a long magnetostrictive rod by a distributed amplifier similar to those used in wide-band r-f service.

The distributed amplifier consists of eight stages of amplification bridged between an input delay line and a distributed plate load—excitation coils spaced along the magnetostrictive rod.

The distributed ultrasonic transducer was developed as the result of an investigation of magnetic-fluid clutches which entailed a search for a satisfactory method for employing magnetic clutches in the transmission of large amounts of power at cycling speeds in the ultrasonic range.

A small magnetic clutch could be built to operate at ultrasonic speeds but a large one would not behave as a rigid body and the transmission of large amounts of power would not be ordinarily possible.

A solution to the problem was suggested by the distributed electronic amplifier. In such an amplifier a large amount of power can be handled by several low-power stages ganged by delay lines so that their inputs and outputs are in parallel without their input and output impedances shunting.

If a mechanical analog of the electronic distributed amplifier could be built, it would have considerable advantages for generation of mechanical oscillations of high amplitudes. Figure 1A illustrates such a distributed mechanical transducer. Several small magnetic clutches actuated by a distributed amplifier are arranged to produce torsional oscillation of high frequency and high power. For comparison, Fig. 1B shows a typical distributed amplifier in which electrical power is transferred to a load by traveling-wave action.

Magnetostrictive Transducer

To study the principles involved in the distributed magnetic clutch, a distributed amplifier was devised to set up traveling waves of ultrasonic energy in a magnetostrictive rod. The resulting lengthening and shortening of the rod could then be changed back into electrical energy, and fidelity and efficiency of electromechanical energy conversion studied. Other means for producing traveling ultrasonic waves such as piezoelectric crystals could also have been employed.

The first model of the magnetostrictive transducer utilized thyratrons to pulse the excitation coils. Fixed time delays were inserted between the thyratrons to delay the input signal by the correct amount. Interstage delays were each individually adjustable and made equal to the transit time of the elastic wave traveling down the output rod.

The basic operation of a distributed amplifier can be understood with reference to Fig. 1B. Pulses are fed into the output by each stage and travel in both directions. Pulses traveling toward the left are absorbed in the resistor shown to prevent reflections and resulting interference.

For the same reason, a frictional termination must be supplied for the free end of the magnetostrictive rod. In practice, however, it has proved difficult to devise such a termination since there is apparently no simple way in which mechanical vibration can be totally, or nearly totally, absorbed.

Final Circuit

The device shown in Fig. 2 is an improved version of the magnetostrictive transducer. In this model, push-pull 6L6's are used to pulse the output line and the input elec-

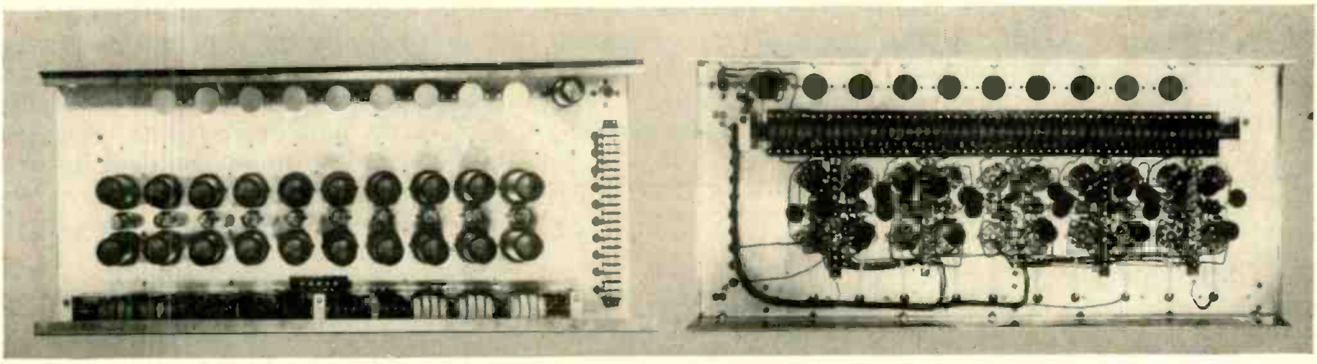

FIG. 2.—Above (left) and below (right) chassis views of f-m magnetostrictive transducer showing exciting coils and delay line

for Ultrasonic Power

By JACOB RABINOW* and MAURICE APSTEIN

Rabinow Engineering Co.
Washington, D. C.

Associate Technical Director
Diamond Ordnance Fuze Laboratories
Washington, D. C.

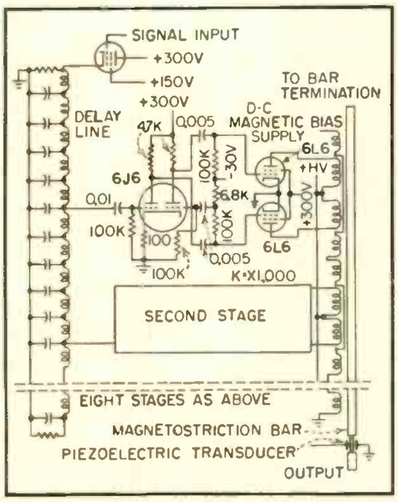

FIG. 3—Magnetostriction amplifier showing delay lines

trical delay line is so constructed that its propagation velocity matches that of the output bar. To measure the output of the transducer, a piezoelectric crystal is attached to the output end of the rod. A circuit diagram of a typical amplifier stage is shown in Fig. 3.

In the final tests, the piezoelectric transducer was replaced by a mutual-inductance r-f transducer developed at NBS.[1] This transducer measures displacement of the end of the bar without coming in contact with it and is believed to give a more correct indication of the bar's motion. Considerable effort was spent on the development of a suitable termination for the unused end of the bar. Best results were obtained by the friction termination shown in Fig. 4. It consists of small permanent magnets placed against the bar and a cylindrical weight clamped to the end of the bar as shown. By adjusting the clamping force, reflections from this end of the bar can be kept to a sufficiently low value.

The great advantage of a distributed transducer is that it is inherently not a resonant device. Because the oscillations in the output member are excited in a space-distributed system, the mechanical length of the bar has no effect on the frequency of oscillation. This should be contrasted with an oscillating system where the physical constants of the system determine the period of oscillation so that the buildup of amplitude is created by successive impulses arriving in time phase with the natural oscillation of such a system. Another inherent and very great advantage of a distributed network is that the heat dissipation and, therefore, the energy that can be delivered to the

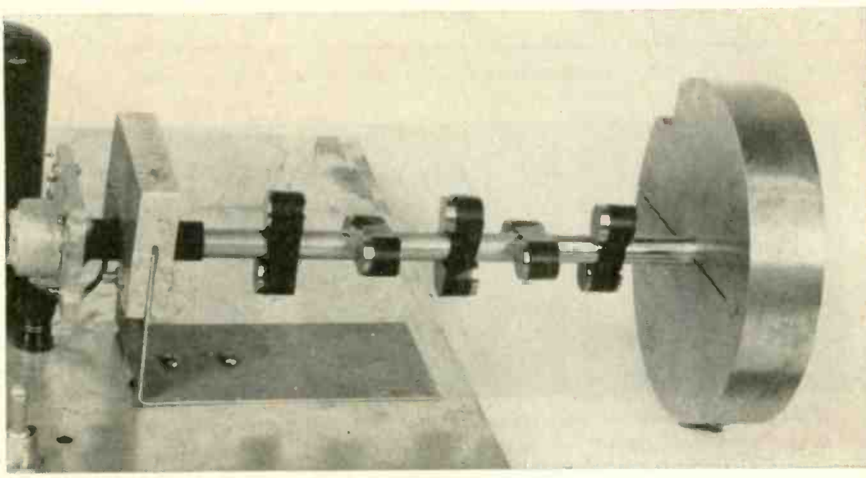

FIG. 4—Termination for end of output bar. Alnico magnets taped to bar in conjunction with clamped weight act as friction device to reduce reflections

* Formerly Technical Advisor, Diamond Ordnance Fuze Laboratories.

device is much greater than that of an equivalent resonant device operated at the same frequency, because the dimensions of the former can be so much greater.

To test the wide-band characteristics of the transducer, a frequency-modulated oscillator was built to feed the input electrical delay line and a special output-detector network was designed to measure the output. The circuit diagrams of these devices are shown in Fig. 5 and 6. With these two units coupled to the magnetostrictive transducer, voice frequencies were transmitted over the network. Overall performance is shown in Fig. 7.

In later work, tests were made to compare the relative effectiveness of rods and tubes. Because of skin effects at high frequencies, magnetostriction takes place only near the surface of the transducer. Tubes with wall thicknesses of 1/8 inch showed an increase in output as compared to rods. Thinner tubes should show still higher efficiencies.

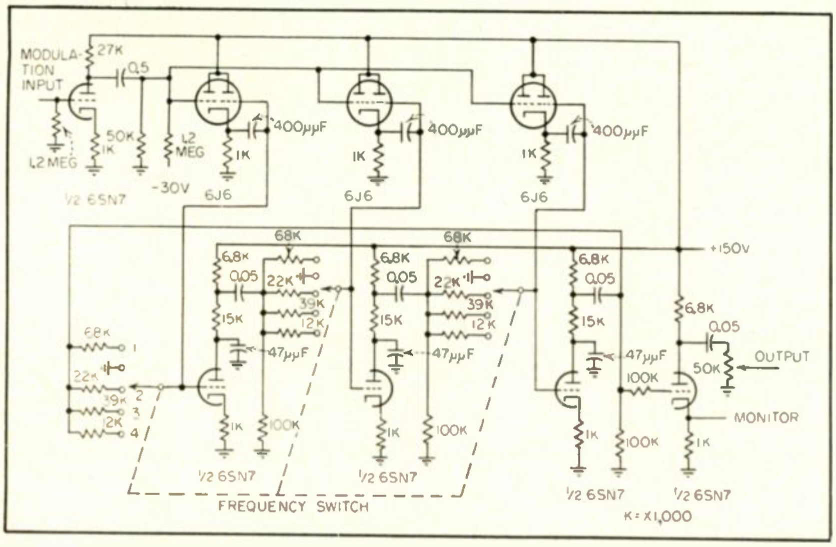

FIG. 5—Frequency-modulated oscillator for transducer. Frequencies for positions 1, 2, 3 and 4 of the frequency switch are 10.4, 20, 13 and 27 kc respectively

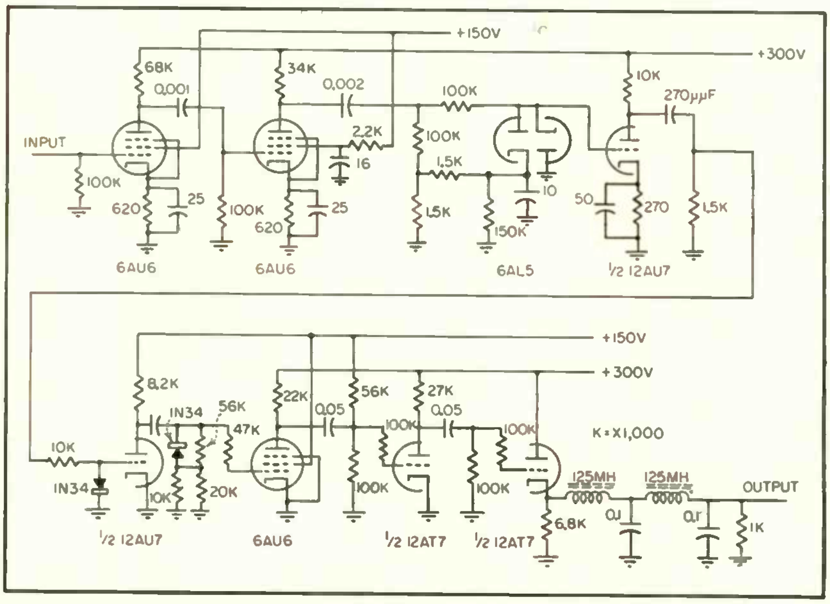

FIG. 6—Low-frequency discriminator used to measure transducer output

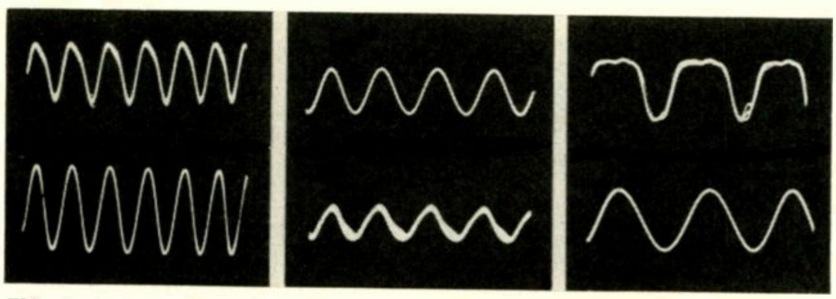

FIG. 7—Frequency-modulated signals transmitted by magnetostrictive transducer. Top row of waveforms are inputs from f-m oscillator modulator. Bottom row of waveforms are outputs from discriminator. The frequencies from left to right are 500, 1,000 and 1,500 cps. An f-m carrier frequency of 27 kc with a maximum frequency deviation of ±15 percent was used

Applications

High-energy ultrasonic vibrations are now being employed in the drilling of ceramics, glass and other hard materials. The broadband characteristics of such transducers may have wide applications in military applications of ultrasonics. The ability to maintain a high-energy traveling wave through long lengths of material is of importance to the study of physical properties of the materials. The stress-strain relationships obtained with steady application of forces do not hold for pulses of short duration. The rate at which pulses travel through a physical body is one of the clues to the elastic properties of the body and it has been difficult in the past to obtain pulses of high energy traveling for appreciable distances through test specimens. The ability to produce longitudinal or torsional oscillations of very large amplitude should also prove useful in the testing of materials, both in fatigue testing of the materials themselves and in inducing vibrations in devices attached to the transducers.

The author thanks Ernest Codier who designed and built the two models of the distributed transducer and electronic equipment, Herbert Curchack who developed the friction termination and did much of the experimental and theoretical work and Israel Rotkin for his supervision and advice.

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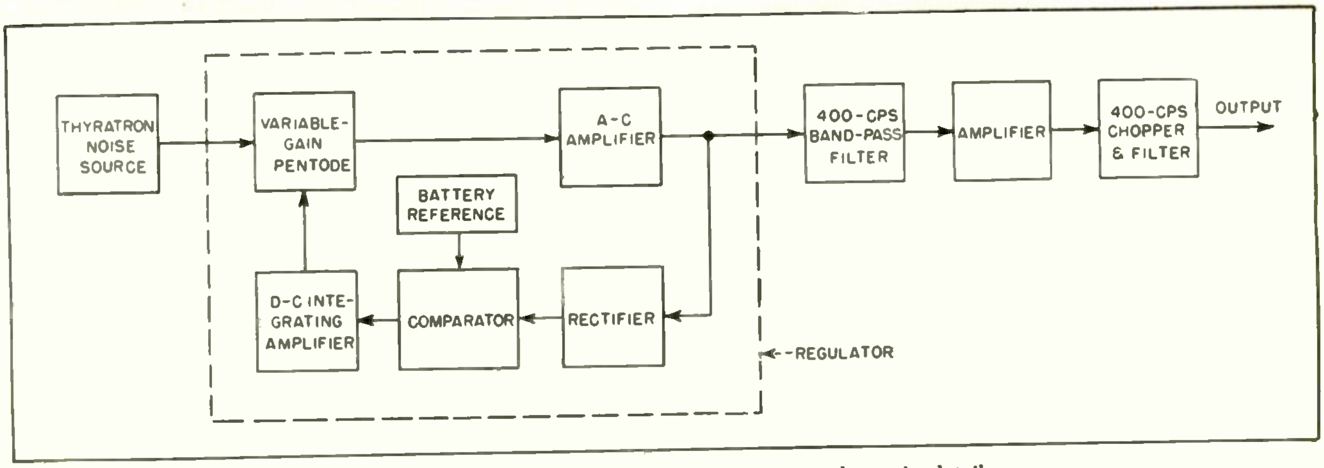


FIG. 1—Block diagram of complete noise generator with voltage regulator portion shown in detail

Stabilized Noise Source for Air-Weapons Design

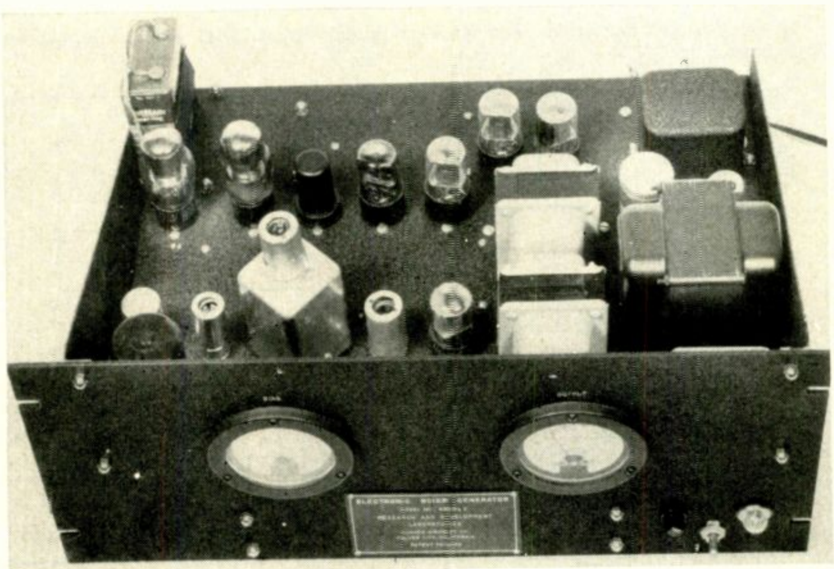
Signal simulates radar noise, air turbulence and circuit noise for design of air weapons by electronic analog. Output of thyratron noise source is voltage regulated and filtered to provide uniform noise signal from 0 to 35 cps

By D. E. BEECHER, R. R. BENNETT and H. LOW
Hughes Research and Development Laboratories
Culver City, California

RECENT YEARS have seen striking advances in the design of guided missiles and other aerial weapons systems. With these advances has come an increasing awareness of the importance of noise and other statistical considerations in modern complex aerial guidance and control systems. Faced with the fact that the noise is, due to the nature of its origin, almost fundamentally unavoidable the system designer is forced to build his system to live with the noise and yet give optimum performance.

Noise Generator

In the design and analysis of complex systems, simulation has come to be a key tool. It has become possible, furthermore, to inject or simulate the various random quantities appropriate to such studies. Radar noise, air turbulence, manufacturing irregularities and circuit noise



Layout of stabilized noise generator illustrates how shield cans are utilized to avoid spurious pickup are examples of statistical inputs that may be electronically generated and supplied to simulation equipment. This article describes a noise generator that can be used with electronic analog computers as the basic source of noise and other random quantities. It is a precision device designed to provide for accurate, quantitative system simulation.

The frequency spectrum of the noise generator output is uniform from d-c to 35 cps, which more than covers the range useful for most simulator applications. Thus it produces white noise for frequencies below 35 cps.

The probability distribution of the output voltage amplitude is Gaussian or normal,[1] which is the

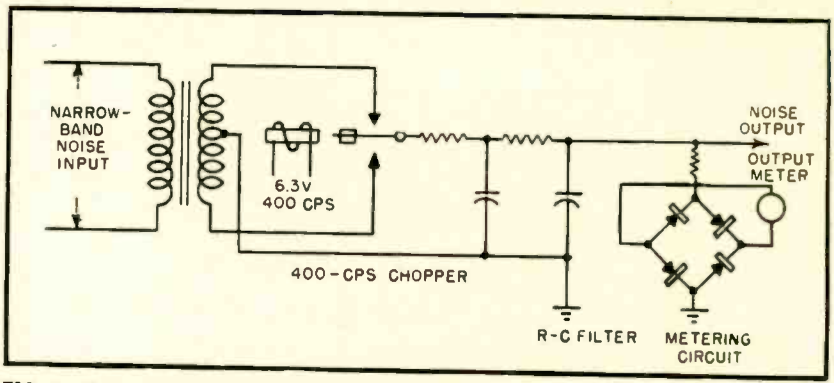


FIG. 4—Output circuit includes chopper, R-C filter and metering circuit

desired distribution for most uses. Other distributions can be obtained through the use of auxiliary apparatus.

A block diagram of the noise generator is given in Fig. 1. The primary source of noise is a type 5727 thyratron. The output level of the noise from the gas tube varies with heater voltage and envelope temperature and in addition appears to vary due to changes in cathode emission. Since these variations are at low frequencies it is possible to use a regulator to compensate for them. The bandwidth of noise accepted by the regulator must be sufficiently wide to permit averaging of the noise level and yet allow for a reasonably short time constant for the regulating action. The noise supplied to the regulator extends from about 30 cps to 3 kc.

Regulator

The regulator circuit is indicated on the block diagram. The noise is passed through a variable-gain pentode, amplified and half-wave rectified. The rectified noise is compared with a reference battery and the difference averaged by the integrator circuit. This is equivalent to first averaging the rectified noise and then comparing this average with the battery reference.

If the average noise amplitude is greater than the battery voltage the gain of the variable-gain pentode is reduced. If the noise is less, the gain is raised. Thus the output of the regulator is noise whose average amplitude is constant and whose spectrum extends from 30 cps to 3 kc.

Due to the nature of the gas tube the amplitude probability distribution at this point is nearly Gaussian. Some distortion is introduced by the slightly nonlinear character of the variable-gain pentode.

A complete schematic of the regulator appears in Fig. 2. The meter indicates the bias on the type 5749

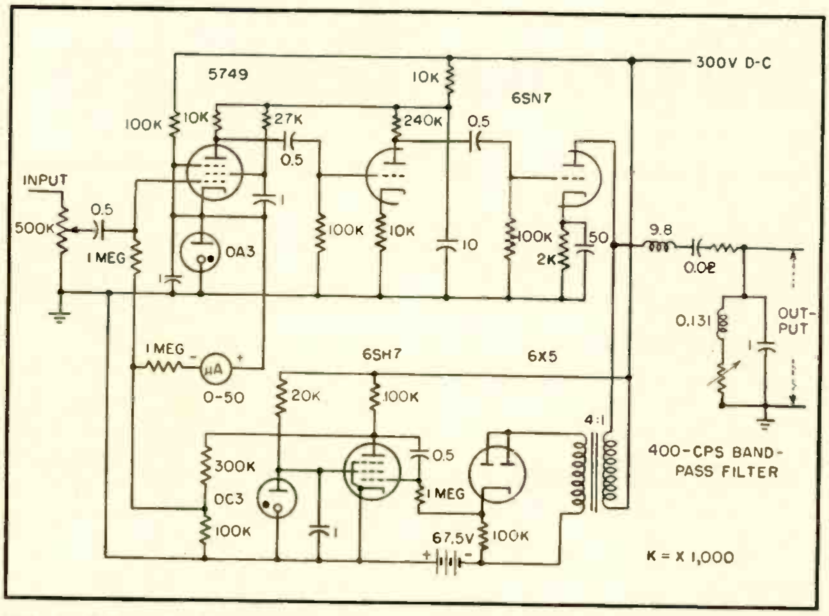


FIG. 2—Schematic diagram of voltage regulator circuit with 400-cps band-pass filter in its output

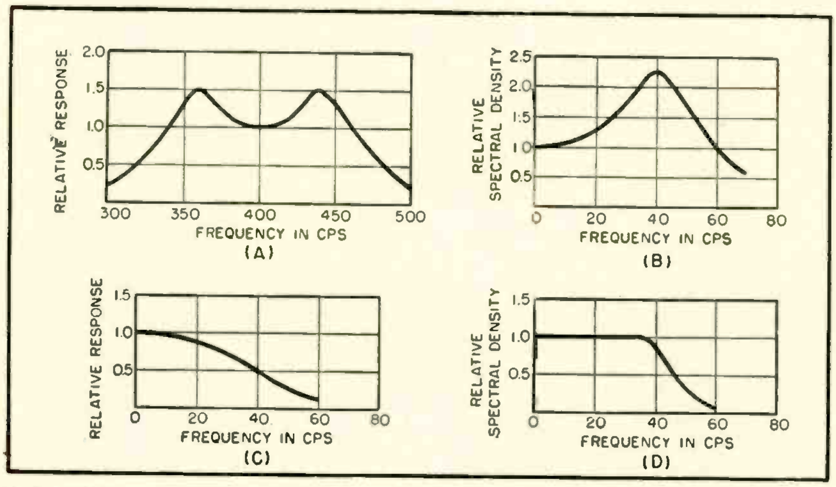


FIG. 3—Frequency response of filters and resulting spectral density of noise signal illustrate development of uniform spectrum

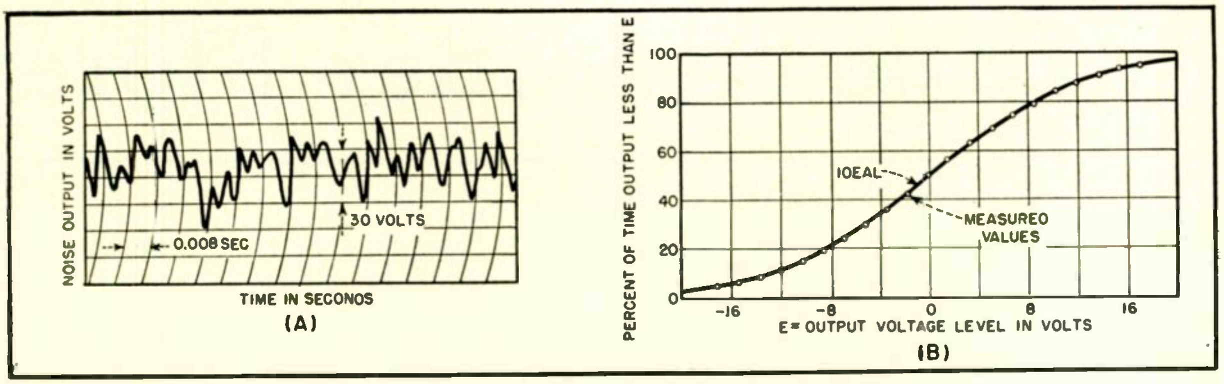


FIG. 5—Recorder sample of noise generator output (A) and probability distribution showing agreement between measured and theoretical values (B)

variable-gain pentode and is a measure of the noise level at the input to the regulator. This indication allows adjustment of the noise input level such that the regulator will operate in the proper region. This adjustment however, is not critical and ordinarily requires no attention.

The spectral density of the regulator output is uniform in the center of the 30-cps to 3-kc band. A portion of this spectrum is selected by the filter whose transmission characteristic is given in Fig. 3A. Thus the output of the filter is centered at 400 cps and has a bandwidth of approximately 100 cps. A degree of adjustment of the frequency response shown is afforded by the variable resistances in the filter circuit. Stabilized toroids and capacitors are used.

Noise Detection

After amplification by a feedback amplifier the noise is detected by a standard 400-cps electromechanical chopper, Fig. 4. The chopper multiplies the noise voltage alternately by plus one and minus one. This multiplication by a square wave results in frequency components consisting of sums and differences of the noise frequencies and the chopper frequency and its various harmonics.

Thus there is low-frequency noise (a component at either 395 cps or 405 cps in the amplifier output will yield a 5-cps noise component at the chopper output) and noise centered at 800 cps, 1,200 cps, 1,600 cps etc. For a perfectly symmetrical chopper only the odd harmonics of 400 cps would be present. The R-C filter which follows the chopper effectively eliminates the high-frequency components, leaving the low-frequency noise.

If there were no R-C filter the spectrum of the low-frequency portion of the output would be as shown in Fig. 3B. The R-C filter, whose gain is shown in Fig. 3C, modifies the spectrum of Fig. 3B to give the output spectrum shown in Fig. 3D. Thus the doubly peaked gain characteristic shown in Fig. 3A was chosen for the filter at the output of the regulator.

The two filters compensate such that the resulting output spectrum is essentially uniform or flat. Measurements show that this arrangement gives a spectrum flat within 0.1 db from d-c to 35 cps.

The frequency shifting procedure insures a uniform spectrum at frequencies less than 1 cps which is not commonly obtainable due to power-supply noise at these low frequencies.

In addition the noise spectrum falls off rapidly above 40 cps. This is a desirable feature inasmuch as the useful dynamic range of the output is not decreased by the presence of useless high-frequency components.

Electronic means can be used for the detection process. However, the electromechanical chopper has the advantage that it does not introduce any d-c offset in the output. This is often an important factor in simulation work.

A standard panel meter is filled with heavy silicone fluid to give a mechanical time constant of several minutes. Such heavy smoothing is needed to average the output voltage since the frequencies involved are so low. Since the noise amplitude is stabilized by a regulator, the output meter serves merely as a monitoring device during operation.

The portion of a strip chart reproduced in Fig. 5A constitutes a typical recorded sample of the noise generator output. The amplitude distribution at the regulator output is not perfectly Gaussian. However, since the noise bandwidth at this point is many times wider than the bandwidth of the filter the amplitude distribution at the output of this filter is insignificantly different from Gaussian. The final output of the noise generator is Gaussian, therefore, since the circuit is linear following this filter.

System Performance

Accurate measurements have been made of the output amplitude distribution. A result of such a measurement, showing the cumulative probability distribution, is given in Fig. 5B. This curve extends to a voltage level that is twice the standard deviation of the output (approximately 10 volts). However, measurements show that the distribution is accurately normal to values in excess of four times the standard deviation, which is more than sufficient for almost all simulation work. The differences between the actual measured values and the ideal curve are within the experimental error.

Reasonable precautions are exercised in construction to insure that any 400-cps fields do not induce voltages in the low-level circuits, since such signals would result in a d-c offset in the output. An interleaved shield can is placed over the chopper for this reason.

Reference

(1) James, Nichols and Phillips, "Theory of Servomechanisms," McGraw-Hill Book Co., Inc., New York, 1947.

Tape Recorder Stores

High-speed, 409,200-character output of computer is used for feeding at slower rate a tape-punch unit or electric typewriter. System can be used for handling teletype messages or telemetering data for processing or storage

By CURTIS W. FRITZE

Engineering Research Associates Division of Remington Rand Inc. St. Paul, Minnesota

ELECTRONIC computing machines now operate so fast that electric typewriters and other conventional data-printing devices cannot keep up with them.

The magnetic tape input-output equipment to be described is designed for use with a large-scale data-processing computer. It serves as a buffer between this high-speed computer and slow-speed printers.

The equipment consists of an output recorder, tape-to-punch reader and input reader, Fig. 1. The output recorder stores output data from the computer on magnetic tape. This tape can be transferred to the tape-to-punch reader which plays back the data to a punch or an electric typewriter. If further processing of the data is required, the output recorder tape can be transferred to the input reader, which reads the data back into the computer.

Recording Technique

Saturation-pulse recording of the magnetic tape is used in the output recorder. The d-c erase head located ahead of the recording-head assembly erases any previously recorded information and uniformly biases the tape to saturation of one polarity. Pulses are then recorded to saturation in the other polarity. Pulses are recorded in six 0.025-inch parallel tracks at a pulse density of 40 pulses per inch. Six tracks were chosen because the output from the computer is a parallel five-level binary code. The extra track is available for locating or control.

Pulse density of 40 pulses per inch was chosen to combat the effects of dropouts due to irregularities in the tape surface and to allow playback at the relatively low playback speeds of the tape-to-punch recorder. The low playback speed and surface irregularities on the tape impose a practical lower limit to the amount of energy which must be stored in each of the magnetized marks on the tape. The use of narrow tracks made it desirable to record longer marks on the tape to store sufficient energy for low-speed playback.

Using these parameters, one seven-inch reel of magnetic tape can store 576,000 six-level binary characters at a density of 960 bits per square inch, providing adequate storage for the entire load of information.

The recording speed of the output recorder is 15 inches per second or 600 six-level characters per second. This is determined by the maximum rate at which information can be taken continuously from the magnetic-drum memory of the computer. With an operational rate of 600 characters per second, the entire memory of the computer, 409,200 characters, can be completely transferred in approximately 15 minutes.

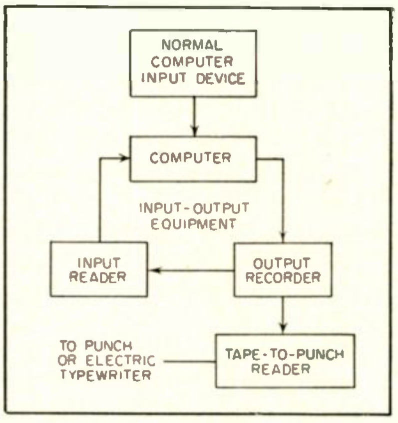


FIG. 1—Functional relationship of units of buffer storage medium

The input reader affords two playback speeds, 7.5 inches per second and 3.75 inches per second, 300 and 150 characters per second respectively. The tape-to-punch reader plays back at a tape speed up to 0.327 inch per second or 13.1 characters per second. The rate is determined by the output mechanism selected, punched paper tape or typewriter. This unit is under a-synchronous control of the output mechanism. It normally stops between characters on the tape until the mechanism receives a has-written signal, whereupon the tape starts moving again.

Tape-Handling Mechanisms

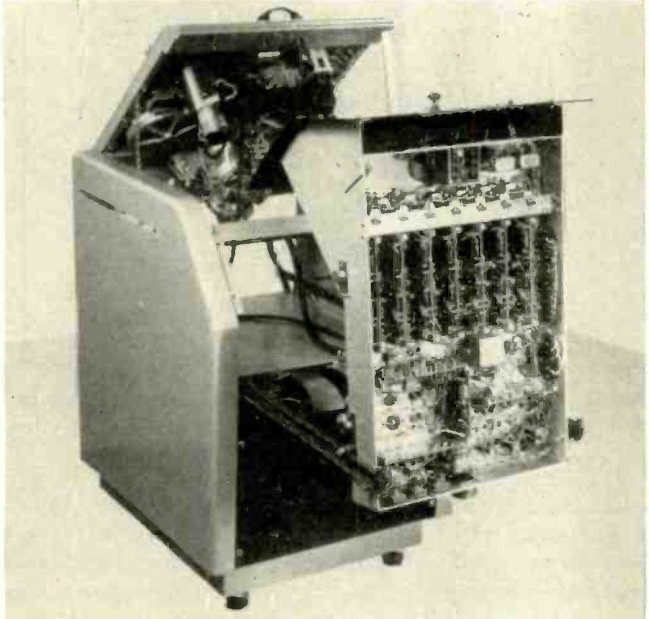
All three units use modified Ampex 400 series tape-handling mechanisms. The tape-handler for the output recorder was modified to allow normal operation or to be started and stopped. The capstan drive motor was removed from the tape-to-punch reader tape-handler and replaced with an electromechanical clutch allowing start and stop of the capstan to be controlled electrically. The capstan clutch was driven by a gear motor at a speed of 25 rpm to provide a tape speed of 0.327 inch per second. The idler flywheel was also removed and replaced with a driven wheel to provide faster acceleration of the tape.

Output Recorder

The output recorder is controlled by the computer. The tape is started

Computer Output

Output recorder and tape-to-punch reader shown from left-to-right. Pulses are recorded in six parallel tracks



Buffer storage unit in servicing position. All three units are similar in construction and appearance

in motion upon receipt of information from the computer, and the information is recorded as soon as the tape is up to speed. The tape continues in motion until no information pulses have been received for more than 0.25 second then stops until receipt of the next block of information.

After recording a character, the output recorder sends a has-written pulse back to the computer to request the next character. Recording rate of the output recorder is 600 characters per second. One character equals six information pulses in parallel.

Initiate-Write Pulse

Figure 2 is a block diagram of the output recorder. When power is first turned on, the buffer storage flip-flops and the gate flip-flop in the control section are set to the nonoperating position by the delayed ground return from the power supply. The first six information pulses are received, one at a time, from the computer. These pulses pass through the recirculation switch to the three-winding (one primary and two secondary) pulse transformers. When an information pulse is received in any channel an initiate-write pulse is sent from one secondary winding to the write gate where it is blocked. No writing can occur at this time. These information pulses trigger the buffer storage flip-flops through the other transformer winding.

Write Gate

When a buffer storage flip-flop is triggered, the thyratron gate writer in that channel is enabled, and the position line becomes positive. This positive condition is detected by the tape-drive detector. The tape drive flip-flop is triggered, and the tape drive starts. After a delay of approximately ¼ second produced by the gate delay, the write gate is enabled by the artificial initiate-write pulse which sets the gate flip-flop. This pulse also passes through the write delay to the write gate. Since the write gate is now open, the artificial initiate-write pulse is passed to the thyratron-gate writers as a write pulse. Each thyratron which has been enabled by an information pulse will fire, causing the corresponding head to record a pulse on the magnetic tape.

After the initial information character has been written, the gate-delay circuit does not function. Thus, as long as information continues to arrive from the computer, the position line will remain positive and the write gate will be enabled. The initiate-write pulses can pass through the write-delay circuit and write gate. The write-delay circuit produces a delay before each writing operation allowing the buffer storage flip-flops to set up and enable the thyratrons.

Has-Written Pulse

Each time a character is written, the buffer storage flip-flops are reset by a pulse from the thyratron writer, and the position line becomes negative. The has-written circuit detects this change and generates a delayed has-written pulse, which is sent to the computer. When the computer receives a has-written pulse, another information character is sent to the output recorder. When information no longer arrives, the position line becomes negative and the tape drive flip-flop is reset. This condition, after sufficient delay to allow for short gaps in the blocks of information, stops the tape drive and dis-

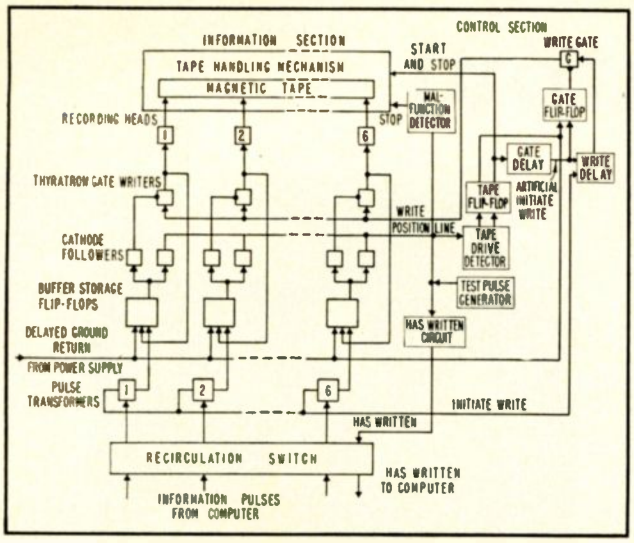


FIG. 2—Output recorder employs malfunction detector circuit to stop tape drive when recorder fails to operate properly

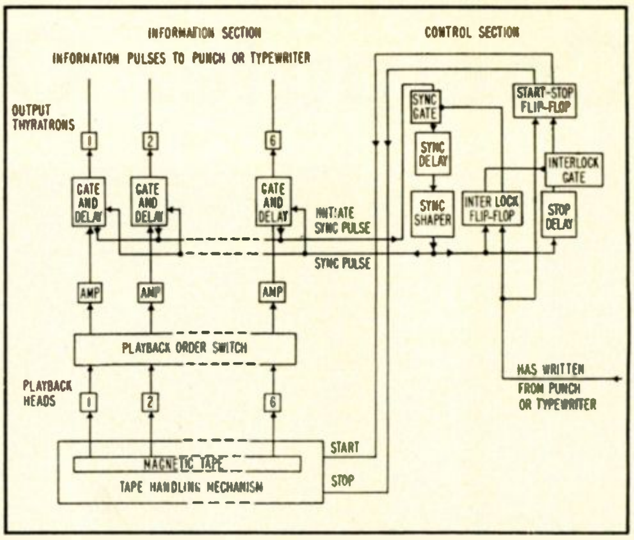


FIG. 3—Tape-to-punch reader has interlock for continuous tape motion should output mechanism operate faster than reader

ables the recorder write gate.

The delay after receiving information and before writing, plus the delay introduced after writing and before transmitting the has-written pulse back to the computer, affords a means of controlling the recording rate. The initial delay in writing also resynchronizes the parallel pulses to insure parallel recording of the pulses on the six recording tracks.

The recirculation switch and test-pulse generator make up a testing circuit for testing the operation of the output recorder. If the recirculation switch is in operate position, information pulses pass through as described. If the switch is in single-pulse position, pulses originating in the test-pulse generator are passed through the switch to the information levels selected for testing. Test tape with pulses in any of the six levels may also be made in this manner.

A malfunction-detector circuit indicates when the output recorder is not operating properly. Any time the position line fails to receive a negative signal during a two-second period, the malfunction-detector circuit stops tape drive.

Tape-to-Punch Reader

The tape-to-punch reader shown in Fig. 3 reads information recorded by the output recorder and plays it back to a typewriter or paper-tape punch for recording.

The information pulses are read, one character at a time, from the magnetic tape by the playback heads. After a character has been read, the tape is stopped by the electromechanical capstan clutch until receipt of a has-written pulse from the punch or typewriter, whereupon the tape is started and the next character read. Thus the playback speed is determined by the punch or typewriter up to the maximum speed of 13.1 characters per second. An interlock is provided to allow continuous tape motion in event the output mechanism is capable of operating at higher speeds than the reader.

The playback-order switch determines the order in which information pulses are to be read, reversed or as recorded. This allows the tape to be played back without rewinding. These information pulses are amplified by plug-in preamplifiers and are transmitted to the gating and delay circuits. When the first information pulse of a character arrives at a gating and delay circuit, that circuit produces an initiate-sync pulse, which is sent to the control section. If the output mechanism has completed the preceding writing operation, it produces a has-written pulse, which sets the interlock flip-flop, and the sync gate is enabled, allowing an initiate-sync pulse to pass. This pulse is delayed, shaped, and transmitted back to the gating and delay circuits as a sync pulse. All of the information pulses temporarily stored in the gating and delay circuits are simultaneously sent to the typewriter translator adapter or to the tape punch when the sync pulse enables the gating and delay circuits.

Figure 4 illustrates the method of resynchronizing the pulses from the six levels by means of monostable-multivibrator gating circuits. The time constant of each multivibrator is slightly longer than half the period between pulses. The pulse from each of the playback heads triggers its multivibrator. Thus through using the initiate-sync pulse to form a sync pulse by delaying and re-shaping, the outputs from all six levels on the tape are resynchronized to allow for tape skew or slight head misalignment. This sync pulse also provides a means of obtaining a timing pulse without requiring a separate timing track to be recorded on the tape.

Multivibrator Gating Circuit

The gating circuit used for resynchronizing is shown in Fig. 5. The circuit consists of a cathode-coupled monostable multivibrator with a gating diode inserted in series with the plate load of the normally conducting side of the multivibrator. When triggered, normally cut-off V_{1A} conducts and V_{1B} is cut off for a period of time determined by R and C.

The positive-going pulse at the plate of V_{1B} is differentiated and triggers a sync delay and then a sync generator as shown by the waveforms of Fig. 4. The positive synchronizing pulse, thus generated when any one or more of the gating multivibrators has been triggered, is applied across the series diode through a series capacitor and resistor. If the multivibrator has been triggered the diode is not conducting and the pulse is capacitor coupled to the input of the thyratron stage. If the multivibrator has not been triggered, the pulse will be short-circuited by the current drawn through the multivibrator and the sync pulse will not be transmitted to the thyratron circuit.

The interlock flip-flop of Fig. 3 is set by the sync pulse, enabling the interlock gate and disabling the synchronizing gate to prevent generation of false synchronizing pulses.

The synchronizing pulse is also transmitted to the stop delay where it is delayed to allow time for completing the reading operation before stopping the tape.

If the output mechanism is capable of accepting information as fast as it is available from the tape, the interlock flip-flop, in conjunction with the has-written signal, provides a means of constant tape motion. If a has-written pulse is received before the tape is stopped, the interlock flip-flop is set to disable the interlock gate and block the stop signal to the electromagnetic clutch of the tape-handling mechanism and the tape continues in constant motion. If the output mechanism is not capable of accepting the information as fast as it is available from the tape the interlock gate will remain enabled. Then a stop signal from the stop-delay will be applied through the start-stop flip-flop to the tape handling mechanism.

The problem of providing enough amplification of the played-back signal from the tape was solved by utilizing plug-in preamplifiers designed to provide a gain of 8,000 in a single pentode stage at frequencies from 2 to 2,000 cps[1]. Heads were connected through a subsonic matching transformer to the input of the plug-in preamplifiers. Thus a signal of approximately 2 microvolts at the heads was stepped up 10 times by the transformer and 8,000 times by the preamplifiers to provide an output of over one volt by one stage of amplification.

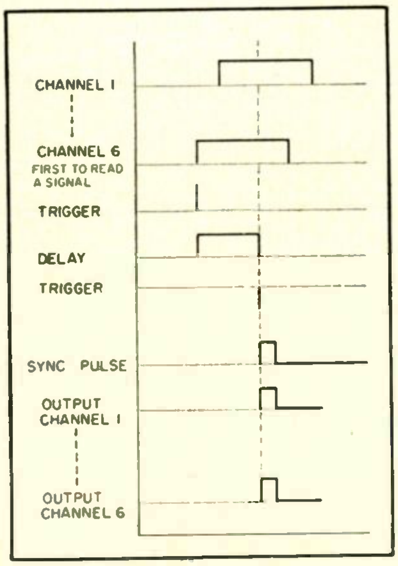


FIG. 4—Timing chart illustrates resynchronizing of pulses from six levels using monostable multivibrator gate

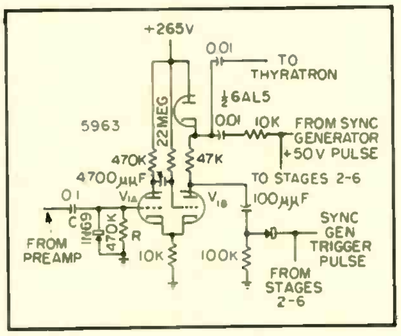


FIG. 5—Multivibrator gating circuit for resynchronizing played-back signals from magnetic tape

The input reader unit sends recorded information back to the computer. The playback-order switch determines which channel of the information section a pulse is to enter. These information pulses are then amplified and transmitted to the gating and delay circuits.

The first information pulse of a character to arrive at a gating and delay circuit produces a synchronized input pulse which is sent to the control section. This synchronizer input pulse is delayed, shaped, and transmitted back to the gating and delay circuits to synchronize the simultaneous insertion of a character into the computer. This circuit is similar to that of the tape-to-punch reader in operation.

The input-information pulses to the computer are 30 volt, 250 microsecond pulses. To provide a timing pulse, the synchronizer output also branches off in the control section and is delayed, shaped and sent to the computer with each character for synchronizing the input portion of the computer.

Test Results

Tapes recorded by the output recorder were used as input pulse sources for final testing of the tape-to-punch reader. A ten-to-one signal-to-noise ratio was observed at the output of the preamplifiers when the typewriter was not in operation.

With the typewriter in operation, the signal-to-noise ratio was approximately five-to-one. However, the circuits are normally disabled during typing thus minimizing the effect of interference. No trouble was experienced with typewriter operation when characters were typed out as recorded by the output recorder.

In the input reader signal-to-noise ratio at the output of the preamplifiers was found to be approximately twenty-to-one.

Final tests were conducted with the computer by recording data on the output recorder, re-entering the data into the computer, again recording it on the output recorder and finally typing out the information by means of the tape-to-punch reader. Satisfactory results were obtained.

Applications

Although the equipment was built for use with a specific computer, it might find many uses with other high-speed data processing systems or data transmission systems. For example, it may find application for storing radio-teletype messages sent at high speed for printing out at a later time. Telemetering data might also be recorded in a similar manner.

The equipment was developed for the Office of Naval Research at the suggestion of Engineering Research Associates Division of Remington Rand Inc.

The author wishes to express his thanks to the many persons who aided in the design and construction of this equipment, including H. L. Daniels, R. R. Ritter, B. F. Swezey and W. O. Edstrom.

REFERENCE

(1) H. L. Daniels, U. S. Patent No. 2,489,272.

Monochrome I-F Strip

Techniques for extending bandwidth of 3.5-mc monochrome receiver i-f strips to pass chrominance information. Outboard-mounting conversion unit described adapts i-f strip for color with a minimum of wiring changes

WITH THE ADVENT of 24 and 27-inch black and white picture tube sizes, more attention was paid by some designers to the better picture quality attainable by more fully utilizing the bandwidth capabilities of the transmitted signal by using wider bandwidth i-f amplifiers. A method will be shown of adapting a such monochrome i-f amplifier strip, flat to about 3.5 mc, for color television.

As shown in Fig. 1, the main difference between a 6-mc color channel and the corresponding monochrome channel is the addition of a chrominance subcarrier at 3.58 mc, with chrominance sidebands extending from approximately 2.3 mc to 4.2 mc.

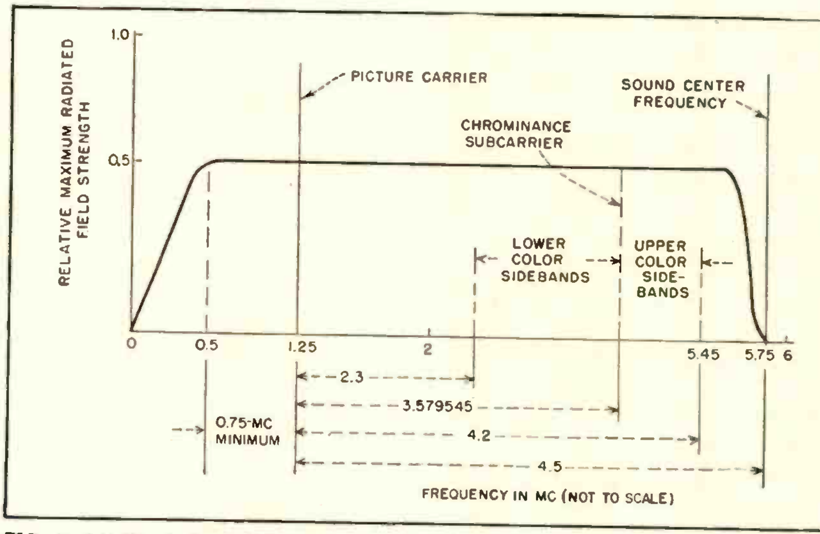


FIG. 1—Idealized transmission characteristic showing relative carrier frequencies

For most present-day monochrome i-f amplifiers, the bandwidth at 6 db down from the flat top of the response is between 3 and 3.5 mc. This means the response to the chrominance subcarrier and its upper sidebands is down appreciably from the flat top of the i-f response curve. Such amplifiers are not suitable for color television because of this narrower response.

Beat Frequency

A further requirement for the color i-f system, which is in conflict with the requirement for greater bandwidth, is the need for greater attenuation at the 4.5-mc sound-carrier frequency, or 41.25 mc in terms of intermediate frequency. One reason this greater attenuation is needed is the 900-kc beat frequency produced, mainly in the second detector, by the difference between the sound-carrier and the chrominance-subcarrier frequencies.

Although, the beat is an f-m effect since the sound carrier is frequency modulated, a definite reduction in beat visibility was attained by making the average beat frequency an odd multiple of half-line frequency.[1,2] The present 20 to 30 db rejection at 41.25 mc in monochrome receivers appears sufficient to reduce the beat to a negligible level.

A further attempt to reduce this beat-frequency interference was made by reducing the maximum sound-carrier amplitude to 70 percent of the picture-carrier amplitude. However, path differences and reflections may vary this ratio considerably.

Sound-Carrier Attenuation

Another reason for requiring greater attenuation at the sound-carrier frequency has to do with only the color receiver. While attenuation can be at 4.5 mc in the chrominance band-pass circuits, considerably more rejection is required in the i-f section before detection than is present in a monochrome receiver. The 4.5-mc beat note is amplitude modulated to some extent with the luminance information and the sidebands resulting from this modulation can cause crosstalk in the chrominance signal even though the 4.5-mc carrier has been attenuated.

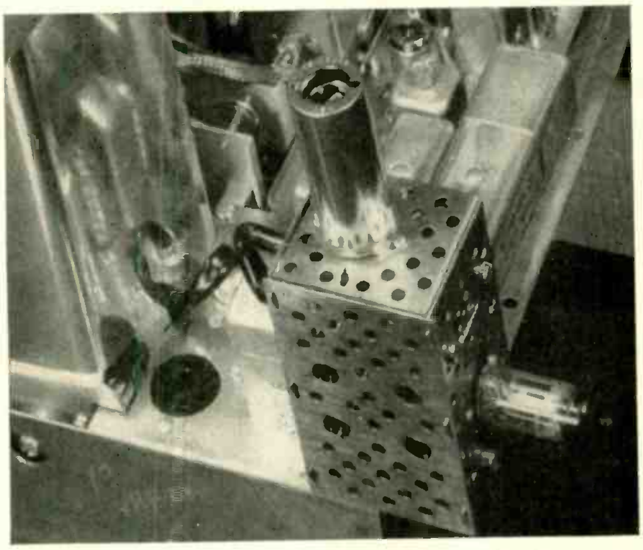
Since the depth of luminance amplitude modulation of the 4.5-mc sound signal is a function of the relative levels of sound and picture signals, the more sound-carrier attenuation in the i-f relative to picture carrier, the lower will be the relative importance of the amplitude-modulated sidebands of the 4.5-mc signal.[3] Sufficient attenuation must be added at 3.58 mc and 4.5 mc in the video section of the color receiver to eliminate any dot patterns.

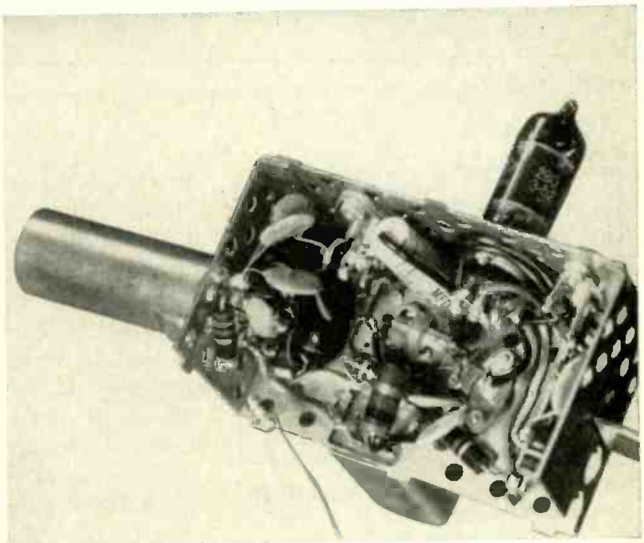
The necessary sound-carrier attenuation in the i-f section of the

Conversion for Color

By PHILIP S. STEINBERG

Senior Engineer
Television and Radio Division
Raytheon Manufacturing Company
Chicago, Illinois





Modification unit mounts on chassis near intercarrier-detector. Unit includes an i-f stage, video detector and cathode follower output

color receiver has been found to be 45 to 50 db with respect to the curve top, with the lower figure applying to a crystal detector as compared to a thermionic detector. Because of its better linearity with a few volts output and the elimination of a filament a crystal detector lowers the effect of the 900-kc beat.

To avoid sacrificing sound sensitivity, the 41.25-mc sound attenuation at the 4.5-mc i-f takeoff point must be maintained at the 20 to 30 db figure, as with monochrome receivers. This requires the arrangement shown in Fig. 2, where the sound is taken off and further attenuation is added at 41.25 mc before the video frequencies are taken out. Separate detectors are required for sound and video frequencies.

Converted I-F Strip

The schematic of a monochrome i-f amplifier adapted for color is shown in Fig. 3. The original monochrome i-f strip had only four 6CB6 stages, with the output from the CK706 crystal detector fed from the 4th i-f stage giving sound, synchronizing and video circuit input voltages. In addition, there were 15,000-ohms and 10 μμf in parallel across the primary of the detector input transformer.

To adapt the i-f strip for color, it was necessary to remove these two components and take off from the secondary of the detector input transformer. The signal is coupled through the 22-μμf capacitance to the grid of the 6CL6 5th i-f stage in the added outboard unit.

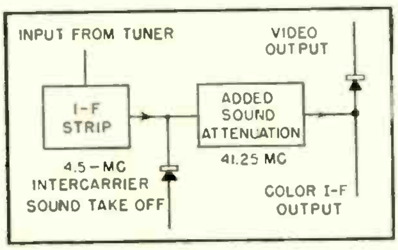


FIG. 2—Block diagram showing separate color i-f, sound and video takeoffs

The 22-μμf capacitance, in conjunction with the input admittance of the 6CL6 at 40 mc and stray and wiring capacitances to ground, gives the same loading as the removed resistor and capacitor. Therefore, i-f response up to this point is not changed.

Filter Characteristics

The 6CL6 drives a band-pass filter with a bridged-T section to give high attenuation at the 41.25-mc sound carrier and a sharp corner frequency as shown in Fig. 4.

There is a valley at the midband frequencies to secure some extension in bandwidth at the higher video frequencies. The peak at 41.65 mc corresponds to a 4.12-mc video frequency, which is about the upper limit for chrominance sidebands. This peaking may be overdone because it results in some loss of gain and makes the 6CL6

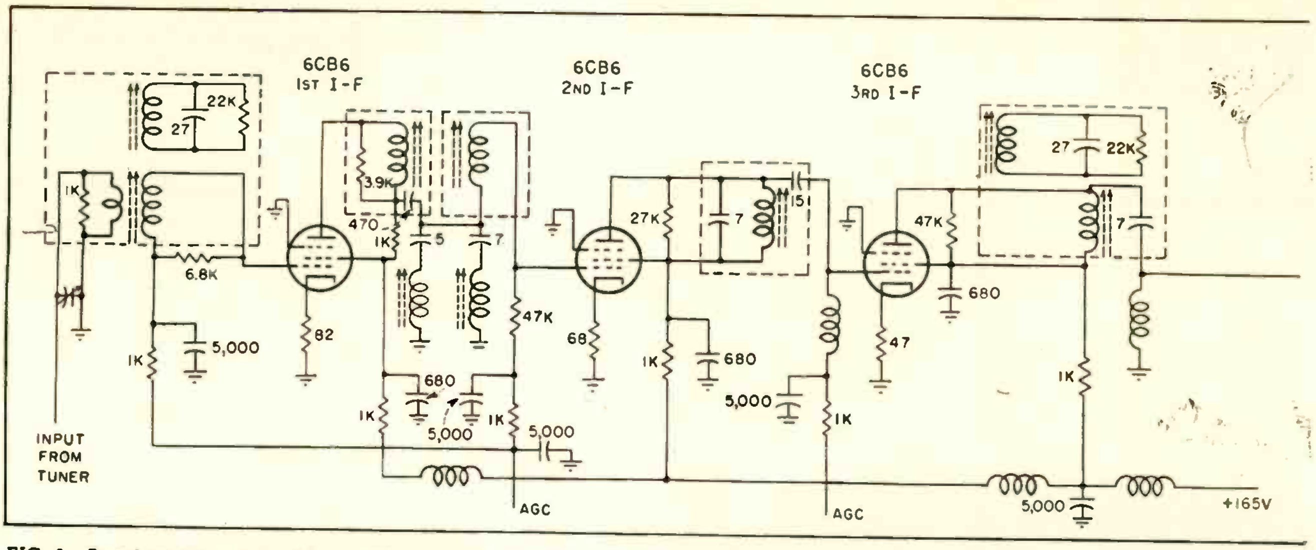


FIG. 3—Standard intercarrier i-f amplifier adapted for color. Conversion is made by taking signal from secondary of intercarrier sound

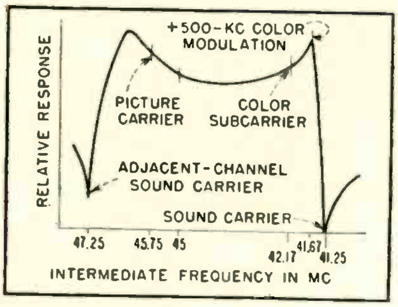


FIG. 4—Response obtained through 5th i-f stage shown in Fig. 3

more subject to overload. Also, a slight tuning adjustment must be made in other parts of the i-f strip to give an overall flat response.

The position of the video carrier at 6 db below the flat top on the overall curve is maintained by adjustment of the staggered i-f coil, which is tuned close to the video carrier frequency of 45.75 mc.

The crystal video detector drives a 6AH6 cathode follower. This is due to the color-set design, which attempted to utilize as much of the monochome set as possible. This was feasible because of the multi-unit type of monochrome set used, which includes r-f/i-f, deflection and high-voltage sections.

Since synchronizing, sound and deflection circuits are nearly identical for color and monochrome sets, only the high-voltage rectifier of the monochrome set was not utilized.

The color circuits were all located on a separate chassis driven with video through coaxial line

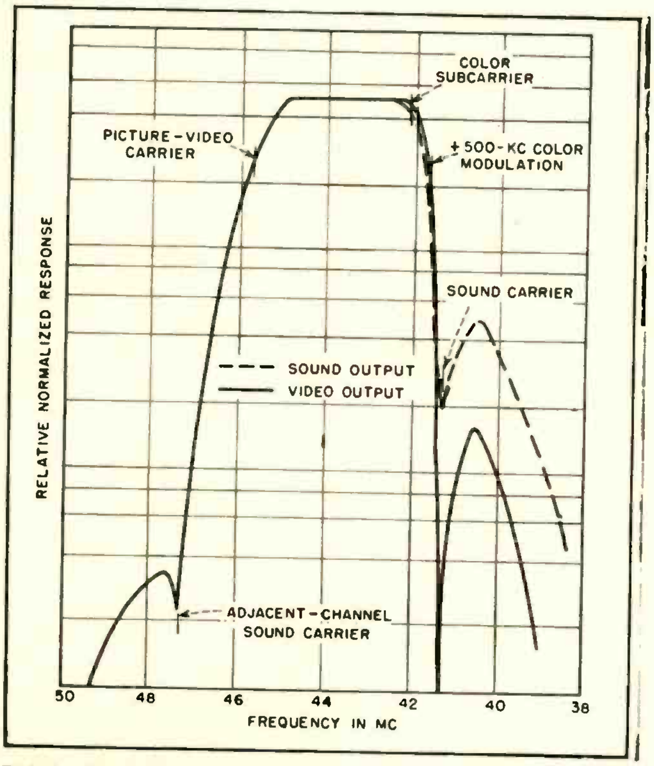


FIG. 5—Normalized responses at sound and video i-f outputs

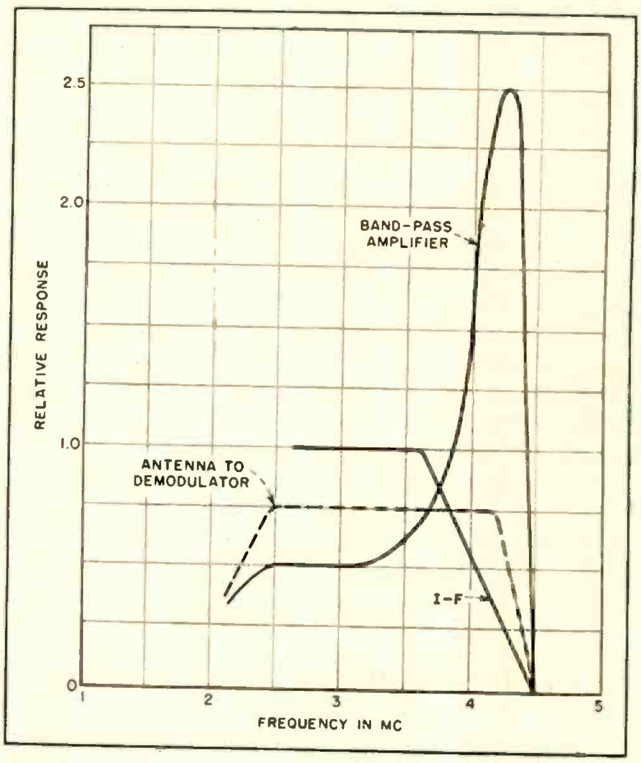
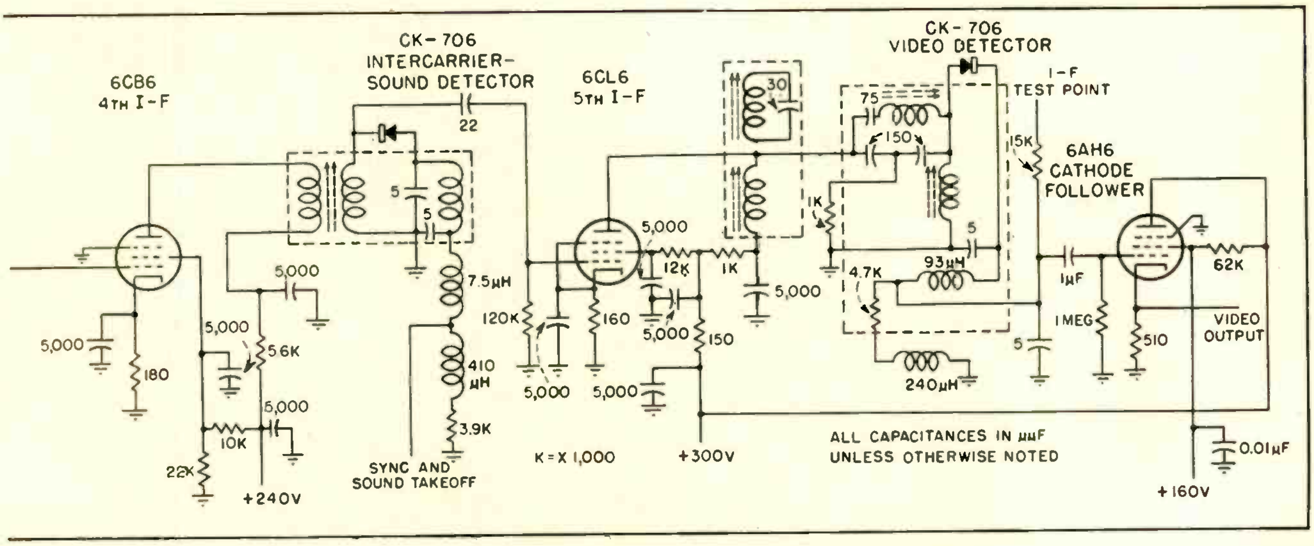


FIG. 6—Receiver response for encoded chrominance information



detector transformer and feeding it through a coaxial line to a 5th i-f stage in the modification unit

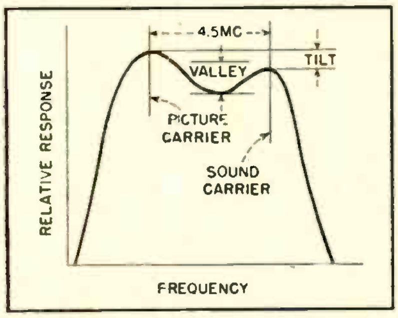


FIG. 7—Typical monochrome receiver tuner response

from the 6AH6 cathode follower on the r-f/i-f chassis.

Gain

The overall gain of the 5th i-f and cathode follower is 7 to 10 db as compared to the sound and sync takeoff (also previous monochrome video takeoff) resulting in about six-volts peak-to-peak video to drive the color chassis. There is about 3 db attenuation across the 22-$\mu\mu$f 6CL6 input coupling capacitance. If this attenuation were not present, it would be necessary to cut the input to the 6CL6 by readjusting the agc level to keep the video output down to the proper level. This would complicate the compatible aspect of the design. In addition, since the gain-bandwidth product of the 4th i-f stage is given by $g_m/2\pi C$, where g_m is the transconductance of the tube and C is the total tuned circuit capacitance, it is necessary, to maintain the proper overall response, that C not be increased.

The photographs show external and internal views of the added color modification unit. The input is taken from the secondary of the sound detector input transformer, which is available under the cover enclosing the intercarrier sound detector crystal, by coaxial line through a hole in the cover. The output jack is located at the lower right beneath the 6AH6 cathode follower. The power plug, which feeds B+ and filament voltages to the unit from the color chassis is located above the 6AH6. The 6CL6 is the tube on top. The side containing the input socket and the cover were made removable to facilitate servicing and construction. Both are held in place by twisted metal tabs. The can is perforated as a cooling aid.

Output Response

Normalized response curves of the outputs at the sound and video detectors are shown in Fig. 5. The sound detector output is actually negative but is shown positive for comparison. The color subcarrier is located at the corner of the curve with the highest chrominance sidebands about 7 db down with respect to the curve top. The wider bandwidth at the video output is due to the peaking in the 5th i-f stage.

If upper and lower sidebands are not equal in amplitude for the overall chrominance channel, color crosstalk occurs, resulting in picture contamination. The crosstalk is due to the quadrature type of encoding and decoding used for the color information.[4] To bring the upper chrominance sidebands up to the same level as the lower sidebands, the video color information may be passed through a band-pass amplifier having the type of response shown in Fig. 6. Some chrominance ringing occurs due to this peaking. Therefore, it is advisable to use as little peaking as necessary.

System Response

With respect to the overall response, a word should be said about tuners. It does no good to take great pains to secure an i-f response flat to $\pm\frac{1}{2}$ db tolerance only to find there is a 3 to 6 db tilt or valley in the tuner frequency response. A typical tuner response showing these effects is shown in Fig. 7.

It is quite likely that tuner tolerances will have to be tightened to the order of ± 1 db for satisfactory color information. Antennas also may have to be held to this flatness tolerance . A result of the subcarrier being too far down on the overall response is loss of synchronization of the color subcarrier reference oscillator in the receiver, with resultant loss of all color information.

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Feedback in Junction

By D. W. GADE

Assistant Professor of Electrical Engineering
Iowa State College
Ames, Iowa

Table I—Summary of Network Coefficients

Coefficient	Grounded Base	Grounded Emitter	Grounded Collector
Mesh-derived			
r_{11}	$r_e + r_b$	$r_b + r_e$	$r_b + r_c$
r_{12}	r_b	r_e	$r_c - r_m$
r_{21}	$r_b + r_m$	$r_e - r_m$	r_c
r_{22}	$r_c + r_b$	$r_c - r_m + r_e$	$r_c - r_m + r_e$
Nodal-derived			
g_{11}	$\frac{r_c + r_b}{r}$*	$\frac{r_c - r_m + r_e}{r}$	$\frac{r_c - r_m + r_e}{r}$
g_{12}	$-\frac{r_b}{r}$	$-\frac{r_e}{r}$	$-\frac{r_c - r_m}{r}$
g_{21}	$-\frac{r_b + r_m}{r}$	$-\frac{r_e - r_m}{r}$	$-\frac{r_c}{r}$
g_{22}	$\frac{r_e + r_b}{r}$	$\frac{r_b + r_e}{r}$	$\frac{r_b + r_c}{r}$

* $r = r_{11}r_{22} - r_{12}r_{21}$

Table II—Network Coefficients for Cascaded Pairs

	Individual Transistor Representation		Network Coefficient*			
Mesh-derived resultant	1st Transistor	2nd Transistor	r_{11}	r_{12}	r_{21}	r_{22}
1	mesh	mesh	$\frac{r'_{11}r''_{11}+r'}{r''_{11}+r'_{22}}$	$\frac{r'_{12}r''_{12}}{r''_{11}+r'_{22}}$	$\frac{r'_{21}r''_{21}}{r''_{11}+r'_{22}}$	$\frac{r''+r'_{22}r''_{22}}{r''_{11}+r'_{22}}$
2	mesh	nodal	$\frac{r'_{11}g''_{22}+r'g''}{g''_{22}+g''r'_{22}}$	$-\frac{r'_{12}g''_{12}}{g''_{22}+g''r'_{22}}$	$-\frac{r'_{21}g''_{21}}{g''_{22}+g''r'_{22}}$	$\frac{1+r'_{22}g''_{11}}{g''_{22}+g''r'_{22}}$
3	nodal	mesh	$\frac{r''_{11}g'_{22}+1}{g'_{11}+g'r''_{11}}$	$-\frac{r''_{12}g'_{12}}{g'_{11}+g'r''_{11}}$	$-\frac{r''_{21}g'_{21}}{g'_{11}+g'r''_{11}}$	$\frac{r''_{22}g'_{11}+r''g'}{g'_{11}+g'r''_{11}}$
4	nodal	nodal	$\frac{g'_{22}g''_{22}+g''}{g''g'_{11}+g'g''_{22}}$	$\frac{g'_{12}g''_{12}}{g''g'_{11}+g'g''_{22}}$	$\frac{g'_{21}g''_{21}}{g''g'_{11}+g'g''_{22}}$	$\frac{g'_{11}g''_{11}+g'}{g''g'_{11}+g'g''_{22}}$
Nodal-Derived resultant			g_{11}	g_{12}	g_{21}	g_{22}
5	mesh	mesh	$\frac{r'_{22}r''_{22}+r''}{r''r'_{11}+r'r''_{22}}$	$-\frac{r'_{12}r''_{12}}{r''r'_{11}+r'r''_{22}}$	$-\frac{r'_{21}r''_{21}}{r''r'_{11}+r'r''_{22}}$	$\frac{r'_{11}r''_{11}+r'}{r''r'_{11}+r'r''_{22}}$
6	mesh	nodal	$\frac{r'_{22}g''_{11}+1}{r'_{11}+r'g''_{11}}$	$\frac{r'_{12}g''_{12}}{r'_{11}+r'g''_{11}}$	$\frac{r'_{21}g''_{21}}{r'_{11}+r'g''_{11}}$	$\frac{r'_{11}g''_{22}+r'g''}{r'_{11}+r'g''_{11}}$
7	nodal	mesh	$\frac{r''_{22}g'_{11}+r''g'}{r''_{22}+r''g'_{22}}$	$\frac{r''_{12}g'_{12}}{r''_{22}+r''g'_{22}}$	$\frac{r''_{21}g'_{21}}{r''_{22}+r''g'_{22}}$	$\frac{r''_{11}g'_{22}+1}{r''_{22}+r''g'_{22}}$
8	nodal	nodal	$\frac{g'_{11}g''_{11}+g'}{g''_{11}+g'_{22}}$	$-\frac{g'_{12}g''_{12}}{g''_{11}+g'_{22}}$	$-\frac{g'_{21}g''_{21}}{g''_{11}+g'_{22}}$	$\frac{g'_{22}g''_{22}+g''}{g''_{11}+g'_{22}}$

* Single primes designate network coefficients of the first transistor. Double primes designate the network coefficients of the second transistor. Definitions of r and g are given in Fig. 5.

VARIATION of circuit properties with feedback is of considerable importance in transistor circuits. Analysis of several single-stage transistor feedback circuits shows that matched input and output impedance, sensitivity and circuit gains can be controlled to a large extent by feedback techniques.[1]

The analysis of transistor circuits by use of four-parameter equivalent circuits[2,3] can be simplified if the full versatility of these equivalent circuits is utilized. When feedback[4] or biasing[5] elements are present in each stage, these elements and the transistor equivalent circuit can be incorporated. The result is one four-parameter equivalent circuit to replace each stage. If transistors are cascaded, adjacent single-stage equivalent circuits can be incorporated into one two-stage equivalent circuit. This process may be repeated until the complete amplifier is represented by one four-parameter equivalent circuit. Feedback between stages presents no additional problem if the feedback paths do not cross.

Equivalent Circuits

In analyzing linear operation of junction transistors, two types of equivalent circuits are particularly useful: a mesh-derived circuit taking the form of a *T* and a nodal-derived circuit in the form of a π. The general forms of these two equivalent circuits are shown in Fig. 1. They are applicable at frequencies for which the effects of reactive elements are negligible.

Equivalent circuits of this type can be used for any transistor connection. Figure 2 shows the specific equivalent circuits for each connection. To reduce the number of

Transistor Circuits

Series and parallel feedback circuits for a single stage are reduced to a four-parameter equivalent circuit for analysis. Cascaded transistor stages reduced in a similar manner result in either mesh or nodal-derived equivalent circuits

parameters, each equivalent circuit is written in terms of grounded-base parameters. Table I summarizes the network coefficients for each circuit of Fig. 2.

Feedback Circuits

Feedback circuits[6] may be studied by means of the expression for return difference[7]. Using the most general transistor representations of Fig. 1, the return difference for r_4 in the mesh-derived case is

$$F = \frac{\Delta}{\Delta^0}$$

$$= 1 - \frac{r_2 r_4}{(R_g+r_1+r_2)(r_2+r_3+R_L) - r_2^2} \quad (1)$$

in terms of the equivalent circuit parameters, or

$$F = 1 - \frac{r_{12}(r_{21} - r_{12})}{(R_g + r_{11})(r_{22} + R_L) - r_{12}^2} \quad (2)$$

in terms of the network coefficients. In Eq. 1, Δ is the circuit determinant and Δ^0 is the circuit determinant with r_4 set to zero.

The determinant can now be written in the form

$$\Delta = (R_g + r_1 + r_2)(r_2 + r_3 + R_L) - r_2(r_2 + r_4) \quad (3)$$

Here R_g is included in the circuit determinant to provide a more useful measure of sensitivity. This is equivalent to defining voltage gain as

$$A_v = \frac{E_2}{E_g} \quad (4)$$

when computing the sensitivity directly.

It is evident from Eq. 2 that the transistor is inherently a feedback device depending to a large extent upon the coefficient r_{12}. Furthermore, any additions to the circuit which change the r_{12} coefficient change feedback. In this paper, additions of this kind are called added feedback.

Figure 3A illustrates three feedback circuits which control directly, but not independently, the r_{12} coefficient.

Feedback in these circuits is termed series-added feedback. Mesh-derived equivalent circuits are used because series feedback is most easily handled by mesh equations.

Nodal Derived Circuits

For the nodal-derived case, the return difference for g_4 is

$$F = 1 - \frac{g_{12}(g_{21} - g_{12})}{(G_g + g_{11})(g_{22} + G_2) - g_{12}^2} \quad (5)$$

Here G_g is included in the circuit determinant. This means that when sensitivity is computed directly, current gain must be defined as

$$A_i = -\frac{I_2}{I_g} \quad (6)$$

Equation 5 shows that feedback can be controlled by controlling the g_{12} coefficient.

The circuits of Fig. 3B illustrate three feedback circuits which control the g_{12} coefficient. Feedback in these circuits is termed parallel-added feedback since feedback elements are placed in parallel with

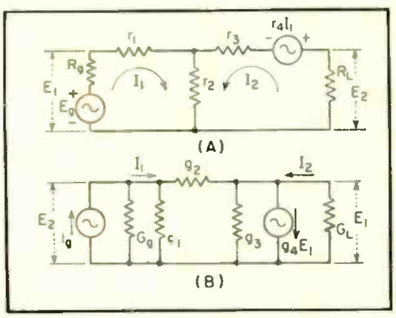


FIG. 1—Mesh-derived (A) and nodal-derived (B) equivalent circuits for junction transistors

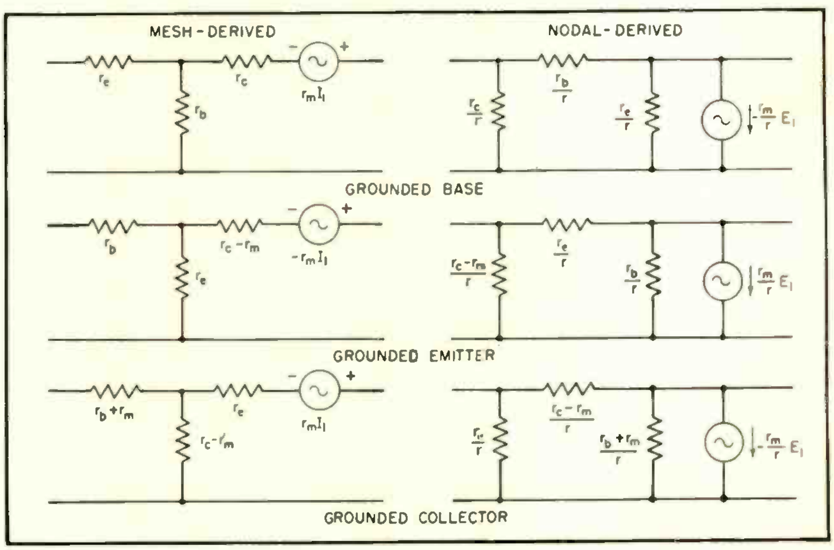


FIG. 2—Equivalent circuits for various transistor connections in mesh and nodal derived forms

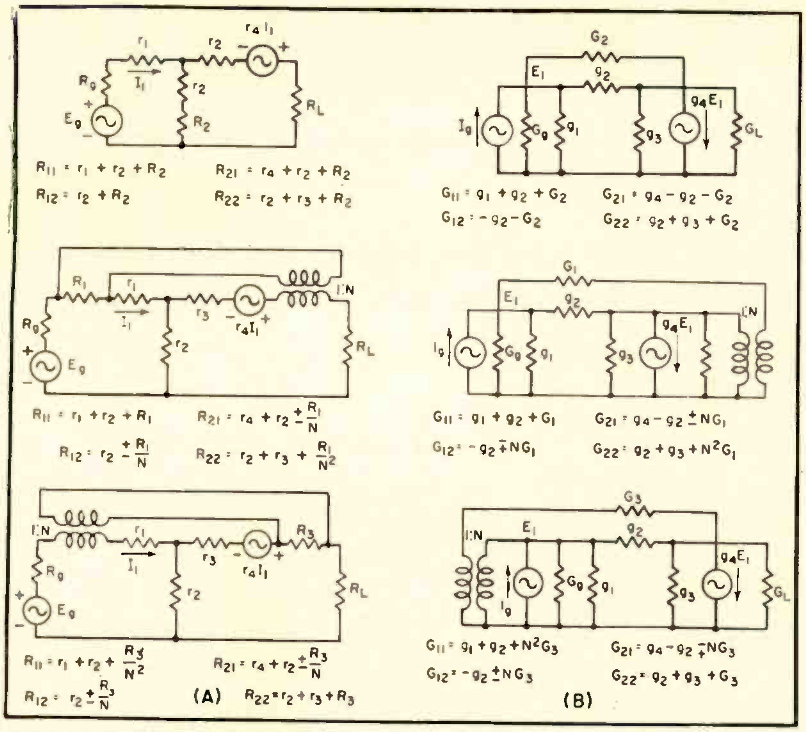
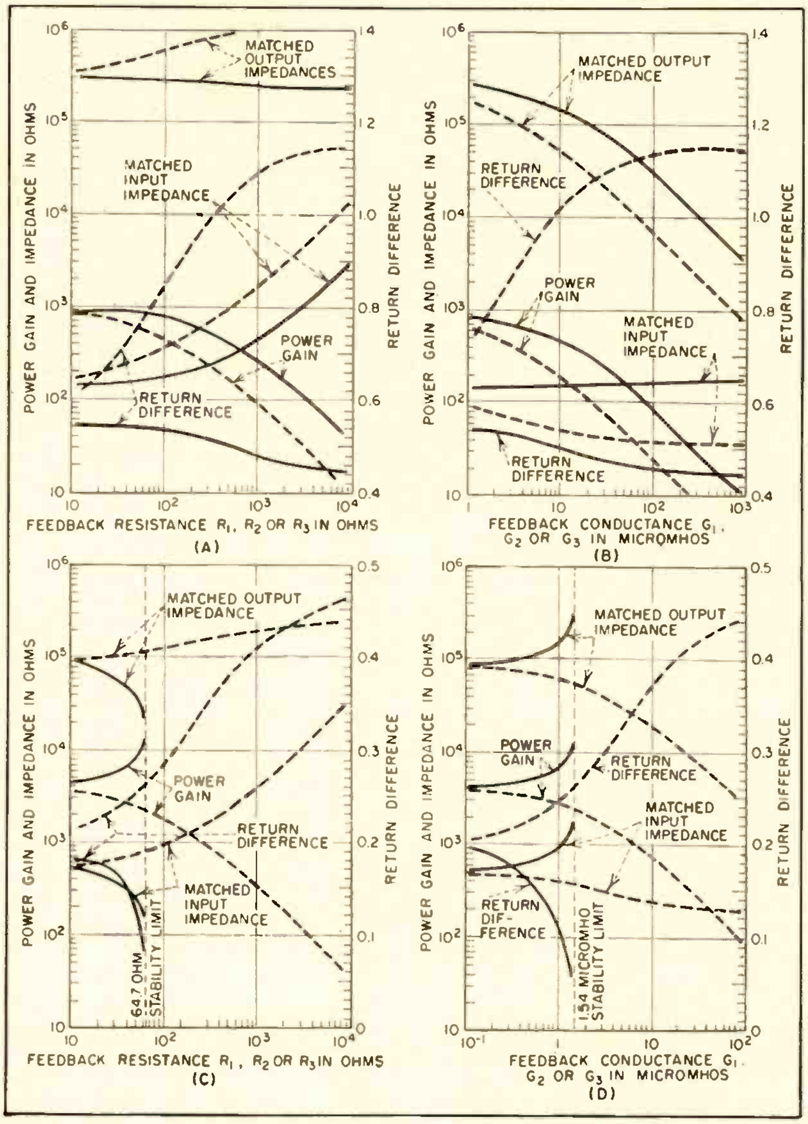


FIG. 3—Network coefficients for series (A) and parallel (B) feedback circuits



the equivalent-circuit parameters. Parallel feedback is most easily handled by nodal equations.

General Circuit Equations

In terms of the network coefficients, useful mesh-derived equivalent circuit equations are

$$R_i = \frac{r_{11}(r_{22} + R_L) - r_{12}r_{21}}{r_{22} + R_L}, \quad (7)$$

$$R_o = \frac{(R_g + r_{11})r_{22} - r_{12}r_{21}}{R_g + r_{11}}, \quad (8)$$

$$A_v = \frac{E_2}{E_1} = \frac{r_{21}R_L}{r_{11}(r_{22} + R_L) - r_{12}r_{21}}, \quad (9)$$

$$A_i = -\frac{I_2}{I_1} = \frac{r_{21}}{r_{22} + R_L}, \quad (10)$$

and

$$A_p = A_vA_i \quad (11)$$

For the nodal-derived equivalent circuit these equations are

$$G_i = \frac{g_{11}(g_{22} + G_L) - g_{12}g_{21}}{g_{22} + G_L}, \quad (12)$$

$$G_o = \frac{(G_g + g_{11})g_{22} - g_{12}g_{21}}{G_g + g_{11}}, \quad (13)$$

$$A_v = \frac{E_2}{E_1} = -\frac{g_{21}}{g_{22} + G_L}, \quad (14)$$

$$A_i = -\frac{I_2}{I_1} = -\frac{g_{21}G_L}{g_{11}(g_{22} + G_L) - g_{12}g_{21}}, \quad (15)$$

and

$$A_p = A_vA_i \quad (16)$$

Input impedance R_i or conductance G_i is measured at the input terminals of the transistor. The output impedance R_o or conductance G_o is measured at the output terminals. Voltage gain A_v and current gain A_i in both cases are the gains from input to output terminals.

When feedback is added to single-stage transistor circuits these general circuit equations may still be used providing the proper network coefficients, shown in Fig. 3, are used. The latter definitions are different from the definition of gain used in conjunction with the calculation of return difference.

Variation of circuit properties with feedback is shown by the curves of Fig. 4. These curves illustrate the variation of input impedance, output impedance, power

FIG. 4—Variations of circuit properties with feedback in grounded-base series (A) grounded-base parallel (B), grounded-emitter series (C) and grounded-emitter parallel (D) circuits. Dashed line indicates negative feedback

gain and return difference for a typical junction transistor under matched conditions. Curves for both grounded-base and grounded-emitter operation are given.

The curves of Fig. 4A and 4B pertain to the grounded-base feedback circuits of Fig. 3 with the one exception that only positive added feedback can be obtained in the circuits using no transformers. A one-to-one transformer was assumed for the other circuits.

Variation of input and output impedance for series feedback is considerably different than that for parallel feedback, as can be seen from the curves. In addition, power gain tends to decrease for both positive and negative feedback and return difference can be raised by use of circuits with transformers.

The curves of Fig. 4C and D pertain to the grounded-emitter feedback circuits of Fig. 3 with the exception that only negative added feedback can be obtained from the circuits not using transformers.

In these cases, the grounded-emitter circuit becomes unstable when the added feedback is positive. The variation of input impedance, output impedance, power gain and return difference for negative feedback is similar to that of the grounded-base connection.

Multiple Feedback

When both series and parallel feedback are present in the same stage, an additional circuit equation is normally required. This is true regardless of whether the transistor representation is of the mesh-derived or of the nodal-derived type. However, it is possible to modify the equivalent circuit so that an additional circuit equation is not necessary.

Figure 5A illustrates a single-stage circuit with both series and parallel added feedback. To analyze this circuit, three equations would normally be required. However, if the transistor is represented by a mesh-derived equivalent circuit, the modified circuit of Fig. 5B can be used. If the transistor is represented by a nodal-derived equivalent circuit, the modified circuit of Fig. 5C can be used. In either case, two equations are sufficient.

Cascaded transistor circuits can be analyzed by a method of circuit reduction of active networks. Using this method a four-parameter equivalent circuit may be found to replace two transistors. This composite equivalent circuit can be of the mesh-derived or nodal-derived type. Except for values of the parameters it is identical to the single-stage equivalent circuits of Fig. 1.

Repeated application of this method produces one four-parameter equivalent circuit to replace a cascaded transistor circuit of any number of stages.

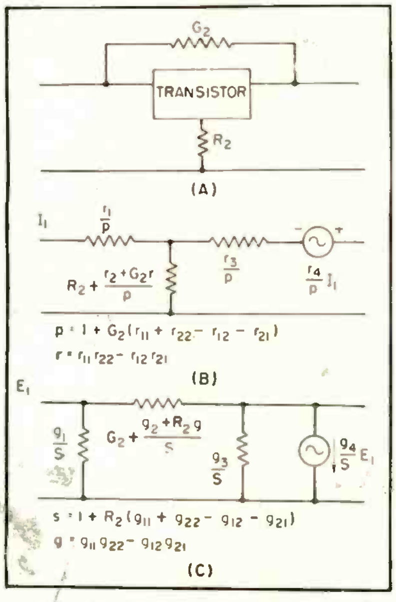


FIG. 5—Single-stage circuit with series and parallel added feedback (A), mesh-derived equivalent circuit (B) and nodal-derived equivalent circuit (C)

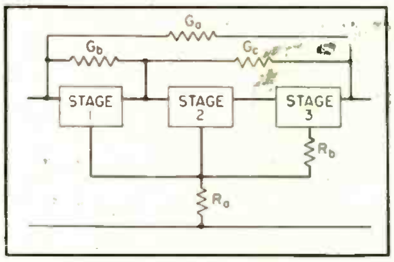


FIG. 6—Three-stage transistor circuit with both series and parallel feedback

Active Networks

Table II contains the information necessary for reducing active networks. This material was obtained by matrix methods. Two stages may be combined regardless of the type of equivalent circuit used for each transistor and the resulting equivalent circuit may be either of the mesh-derived or nodal-derived type.

To illustrate the use of this method on a three-stage transistor circuit containing both series and parallel feedback, Fig. 6 is shown.

Let the first stage be represented by a nodal-derived equivalent circuit. Then, G_b may be directly added to the network coefficients of this circuit. Let the second and third stages be represented by a mesh-derived equivalent circuit. Resistance R_b may then be added directly to the third stage. The last two stages can now be combined by use of the relationships of Table II, line 5. This resultant two-stage equivalent circuit is of the nodal-derived type. Therefore G_c may be added directly. Now, the equivalent circuit of the first stage with G_b included can be combined with the two-stage equivalent circuit with G_c and R_b included, resulting in a three-stage equivalent circuit, which may be of either the mesh or nodal-derived type.

If the three-stage equivalent circuit is obtained by use of the relationships of Table II, line 4, a mesh-derived circuit results. The conductance G_a may now be added to this circuit by the method illustrated in Fig. 5B, and R_a may be added directly.

If the three-stage equivalent circuit is obtained by use of the relationships of Table II, line 8, a nodal-derived circuit results. Here, R_a may be added to the circuit by the method illustrated in Fig. 5C, and G_a may be added directly.

Regardless of the method used, the circuit of Fig. 6 can be reduced to one active network defined by four parameters. This is applicable to cascaded circuits in general.

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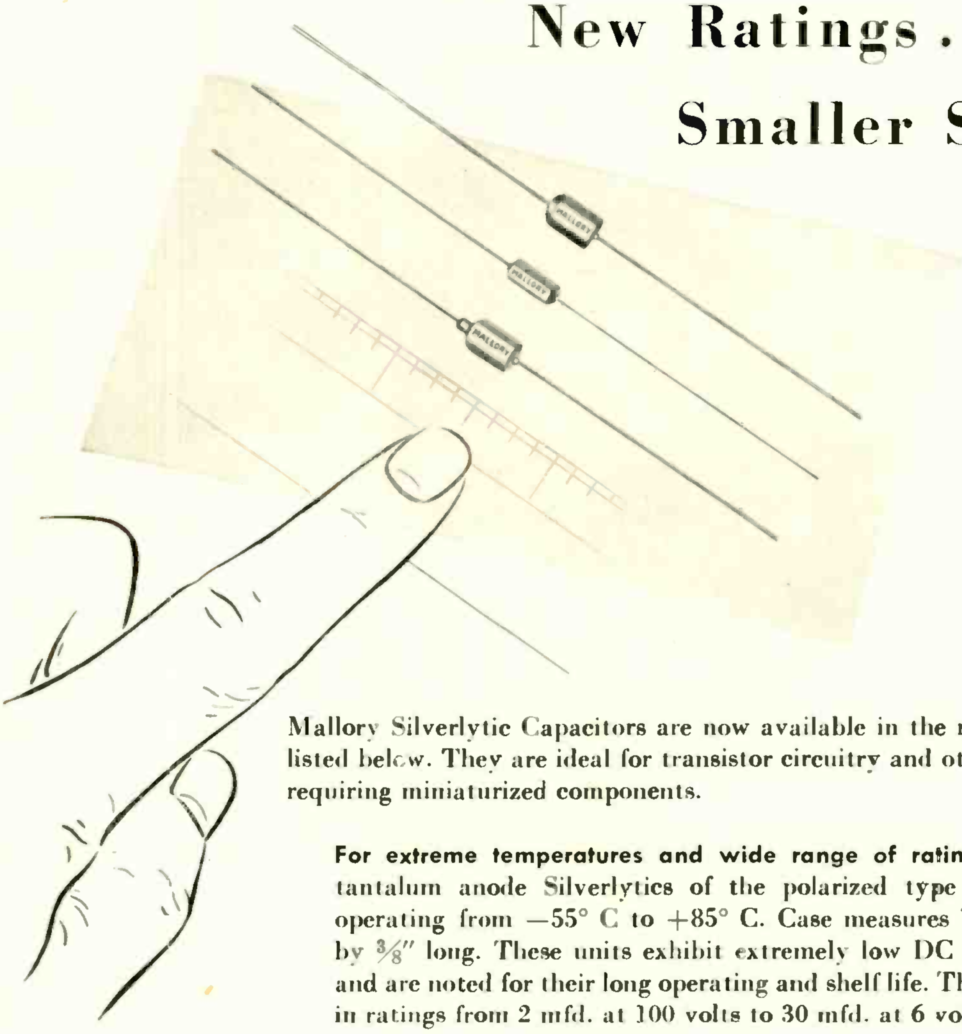

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ELECTRONS AT WORK

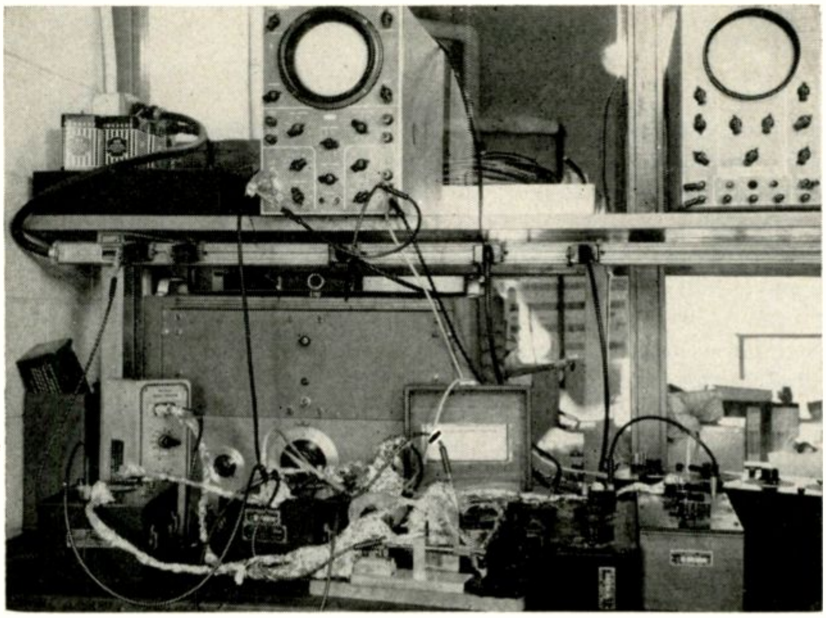
Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS

featured in this issue:

Metal Foil Used to Shield Laboratory Equipment

By Alexander Finlay
Battelle Memorial Institute
Columbus, Ohio

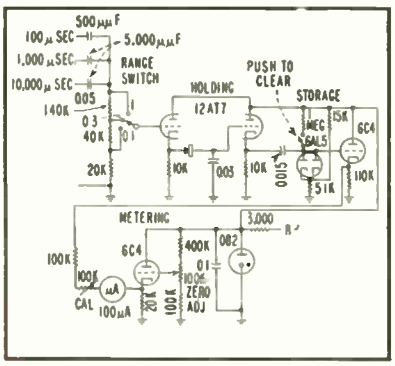


Foil shielding can be quickly applied to equipment in making laboratory tests

WHEN large or irregularly shaped objects must be electrostatically shielded in the laboratory, mechanical difficulties are sometimes serious. Many square feet of shielding, capable of being formed into any conceivable shape can be obtained from a roll of aluminum foil. Heavy-duty freezer wrap provides excellent electrical and mechanical properties.

In cases where the foil might make an accidental electrical connection to part of the system being shielded insulation is necessary. Ordinary cellulose tape is often quite satisfactory for this purpose. This shielding system is not suitable for any permanent set-up but it does provide a tool for the research laboratory, which often results in a saving of time and effort.

Vacuum-Tube Voltmeter for Impulse Measurements



By Richard F. Blake
Equipment Research Branch
Naval Research Laboratory
Washington, D. C.

TO MEET A NEED for a means of measuring peak values of transient waveforms, the impulse vacuum-tube voltmeter shown in the diagram has been developed. Stability and accuracy of the instrument are equivalent to those of a conventional vtvm. Response time is 150 μsec permitting use on a variety of waveforms. On waves with a shorter duration than 150 μsec the instrument will no longer record absolute value but will give relative readings between waveforms of the same shape.

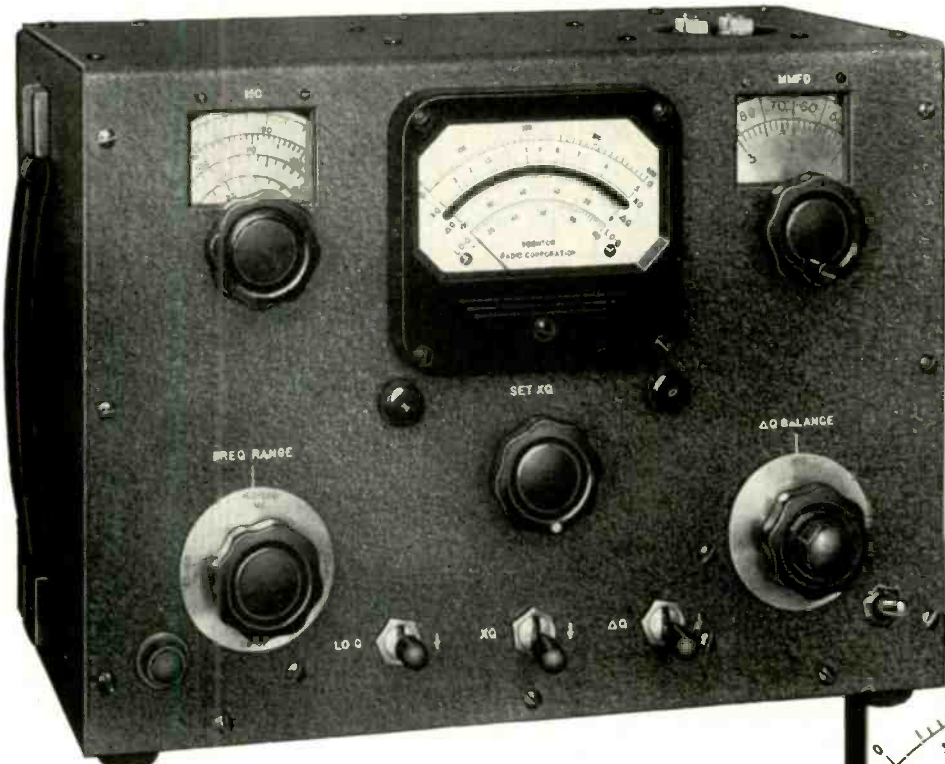
The holding circuit uses a high-impedance vacuum-tube voltmeter

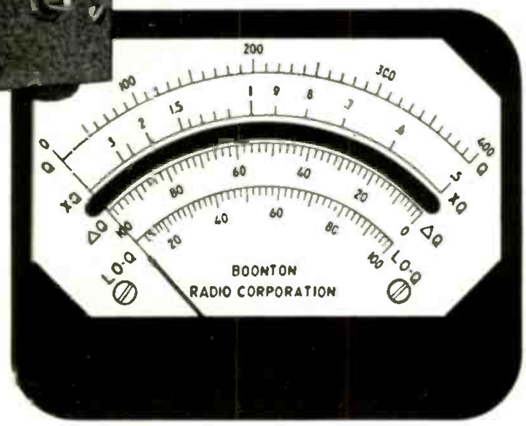
Impulse voltmeter holds transient peak voltage reading. Decay rate is about ten scale divisions per minute

Measure Difference In Q

with

The Q METER *Type 190-A*





In Designing Tuned Circuits the effect on Q of adding capacitors, iron cores, or resistors must frequently be determined. The Q of the separate components is also often needed. These measurements made on Q Meters formerly available required the use of a small difference between two large Q values in various formulæ. This led to large errors. The Q Meter Type 190-A reads the difference between the Q of a reference circuit and the Q of this circuit when new components are added. The scale that indicates this *Differential Q* has a sensitivity 4 times as great as the scale which reads Q. The accuracy and ease with which *Differential Q* can be read is greatly improved by use of the *190-A Q Meter*.

The Q Meter Type 190-A has a "Lo Q" scale which reads Q down to a value of 5. The internal resonating capacitor is directly read and has a vernier arrangement for accurate reading of capacitance. The dial rotates approximately 10 times in covering the capacitance range. All readings are made on a single meter corrected for parallax.

SPECIFICATIONS

FREQUENCY COVERAGE: 20 mc to 260 mc. Continuously Variable in Four Ranges.

FREQUENCY ACCURACY: Calibrated to ± 1%.

RANGE OF Q MEASUREMENTS: 5 to 1200.

RANGE OF DIFFERENTIAL Q MEASUREMENTS: 0 to 100.

ACCURACY OF Q MEASUREMENTS: Circuit Q of 400 read directly on meter can be determined to accuracy of ± 5% to 100 mc and to ± 12% to 260 mc.

INTERNAL RESONATING CAPACITANCE RANGE: 7.5 mmf to 100 mmf (direct reading) calibrated in 0.1 mmf increments.

ACCURACY OF RESONATING CAPACITOR: ± 0.2 mmf to 20 mmf
± 0.3 mmf to 50 mmf
± 0.5 mmf to 100 mmf

POWER SUPPLY: 90-130 volts—60 cps (internally regulated). Power Consumption—55 watts.

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- A counter type resonating capacitor dial for improved setting and reading accuracy.
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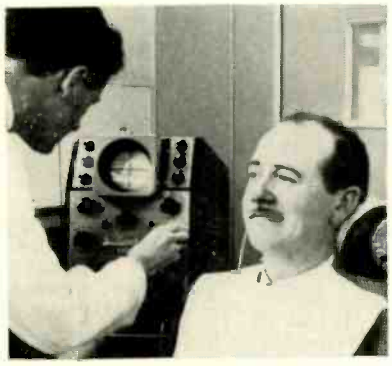
design. To achieve fast response a crystal-diode short time-constant circuit is used to stretch the duration of the applied signal before feeding it to the storage capacitor. When the transient is applied to the capacitor its output attempts to go positive causing the 6AL5 diode to conduct until the 0.015-μf storage capacitor is charged negatively to a voltage equal to the positive peak of the applied voltage. When the transient returns to zero the voltage of the storage capacitor is applied to the grid of the 6C4 in the metering circuit.

The metering circuit is limited in the amount of negative voltage it can measure by tube cutoff. To increase the range, a positive bias is inserted in the cathode of the diode. The grid signal then goes negative with respect to the bias rather than with respect to the zero value.

The instrument is calibrated by applying a known step voltage to the input and adjusting the 100,000-ohm resistor in the metering circuit for the proper indication. A three-position switch provides scale sensitivities of 30, 100 and 300 volts.

Mobile TV Control Room

Swiss mobile television unit recently completed by British Marconi includes control console. Sound controls are in the right foreground. Producer's program controls are at left. Behind are three monitor scopes



Oscilloscope Shows Denture Strain

Research in detection of strain in ill-fitting dentures is being carried on by Edinburgh Hospital and School in Scotland. Strain gage connected by wire to oscilloscope gives visible indication of defects. Permanent record can be obtained by photographing oscilloscope display

Series Capacitors Multiply Battery Voltage

By J. M. Reed

National Schools
Inglewood, Calif.

A COMMON METHOD of building up a high voltage has been to charge capacitors in parallel and discharge them in series. Capacitors operated thus will produce a terminal voltage equal to the battery voltage times the number of capacitors in series.

To obtain 6,000 volts from a 100-volt battery would require 6,000/100 or 60 capacitors. It is evident that such a large number of capacitors is not practical from the standpoint of cost, bulk and resulting capacitance.

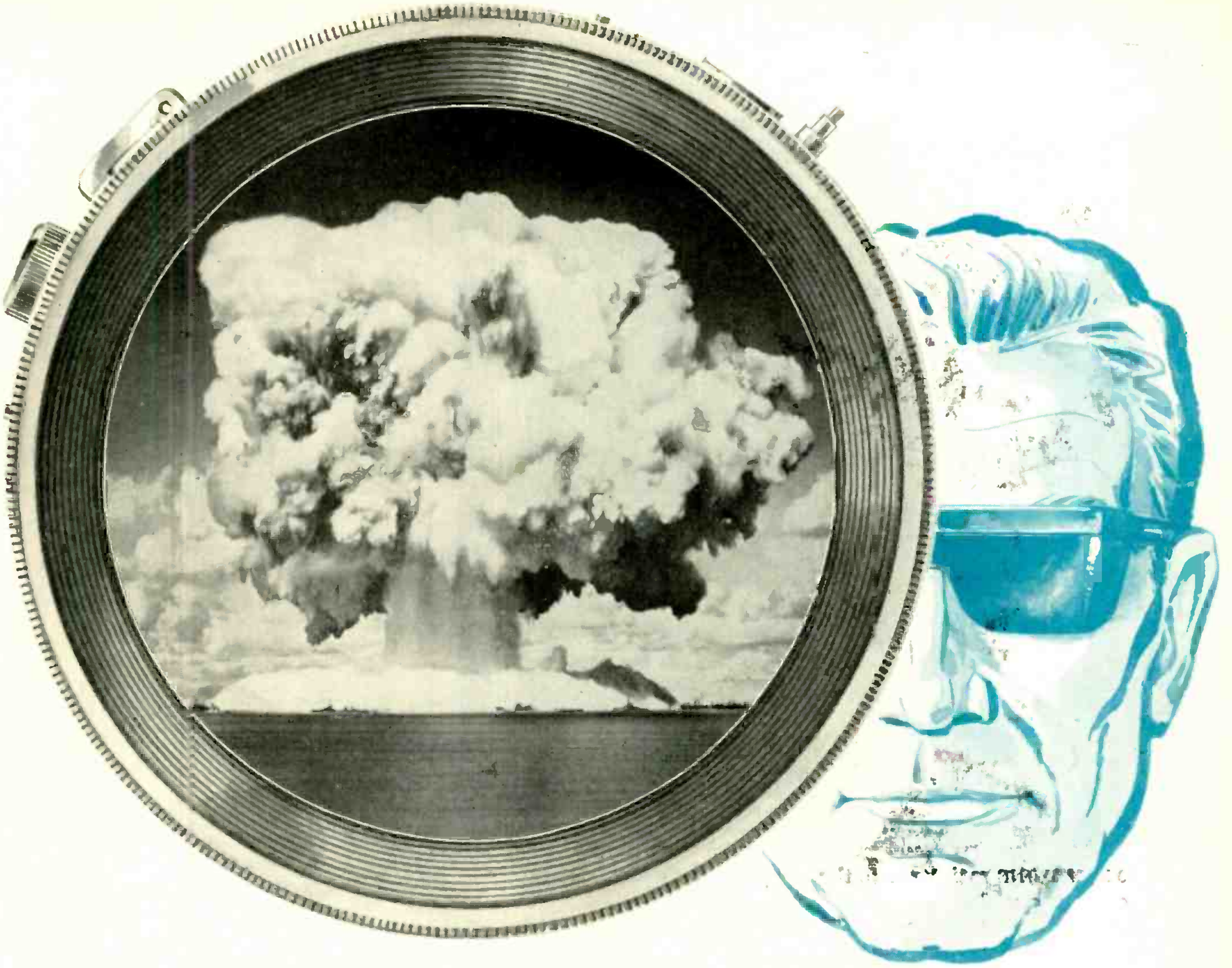
The method to be described produces 6,400 volts using only six series capacitors with a 100-volt battery. Any voltage from 100 to 100,000 volts or more can be built up. There is no top limit of voltage except the voltage break-down of the dielectric.

Battery-operated high-voltage supply produces 2,880-volt output from 90-volt source

The six capacitors are arranged so that the first has twice the capacitance of the second, the second is twice the capacitance of the third and so on. The first capacitor is charged to 100 volts by the battery.

This capacitor is then placed in series with the battery and the combination charges the second capacitor to a voltage somewhat less than 200 volts. If the first capacitor is recharged several times and discharged in series with the battery, the second capacitor will eventually obtain a charge of 200 volts.

These two capacitors and the battery are now placed in series and used to charge a third capacitor. This capacitor will take a charge



how to stop an h-blast

WANTED: a camera to stop the action of a nuclear explosion at a pre-selected microsecond, with high quality image-definition . . . that was the problem handed by the AEC and its Los Alamos Scientific Laboratory to the Boston firm of Edgerton, Germeshausen & Grier, Inc. EG&G solved it by inventing the non-mechanical Rapatronic shutter . . . employing the Faraday Effect of magnetically rotating the plane of polarized light as it traverses an optical element . . . and relying on HELIPOT* precision potentiometers and DUODIAL* turns-counting dials for sensitivity setting and calibration.

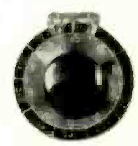
A light-pulse from the blast falls on a photocell . . . generates a signal that passes through a variable time-delay to trigger a condenser-discharge circuit . . . releasing energy which surges through a coil wound around a lead-glass lens. The resulting magnetic field rotates polarized light from the blast as it passes through the lens . . . effecting a one-microsecond exposure.

Sensitivity of the photocell circuit is controlled by a standard-linearity Model A 10-turn HELIPOT, calibrated with a Model RB DUODIAL. Time-delay from photocell pick-up to shutter operation . . . continuously variable from 0 to 100 microseconds . . . is controlled by a Model A 10-turn HELIPOT of 0.1% linearity, calibrated with a Model W10 DUODIAL.

The coil of the HELIPOT is wound with more than 10,000 turns of resistance wire . . . the DUODIAL is settable to a fraction of any of its thousand scale-divisions . . . and the Rapatronic shutter can be tripped at any preselected fraction of a microsecond.

For complete details of this and other HELIPOT applications, write for Data File 701.

MODEL A HELIPOT



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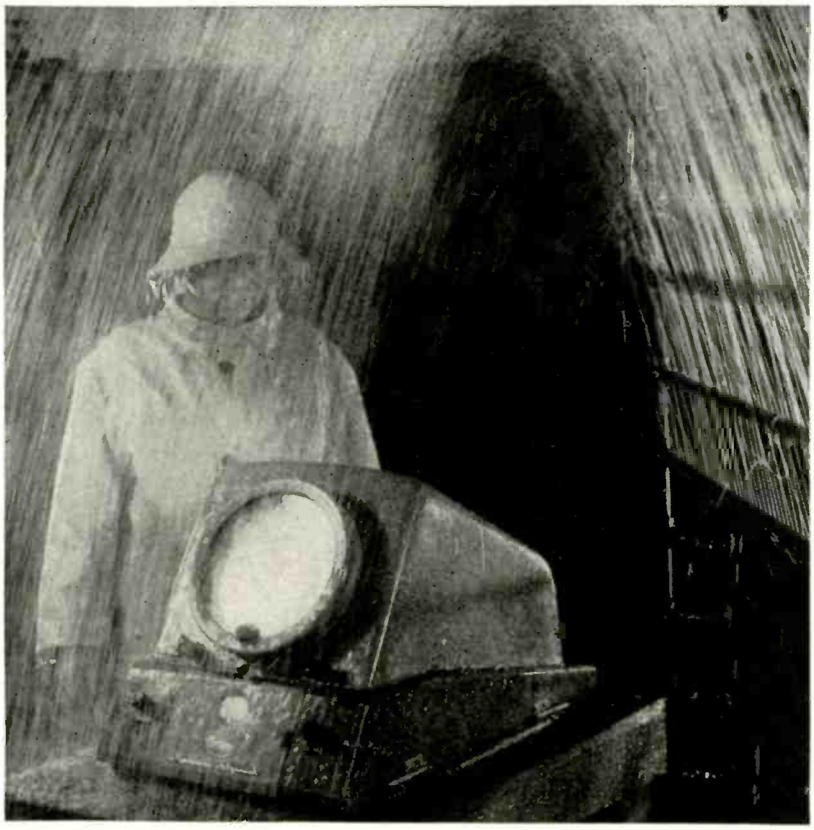

TO DETERMINE resistance to the most severe dripping water, spray or rain conditions likely to be encountered for the type craft for which the system is designed, a Raytheon Mariners Pathfinder model 1500 radar indicator-receiver and antenna-transmitter is shown subjected to a water spray test.

Navigation under adverse weather conditions, one of the prime benefits of commercial radar, can only be accomplished by total exclusion of water entry into the unit enclosure or by controlling the degree and area of such entry and subsequent path of any flow.

The spray rack shown comprises tiers of horizontal half-inch pipes spaced six inches, closed at one end and individually connected at the other end through gate valves to a vertical manifold. This assembly is mounted on an angle-iron frame, castered for portability and adjustment. The manifold is connected through a flexible rubber hose to a wall faucet.

A row of holes was drilled along the length of each pipe one inch apart, using a 64 drill. These horizontal sections of pipe are only made hand tight, thereby allowing control, by rotation of the pipe, of the angle of contact of the spray with the specimen undergoing test. Pressure is adjustable at the inlet to the system, up to full main pressure of 80 psi. This rack will produce a simulated rainfall over an approximate six-foot-square area in excess of 10 inches an hour.

An allied test involves subjecting the unit to a fog produced by water fog head designed for fire protection installations. This is a Rockwood Sprinkler Co. type L-12A, installed on a one-inch pipe operating under a dynamic pressure of 40 psi at the foghead. The unit under test is mounted directly below the fog head, which is 10 feet 6 inches above the floor level.

somewhat less than 400 volts but after several rechargings will attain exactly that value.

This process of charging an additional capacitor to a voltage double the previous one is continued as

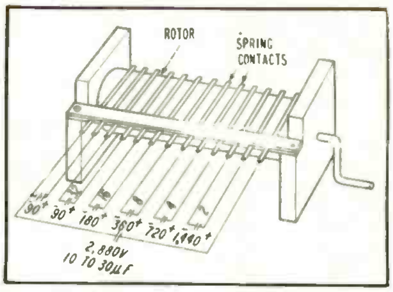

FIG. 1—Switching unit used to build up 90-volt battery output to 2,880 volts

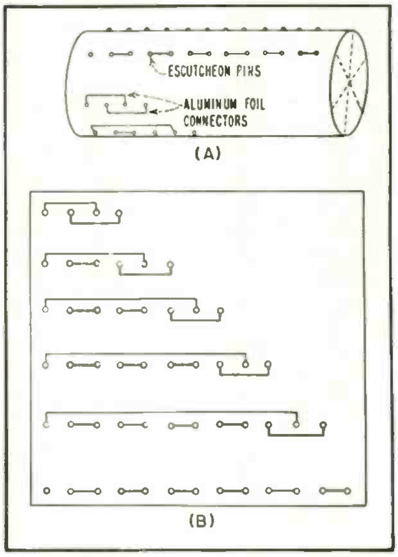

FIG. 2—Rotor unit (A) wired as shown in (B) is used to connect capacitor across battery potential and then connect charged capacitor in series with battery and next capacitor to be charged

often as desired. Each capacitor added to the series hook-up doubles the available voltage. With the six-series capacitor, the voltage of a 100-volt battery is built up to 6,400 volts. The addition of another capacitor would double this voltage to 12,800 volts. The terminal or final voltage obtainable is given by

$$E_T = 2^N E_B$$

where E_T = final terminal voltage, N = number of series capacitors, E_B = battery or starting voltage.

The capacitors can be of any value so long as they keep an approximate ratio of two-to-one. The final voltage from a system of this sort can be used to charge a much larger capacitor where higher power is needed.

For example, the series combination could be used to charge a 30 μf or larger capacitor even though the total capacitance of all the series capacitors is less than 1 μf. Once the storage capacitor reaches terminal voltage, the charge and discharge currents die out reducing

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the battery drain to that owing to leakage in the dielectric.

This system is being used to operate a 900-volt Geiger tube from a single $67\frac{1}{2}$-volt battery and a 2,200-volt strobe-flash bulb from a 300 volt battery.

The switching of the capacitors in the proper sequence is done by turning a small hand-cranked rotor.

About five seconds are required to crank the voltage up to the final value, depending upon the output voltage wanted and the capacitance of the final storage capacitor across the output. Figure 1 shows the general construction of the rotary switch. The frame is wood or hard fiber. The rotor is wood or plastic. Spring contacts are made from brass spring ribbon, $\frac{1}{8}$-inch wide by 0.03 in. thick.

Spring contacts slide over the heads of small escutcheon pins to make contacts. The wiring is done on the rotor with $\frac{1}{8}$-inch wide aluminum foil. The escutcheon pins make contact when driven through the foil. After the wiring is completed, plastic tape is laid over the aluminum foil wiring to insulate it and prevent damage. Rotors wired with printed circuit techniques should be satisfactory.

It is essential that there be very low leakage between spring contacts. Formica strips having low leakage were used to clamp the springs. Springs were cemented in place with sealing wax. A grooved plastic strip would be more serviceable.

Contact Spacing

As the voltage gets higher toward one end of the rotor, the spring contacts should be more widely spaced to prevent arc-over.

The rotor is wired as shown in Fig. 2. The sequence is shown to obtain 2,880 volts from a 90-volt battery. For other voltages, the rotor would be divided into a different number of equal parts.

Since the first few capacitors in the sequence usually operate at low voltage, they can be electrolytics. Paper or mica units are needed for the last few capacitors where the voltage exceeds 400 volts.

The principle outlined here can be applied to any source of low d-c

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voltage where it is desired to boost this voltage for metering purposes or to obtain high-voltage discharges.

TV Avalanches

A SWEDISH ENGINEER making a four-nation tour arranged by the International Labor Organization, an agency associated with the United Nations, will study hazards of blasting operations in France, Germany, Canada and U.S.A.

Among problems to be investigated are those of premature detonation resulting from lightning and atmospheric electricity. Although Swedish experience with radio has shown no hazard from this source, precautions in the United States have been standardized for police, road maintenance and other cars using two-way radio.

While Sweden has no television broadcasting at present, authorities are anxious to ascertain the possible danger of such transmissions prior to establishment of television service.

According to a recent release from ILO, it has been suggested that radio signals from police cars can set off mountain avalanches.

Transistor Pulse Supply

BY T. A. PRUGH AND J. W. KELLER
Diamond Ordnance Fuze Laboratories Washington, D. C.

SIMILAR to a single-transistor bistable switching circuit, a thyratron-type switch uses, instead of added base resistance a large choke coil. Similarly, a choke coil supplies the bias for the collector. This circuit operates as if the transistor is merely a switch in series with the two capacitors C_1 C_2 and the load resistance. When the switch is open, there is a difference in potential of about 20 volts between the emitter and collector. When the switch closes, this difference is transferred to the load.

The output pulse amplitude of this circuit is

$$V_o = (E_e - E_c) - Ir_{ec}$$

where

E_e = d-c bias on emitter
E_c = d-c bias on collector
I = peak current

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ACTUAL SIZE

ALLIED TYPE KH RELAY
weighs .32 oz. — has low capacity for RF switching

ELECTRICAL SPECIFICATIONS:

CONTACTS: Maximum of double pole rated at .25 amperes at 26.5 volts DC or 115 volts AC resistive

COIL: Sensitivity—nominal 1.0 watts, maximum 0.3 watts
Resistance—up to 1500 ohms
Voltage—up to 40 volts DC

TEMPERATURE: Minus 60° C to plus 125° C

VIBRATION: 10G up to 500 cycles

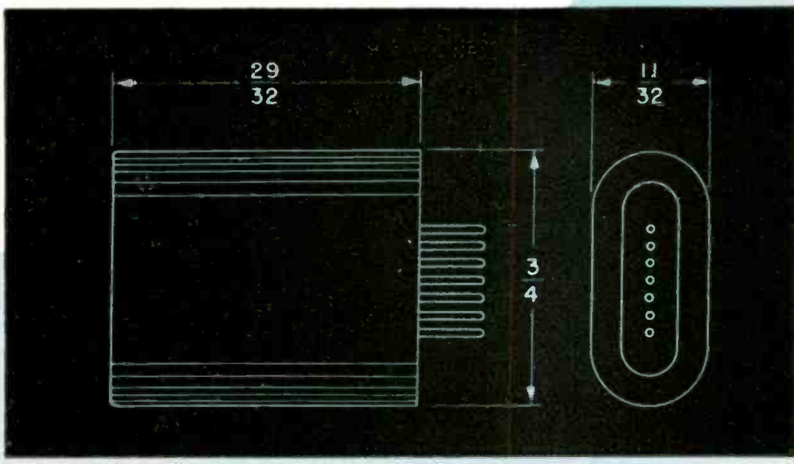
SHOCK: 50G plus (operating)

SPEED OF OPERATION: 1.5 millisecond at nominal voltage direct from battery supply and 1 millisecond with series resistance

ALTITUDE: 70,000 feet or 1.3 inches of mercury

TERMINAL TYPES: Printed circuit, solder terminals and plug-in

CAPACITY: N. O. contact to case 0.85 mmf



Write for catalog sheet giving complete information

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N.Y.

ALLIED

r_{ec} = internal resistance from emitter to collector

The pulse time constant if the choke coils are large is

$$T = (R_L + r_{ec})\ (C_1C_2/C_1 + C_2)$$

The resistance r_{ec} encountered via the emitter and collector, is dependent upon the current amplitude in the same way as the forward resistance of a diode. Consequently the internal impedance of this circuit becomes quite low for small load resistances. For a peak current of 7 amperes, r_{ec} has been observed to be less than 5 ohms.

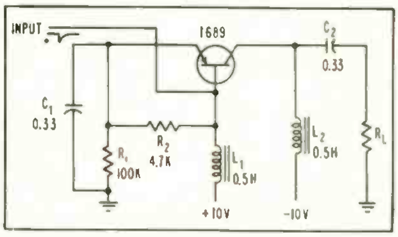


FIG. 1—Thyratron-type switch using transistor acts to break circuit in series with two capacitors and load resistance

Figure 2A shows the output pulse when L_1 and L_2 are large. It exhibits the simple RC decay where the peak voltage is the supply voltage minus the internal drop.

If L_1 is chosen smaller than normal the simple RC decay is interrupted by premature cutoff of the switch as shown in Fig. 2B and only part of the total pulse is avail-

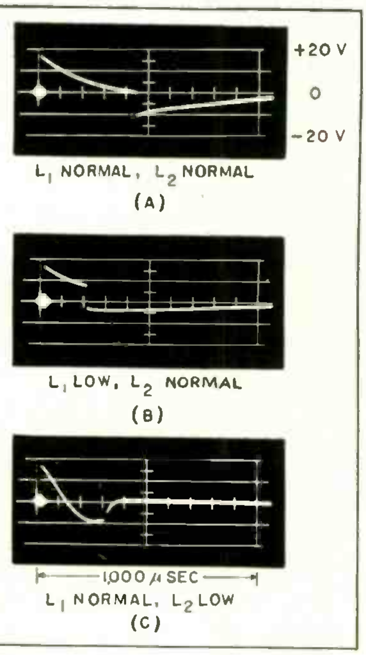


FIG. 2—Output pulse shape determined by suitable values of inductance

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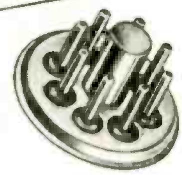

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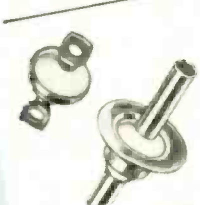

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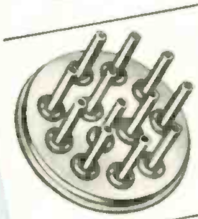

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able. The size of this inductance is dictated by the largest R_L encountered.

If L_2 is chosen too small, the output pulse takes on the flavor of an LC rather than an RC decay as seen in Fig. 2C. Similarly, the size of L_2 must be selected on the basis of the largest load resistance encountered. Inductances in the neighborhood of one-half henry are adequate if 1,000 ohms is the maximum load resistance. Of course other pulse shapes may be desired in which case L_1 and L_2 would be chosen differently.

Two different methods of triggering this switch have been used. A negative pulse can be applied to the base with instant triggering action, or the two resistances R_1 and R_2, that provide the small negative bias for the emitter can be removed and this bias supplied by the input circuit. Triggering action is then accomplished when the level of bias is raised to a potential close to the base potential.

The single stage described has an adequate performance in the temperature range of interest except for its peak amplitude, which is too small. With supply voltages of -10 and $+10$, the output is limited to about 18 volts. A peak voltage of several times the supply voltage is needed.

This large amplitude can be obtained by simply connecting three of the stages in series as shown in Fig. 3. Only the first stage need be triggered and this triggering can be done as already mentioned for a single stage. Subsequent stages are triggered by the positive pulse on their emitters received from the preceding stages.

The behavior of output-pulse amplitude as a function of temperature is shown in Fig. 4.

The output voltage of the three stages is

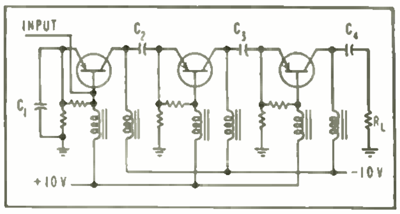
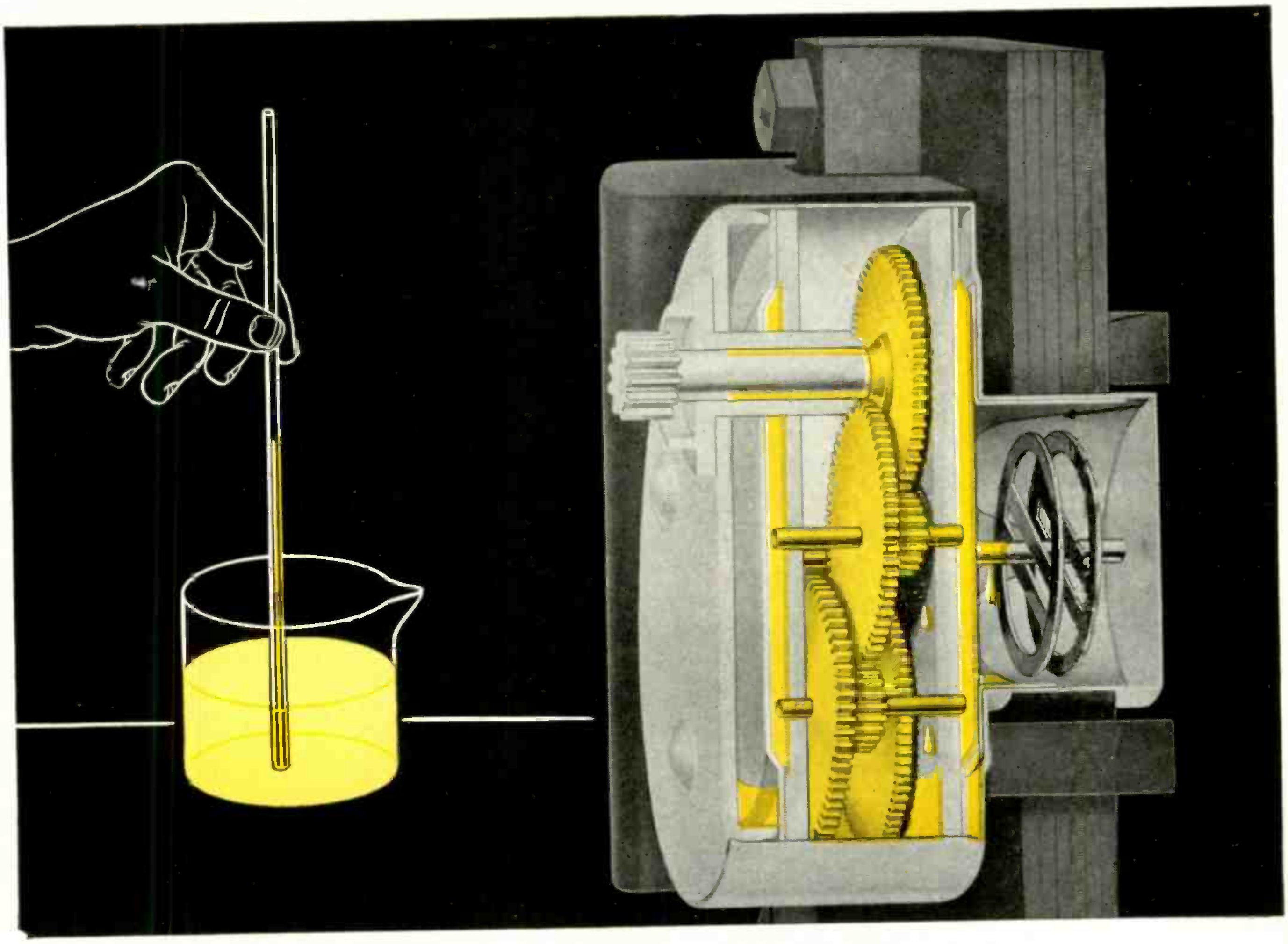


FIG. 3—Multiple-stage circuit furnishing output pulse almost three times the supply voltage amplitude



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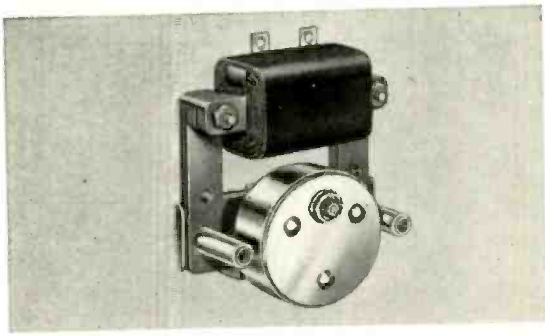

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$$V_o = 3(E_e - E_c) - 3Ir_{ec}$$

and the decay time is

$$T = (R_L + 3r_{ec}) \times \frac{C_1C_2C_3C_4}{C_1C_2C_3 + C_2C_3C_4 + C_3C_4C_1 + C_4C_1C_2}$$

Transistor Performance

The application of the switch circuit just discussed occasionally calls for current amplitudes considerably

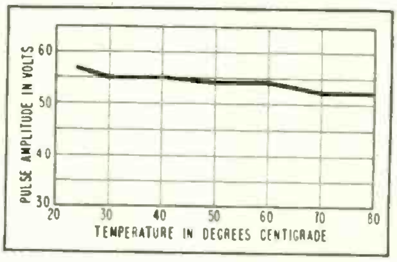

FIG. 4—Output pulse amplitude of three-stage circuit as function of temperaturo

above known ratings of the transistors. For this reason it was felt that some qualitative data should be obtained on the capabilities of transistors in this circuit. The collector characteristic curves of Fig. 5 show the gradual and typical deteriora-

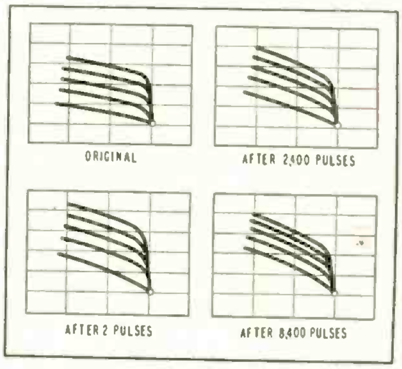

FIG. 5—Change in transistor collector characteristics due to various numbers of pulses

tion of a type 1689 transistor used in a two-stage switch delivering a 40-volt pulse across a 47-ohm resistor. The peak current is about 0.8 amp. The circuit is still in fairly good working order after 8,000 pulses although it is clear that alpha and r_e are decreasing and I_{co} is increasing. The point of unsatisfactory operation has not been determined with the small sample of about 15 used in this ex-

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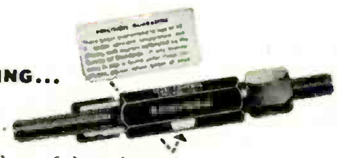

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periment. Often the end came rather suddenly with a complete collapse in alpha, which, incidentally was occasionally recoverable.

If the pulse amplitude is reduced to 0.4 amp, only a small percentage of transistors will be affected by pulses numbering in the million. If reduced to 0.2 amp no failure of a transistor has been recorded. In terms of load for a three stage switch, if the load resistance is greater than 250 ohms, a long and useful life can be expected from the average 1689 and at least 5 pulses could be expected into 10 or 20 ohms.

Credit is due E. Harrison who obtained most of the data for this paper.

Spectrophotometer Shows CRT Displays

ABSORPTION CURVES, diffuse reflectance curves and emission spectra from various sources can be studied with a cathode-ray display spectrophotometer that scans and plots the interval from 400 to 700 millimicrons in 1/180 second at a repetition rate of 60 spectra per second.

For conventional use, the spectrophotometer operates on optical principles with compensation such that the multiplier phototube output is constant for all wavelengths when no sample is inserted in the beam. A scanning mirror sweeps the image of the spectrum plane from the telescope across an exit slit to the multiplier photocathode.

Figure 1 is a diagram of the scan-

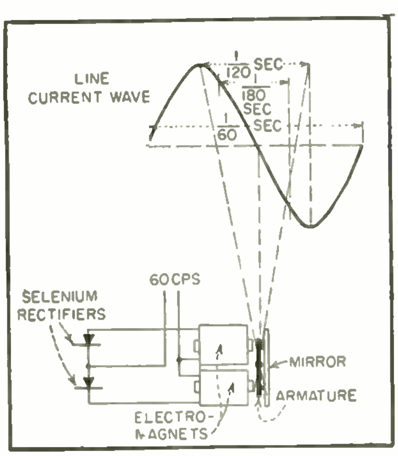
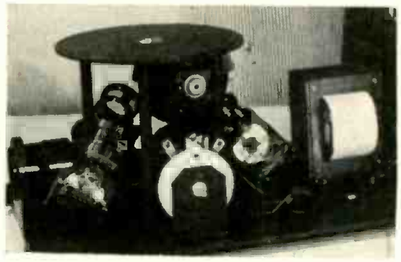


FIG. 1—Special magnetically deflected mirror and line current wave

ning mirror. It consists of a soft iron armature pivoted at its center, which carries the mirror and a pair of electromagnets. Angular displacement of the mirror with respect to time is constant over a substantial portion of its swing. The rectifier arrangement allows one magnet to pull the mirror to one extreme position and energizes the other magnet during the subsequent half cycle. The mirror thus scans the spectrum over the exit slit twice per cycle. Motion in only one direction is used, however, to avoid hysteresis difficulties. Mirror amplitude is adjusted to scan the desired interval linearly during



Reflectance illuminator unit

1/180th of a second.

The pentagrid converter tube at lower left of Fig. 2 obtains a sine-wave signal from the mirror line. The network shifts this sine wave 90 deg so the potential wave applied to grid 3 agrees in phase with the current wave through the magnets and the instantaneous displacement of the mirror. Inverse feedback and plate saturation distort the portion of sine wave occurring during

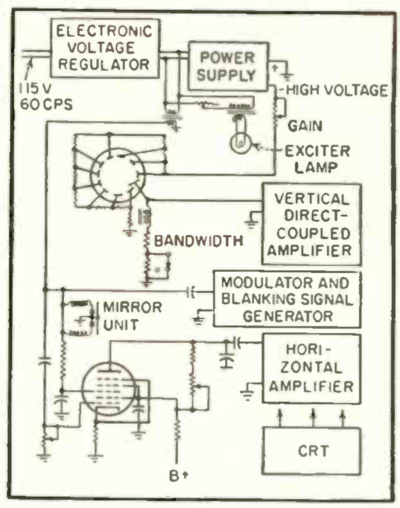


FIG. 2—Simplified diagram shows interconnection of parts

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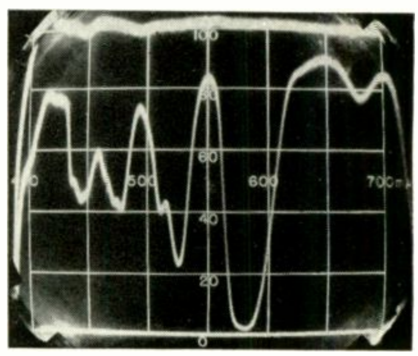
Distributors in principal cities (listed in the "yellow pages" under "Recording Equipment"); distributed in Canada by the Canadian General Electric Company the useful sweep interval of the mirror to an approximation of the optical dispersion curve of the instrument.

A small correction is mixed with this through grid 1 and its network to obtain precise agreement between the potential-time curve of the waveshaper and the wavelength-displacement curve of the spectrometer. The scanning mirror, makes this possible since it interprets wavelength in terms of time. Waveshaper output is fed to the horizontal amplifier of the indicator and the cathode-ray tube spot is thus moved nonlinearly with respect to time such that the output of the detector, which is proportional to intensity, is plotted against a linear wavelength scale.

The detector output circuit constants are chosen to give a high-frequency cutoff determined by the length of time required to scan the spectral image of the entrance slit across the exit slit for any one wavelength. This works out to 50,000 cps for the 7-millimicron slit used in absorption work and 15,000

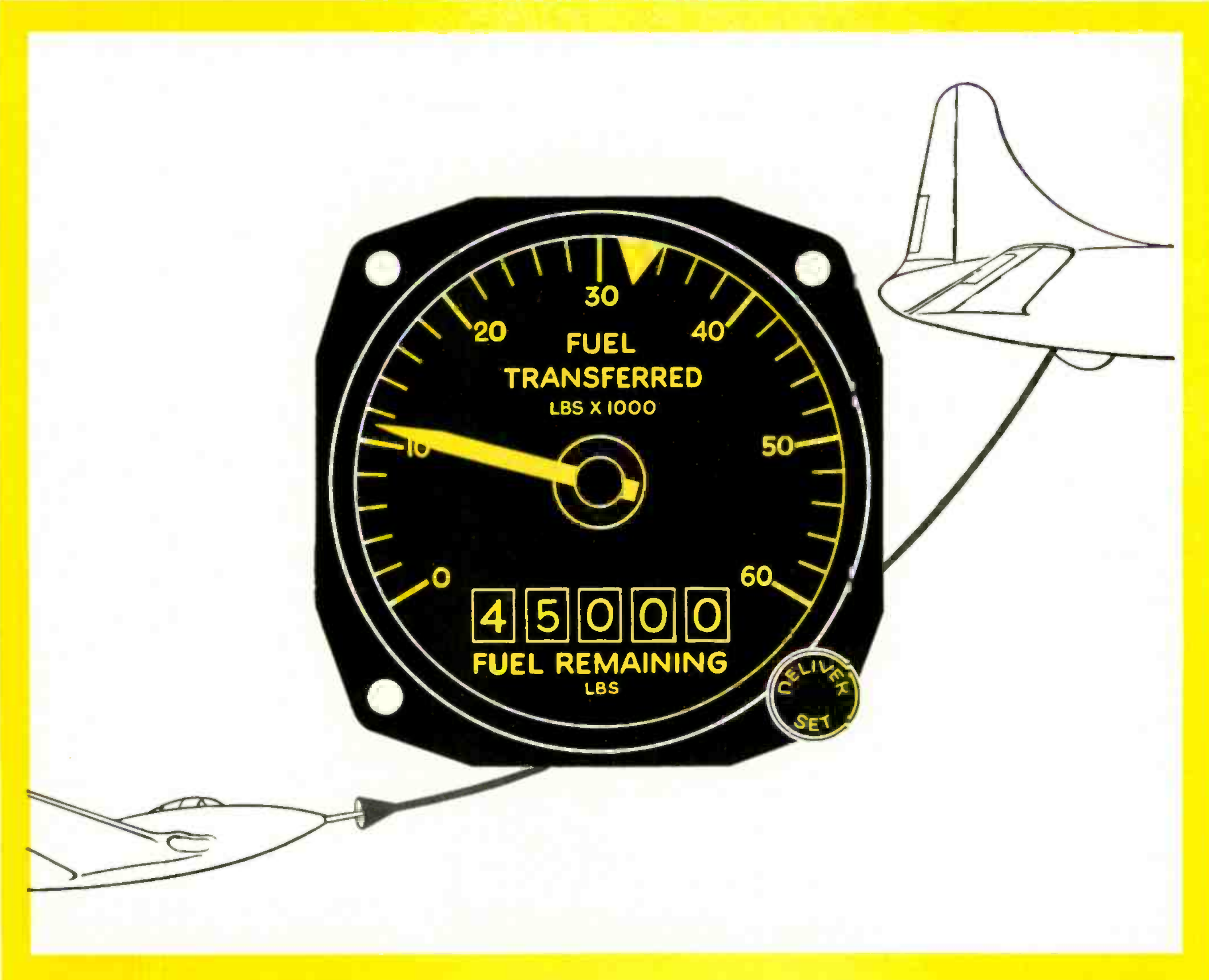


Oscillogram made with recording camera shows three traces. Sample curve is didymium filter

cps for the 20-millimicron slit used in reflectance work.

Direct-coupled amplifiers must be used to maintain the zero-light indication coincident with scale zero. The high-frequency limit is adjusted in the multiplier circuit to use minimum total bandwidth and assure maximum signal-to-noise ratio. The modulator and blanking generator develop a dual-purpose waveform from the same sine wave applied to the mirror and scanning-wave generator.

The first function is to blank the cathode-ray tube during the unused



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portion of the total operating cycle. The second function is to increase the spot intensity as it moves across the screen with ever-increasing velocity so that the trace brightness will be reasonably constant over the entire scale. The net result of these interactions between optical, mechanical and electrical design is a plot of spectra that is rigorous within the reading accuracy of the instrument.

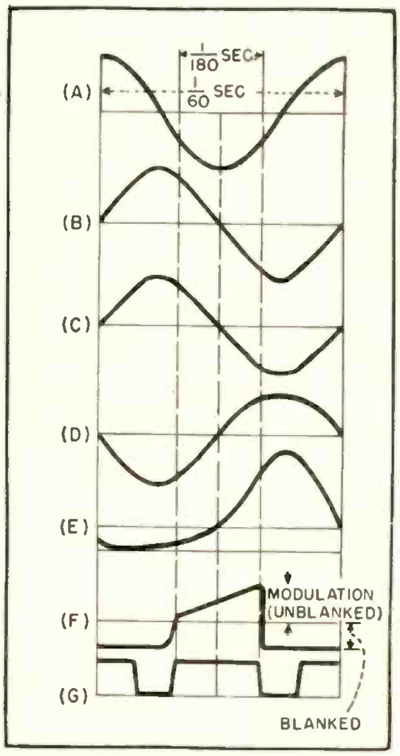


FIG. 3—Waveforms described in text

Figure 3 gives the waveform relationships on a one-cycle time base. The upper curve is the line potential wave. The center third of the interval is the active time of the instrument. The second waveform (B) is the line-current wave for the mirror magnets, −90 deg out of phase. The next (C) is the displacement curve of the mirror with respect to the same time base. The next waveform (D) is the phase-shifted potential wave applied to the scanning waveshaper input, which comes out as the horizontal scanning wave (E) and has the same shape as the instrument dispersion curve.

The sixth wave (F) is the blanker output, showing how the indicator is cut off during the unused portion of the cycle and how

the spot intensity is increased roughly with spot velocity. The last waveform (G) shows the output wave of the multiplier when no sample is in the beam.

The reflectance illuminator is shown in the photograph. The three exciter lamps and their lens assemblies are arranged at 120 degrees from each other in the horizontal plane and illuminate the pickup area at 45 degrees in the vertical plane. Energy diffusely reflected from a surface placed over the pickup area is reflected by the first surface mirror through the collector at the left and into the other unit.

The oscillogram was made with a recording camera. It shows three traces,—the full-scale trace with nothing in the beam, the sample curve (in this case a didymium filter) and the zero trace with the beam shuttered. The whole process requires about a second. The instrument plots its own white-light error and records it for reference.

Resolving power of the instrument varies with wavelength since the slit widths are constant through the scanning cycle. The average for transmission work is about 6 millimicrons and for reflectance about 20 millimicrons. Accuracy is one percent of full scale.

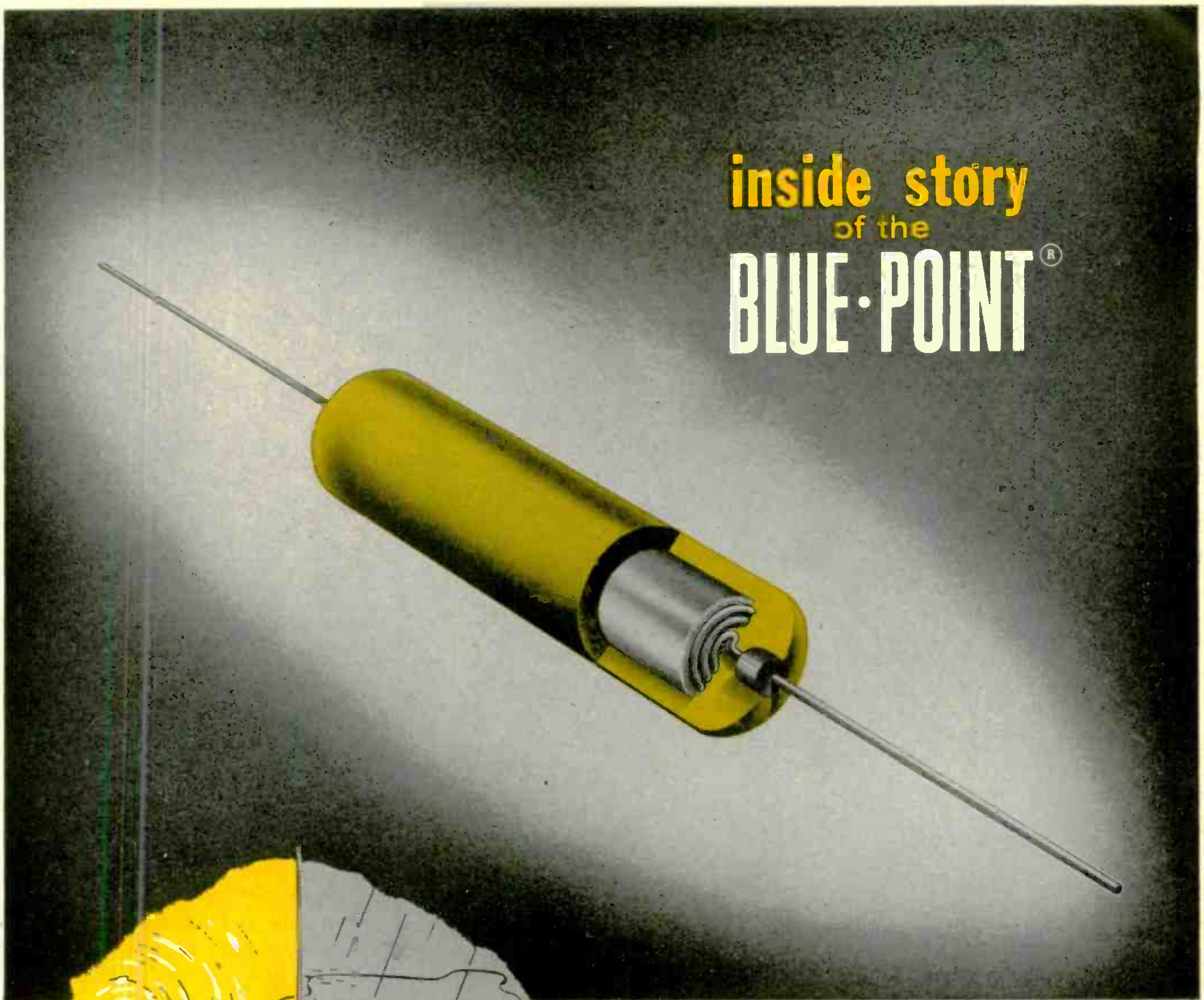
Information concerning the instrument has been furnished by American Optical Co., Instrument Division, Buffalo, N. Y. and is similar in some respects to that presented by R. C. Beitz in the *Journal of the Optical Society of America*.

Electronic Juggler

By Charles Whaley and Sidney Godet

Reeves Instrument Corp.
Subsidiary of Claude Neon Inc.
New York, N. Y.

The electronic juggler is an application of electroservomechanisms simulating the human one-finger broomstick balancing act. The broomstick is essentially an inverted pendulum swinging freely to and fro under the combined action of gravity and momentum. In the electronic unit the broomstick is a 3-foot brass tube with a light source and batteries located in a container on the upper end. The lower end of the tube, a pivot



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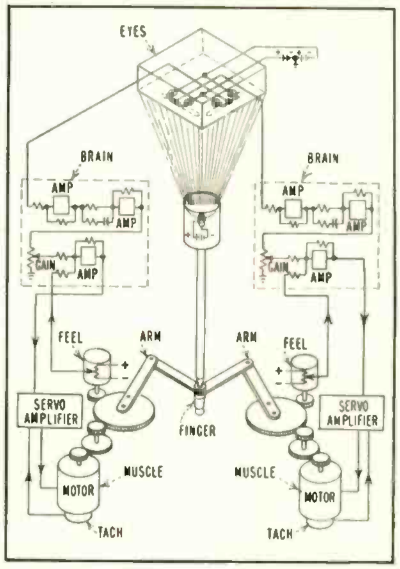

Juggler duplicates human act of balancing stick on tip of finger. Labeling shows human functions duplicated by servo system

point, sits on a finger as shown in the diagram. The finger is on a ball bearing riding on a glass plate, thereby minimizing friction. The finger is cupped on top to support the broomstick.

Light falls on two sets of phototubes located in a frame 9 inches above the end of the stick. The phototubes provide x and y (rectangular co-ordinate) position error data.

The error from the phototubes due to the falling of the broomstick is amplified, shaped and summed in with the feel error from a potentiometer connected to the servo drive by means of a system of d-c amplifiers and R-C networks.

A servo amplifier converts the d-c signals into a-c and provides power to drive a 10-watt two-phase servomotor. The motor drives a system of gears and linkages that positions the finger in response to the phototube and feel errors. A d-c tachometer provides a stabilization signal to the servo amplifier.

The approximate equation of the broomstick pendulum in a single plane is

$$\frac{d^2u}{dt^2} = \frac{g}{l}(u - v) \qquad (1)$$

where u = position of top of broomstick
v = position of bottom of broomstick
g = acceleration of gravity
l = length of broomstick

The control system performance

Model 539 VSWR Test Set consists of removable indicator unit (top) and power supply (bottom) fitted in compact aluminum combination carrying case.

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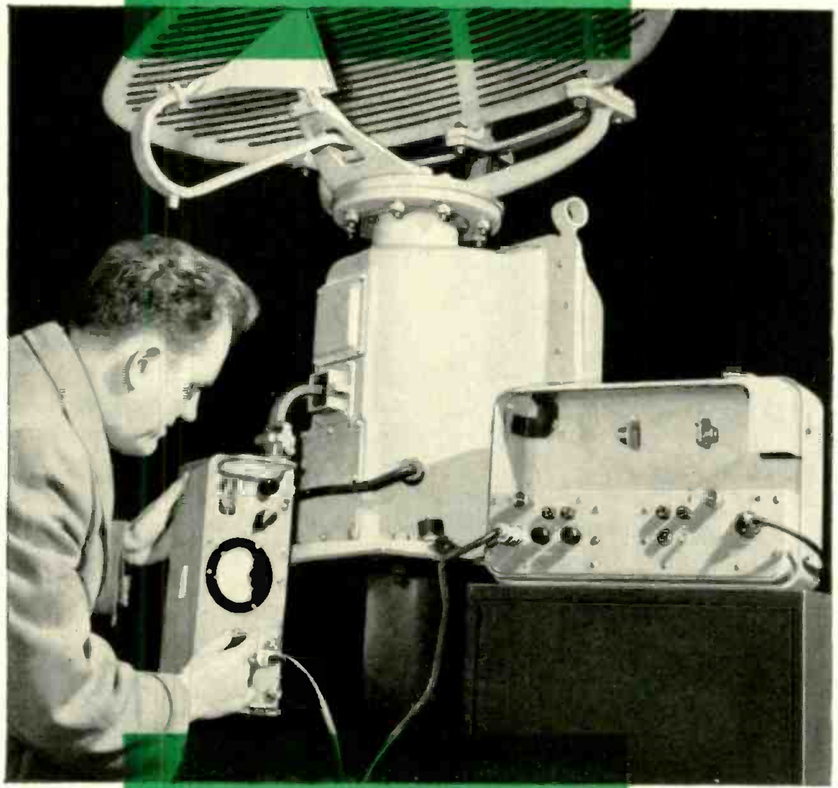

■ Now available is the Sperry Microline* Model 539, VSWR Field Test Set, designed for accurate measurement of the voltage standing-wave ratio of X-band radar equipment during installation, maintenance and repair. This compact portable test set is also ideal for use in production and laboratory testing.

■ Model 539 is a direct-reading reflectometer-type instrument which consists of a klystron oscillator, high directivity directional coupler, detector, amplifier and indicator, power supply and modulator. Calibration is accomplished with a reference mis-match.

■ The simplicity of adjustment and operation of the test set make it extremely useful for accurate measurements over the entire range. It is particularly useful in adjusting a standing-wave ratio since the meter gives a continuous indication. Indicator unit can be easily connected to the equipment to be tested with a thumbscrew-operated clamp.

■ This test set is approved by the military as the AN/UPM-12 meeting all the requirements of Specification MIL-T-945A.

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

For convenience in field work, the microwave indicator unit can be easily removed from carrying case.

SPECIFICATIONS

VSWR Ranges	1.05–1.3±5% 1.3–2.0±5% 2.0–3.0±10% 3.0–10.0 uncalibrated
Freq. Range	8.5–9.6 kmc
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Dimensions	Length 19¼ in. Width 12 in. Height 10¼ in.
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Power Requirements	105–125 volts 50–1000 cycles 75 watts

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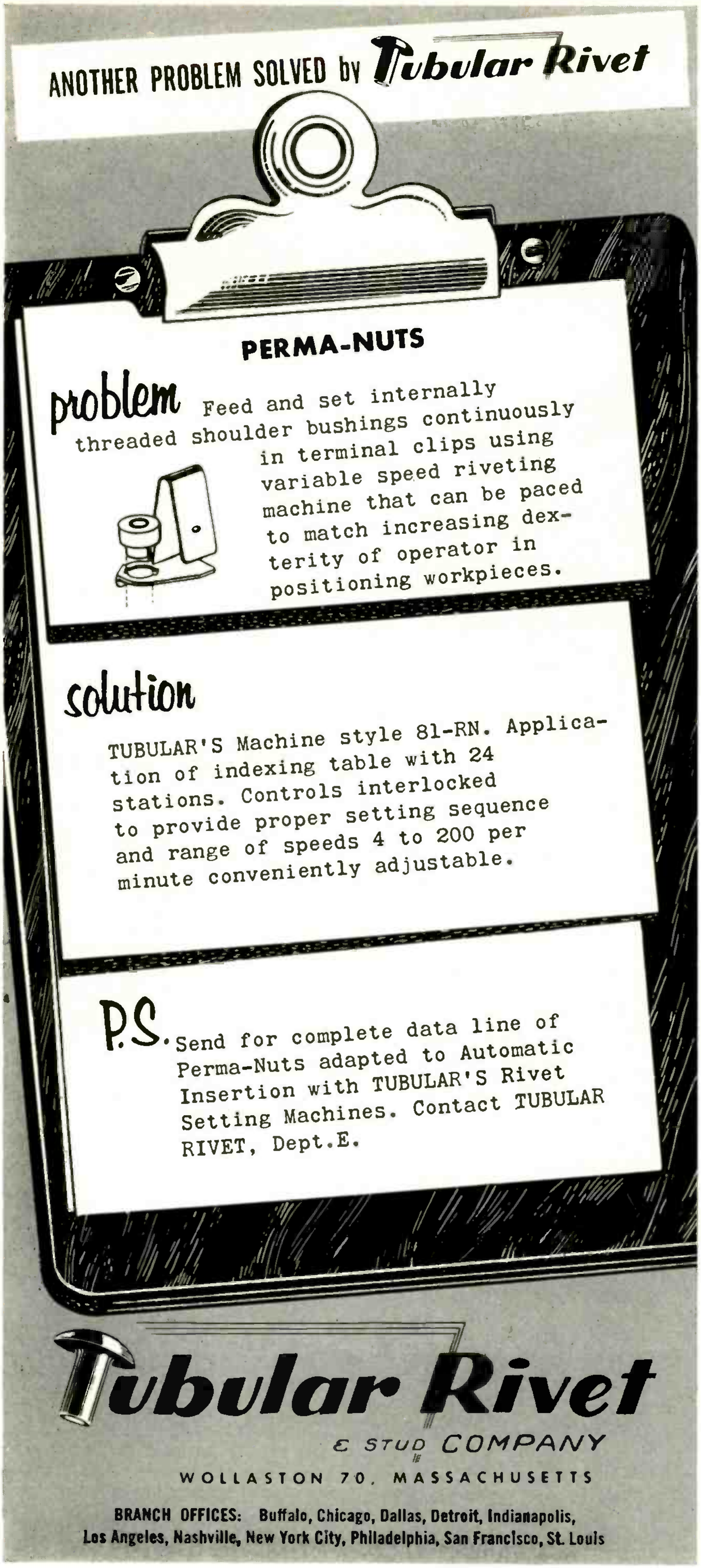

is given by

$$v = (l + a)u + b\frac{du}{dt} \qquad (2)$$

where a and b are constants, and Eq. 2 is instrumented for each of the two control planes by the brain, which is a standard computer unit. Combination of Eq. 1 and Eq. 2 gives the system performance equation

$$\frac{d^2u}{dt^2} + \left(\frac{bg}{l}\right)\frac{du}{dt} + \left(\frac{ag}{l}\right)u = 0 \qquad (3)$$

Although Eq. 1 gives rise to instability (broomstick falls over), Eq. 3 gives rise to stable operation, where a controls the restoring force, and b controls the system damping.

The electronic juggler is stable in operation. In holding the light source in a practically fixed position, the finger moves about $\pm\frac{1}{4}$ inch from its equilibrium position. If the broomstick is manually rotated in either direction, it sustains the rotation.

The system recovers satisfactorily from momentary interruption of the light beam. The system is critical to any restriction and reacts violently if constrained. No dynamic measurements have been made, but it is apparent that the electronic juggler is a much better performer than a person attempting to balance a pole on his finger.

Graphical Solution of Power Transfer Problems

By A. C. MacPherson
National Bureau of Standards
Washington, D. C.

USE OF A MODIFIED Smith chart permits a graphical solution to the problem of power transfer from a generator of complex reflection coefficient S_G to a load of complex reflection coefficient S_L. In this method it is assumed that the waveguide or coaxial outputs of the generator and load have identical cross sections and that only the dominant mode is present at these outputs. If the generator is matched ($S_G = 0$) the power delivered is proportional to $1 - |S_L|^2$. When the generator is not matched, however, the power delivered is proportional to $(1 - |S_L|^2)\ R$, where R is a real

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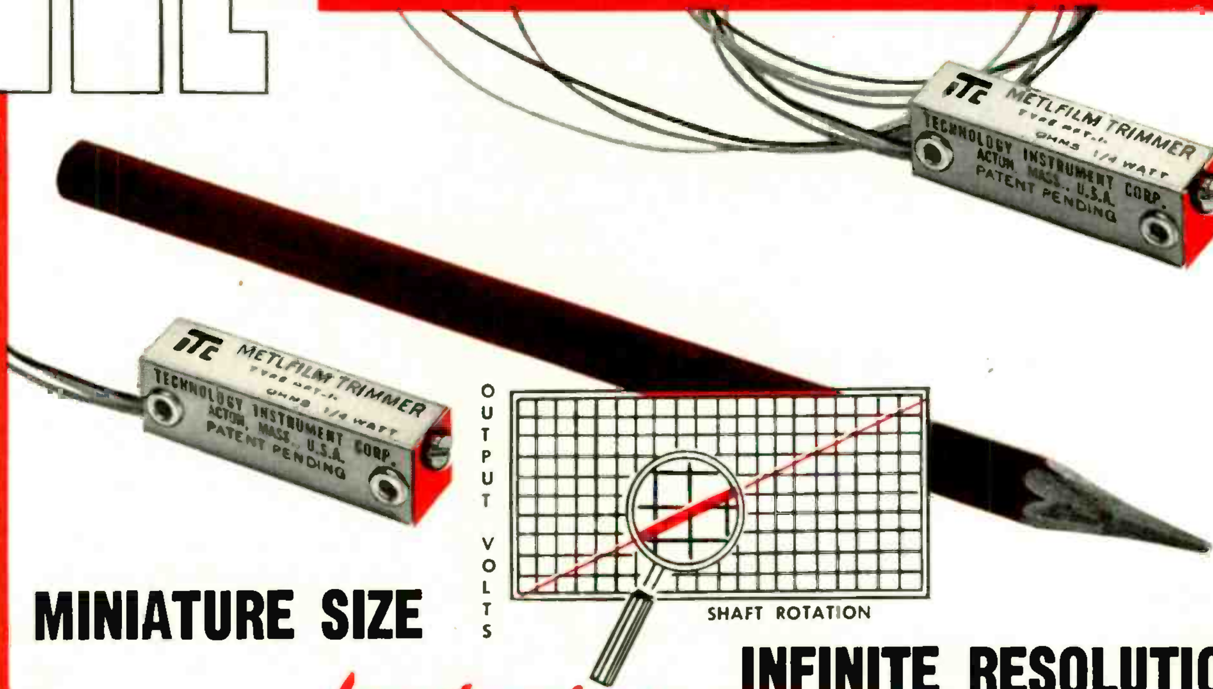

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Resistance Range: 50-25,000 ohms

Total Resistance Tolerance: ± 10%

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Power Rating: 1/2 watt at 40°C.; 1/4 watt at 125°C. per JAN-R-19 test specification.

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Temperature Coefficient of Resistance Element: .000250/°C (nominal)

Dielectric Test: 500 volts DC between all leads, shaft and mounting eyelets for 5 seconds without flashover or breakdown.

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Resistance Element: Metal film deposited on inert base.

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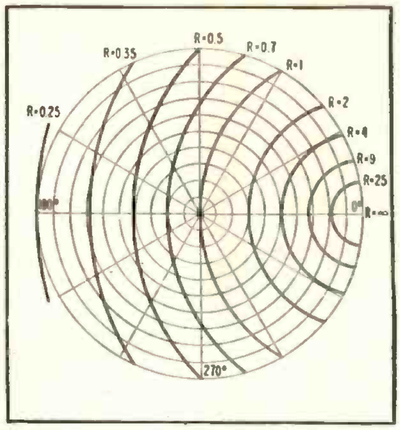

Smith chart for graphical solution of power transfer problems

number which depends on $S = S_GS_L$. The accompanying modified Smith chart gives a graphical solution for R. The vector S is drawn on the chart with its origin at the center. The terminus of S will then lie on the proper contour of constant R and can be read off. For example if $S = 0.8 \exp (j\, \pi/6)$, $R = 4$

The chart is particularly useful in studying variation of power delivered to a terminating impedance through a lossless line the length of which is varied. In this case the

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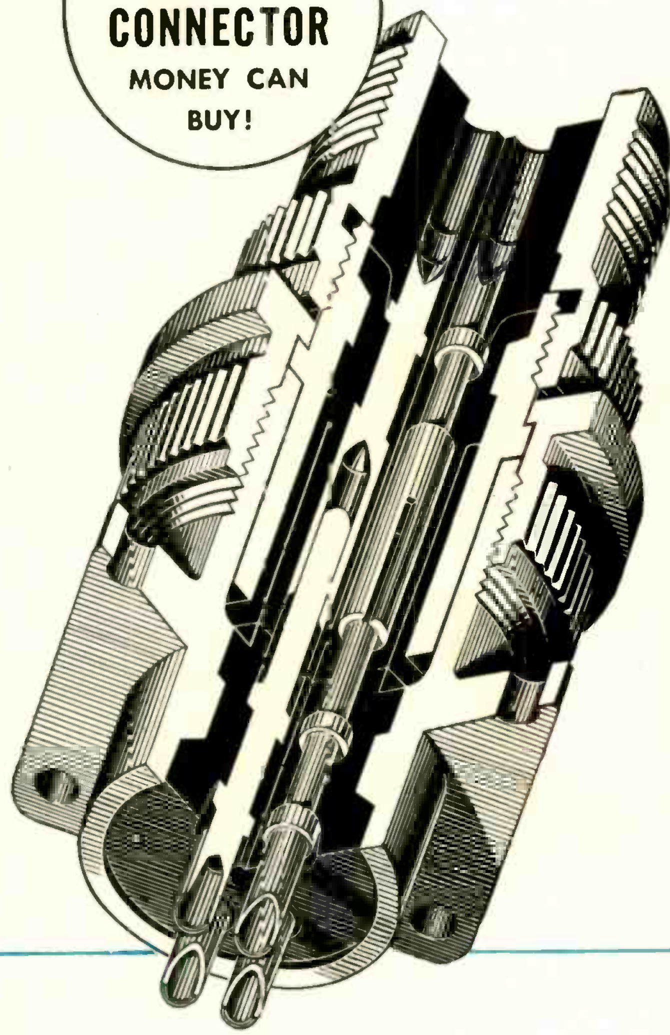

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factor $1 - |S_L|^2$ is constant and can be ignored.

For example, determine variation in power transferred from a generator of $|S_G| = 0.6$ to a load of $|S_L| = 0.5$ as the line length between the generator and load is varied. Varying the line length is equivalent to varying the phase of S_L which is in turn equivalent to varying the phase of S. Since $|S| = |S_L|\,|S_G| = 0.3$, we consider a vector of length 0.3 whose phase varies from 0 to 360 degrees. By noting the R contours which the terminus of the vector touches as it rotates we obtain the variation of power transfer. In this case maximum power is proportional to approximately $2\ (1 - |S_L|^2)$ and the minimum is proportional to approximately $0.6\ (1 - |S_L|^2)$. For minimum variation, it is important to have $|S|$ as small as possible.

Tritium Battery

USING TRITIUM, a constituent of the hydrogen bomb as the source of initial power, a new nuclear battery produces up to one microwatt of power.

The beta rays given off are said by Tracerlab, developers of the unit, to be practically harmless.

The battery produces up to 400 volts at relatively low current values. Optimum useful life of 18

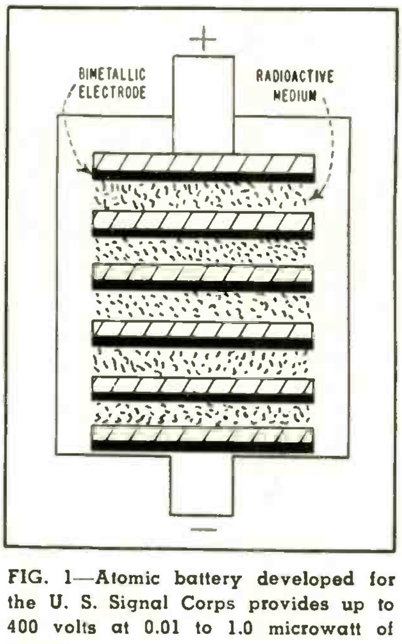

FIG. 1—Atomic battery developed for the U. S. Signal Corps provides up to 400 volts at 0.01 to 1.0 microwatt of power

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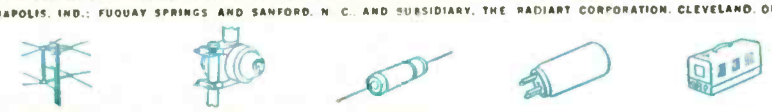

Tritium battery cells may have useful life up to 30 years depending on design

years is claimed during which time a constant circuit voltage would be generated, although the current would gradually decrease at a known rate.

The cylinder shown in Fig. 1 is smaller than a conventional flashlight battery. It is filled with the radioactive medium that surrounds pairs of metal plates having different surface electrical characteristics. These serve to attract the radioactivated current thus producing useful external current. The current reaching the plates delivers a voltage in proportion to the difference in the surface electrical characteristics of the plates. The principle involved is essentially one of ionization.

Self-Keyed Transistor Oscillator

BY FRANK C. ALEXANDER, JR.

Gulf Research and Devolpment Co. Pittsburgh, Pa.

A PERIODICALLY KEYED audio oscillator was required for an unattended beacon device. Minimum battery drain and simple circuits were prime design objectives.

The basic circuit developed is shown in the circuit diagram. The Clapp-oscillator configuration provides a stable carrier frequency. The prf is controlled by C_5 and duty cycle is adjusted with R_D.

The 1N91 diode clamps the emitter negative swing to ground and charges timing capacitor C_5, which cuts off the transistor. Discharge occurs slowly through small

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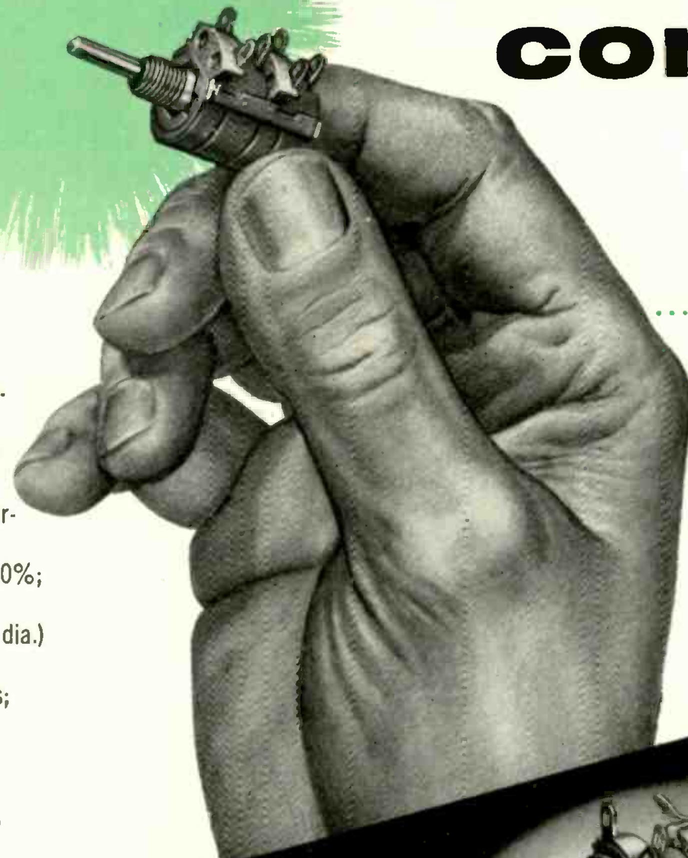

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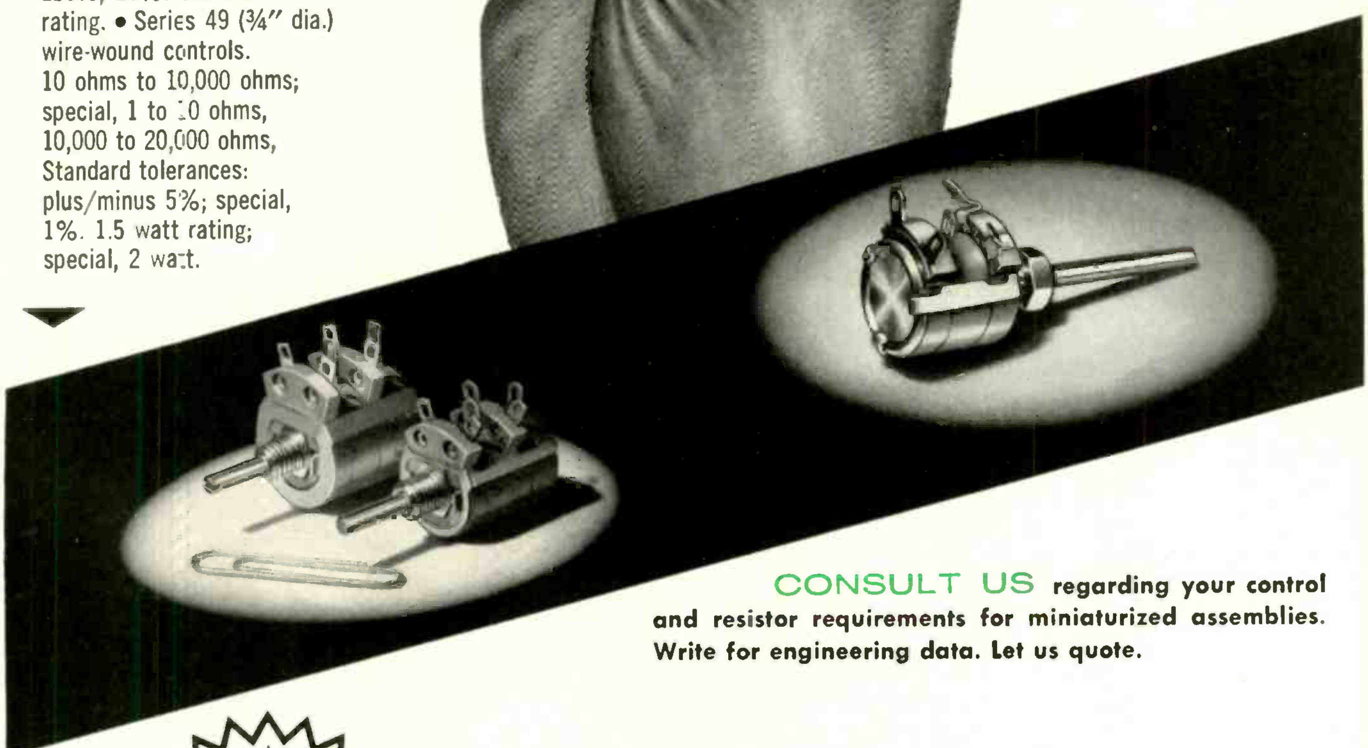

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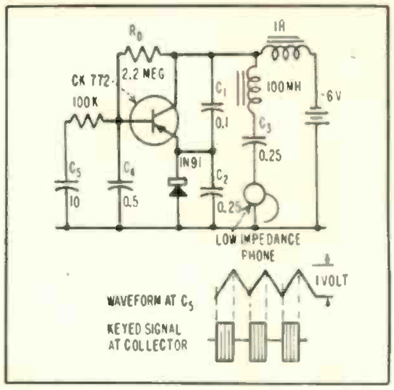

Transistor oscillator provides prf from 100 per second up to 2 per minute

cutoff conductance until oscillation conditions again obtain. The cycle then repeats.

The inductors have Q's of 30 at 1 kc. They are wound on small Ferroxcube pot cores.

Carrier frequencies of 2 megacycles have been achieved with this circuit using TI-201 *npn* transistors. Pulse repetition frequency is adjustable from 100 per second to 2 per minute by varying C_5. To use *npn* transistors the polarity of the battery, diode and electrolytic capacitor should be reversed.

REFERENCES

(1) R. L. Wallace, Jr., and W. J. Pietenpol, Some Circuit Properties and Applications of n-p-n Transistors, *Proc IRE*, 39, p 753, July 1951.
(2) Peter G. Sulzer, Junction Transistor Circuit Applications, ELECTRONICS, 26, No. 8, p 171, Aug. 1953.

Phototransistor Card Reader

USING PHOTOTRANSISTORS to detect markings, a 118-channel card reader is now in operation for automatic handling of toll telephone calls. Using the phototransistor in conjunction with a transistor amplifier as shown in the diagram the unit has made 28,000,000 laboratory test readings with negligible failures.

The phototransistor is illuminated by a light beam modulated at 400 cps when a card punch hole passes over the reader. The light acts as the emitter of the phototransistor, which has a collector impedance of about 10,000 ohms. This impedance is reduced to approximately 3,000 ohms by the illumination. The a-c signal from the photo-

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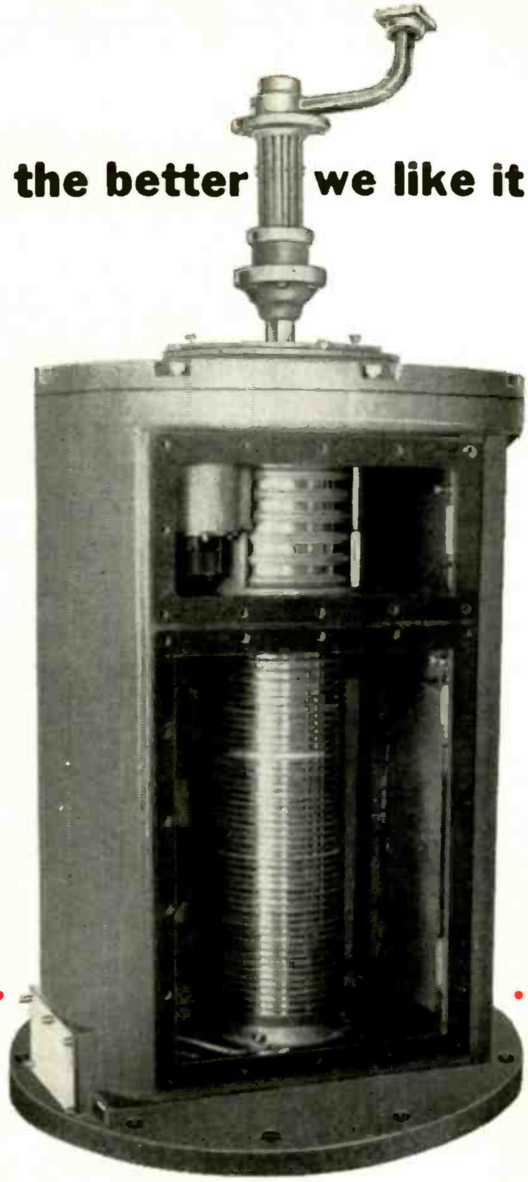
Virtually every project in the electronics manufacturing field involves operations within the scope of the D. E. Makepeace Company. As specialists, Makepeace is able to supply electronic assemblies for components which meet the most exacting specifications.



WAVEGUIDE TUBING AND MICROWAVE ASSEMBLIES

Long experience in the manufacture of precision drawn waveguide tubing, enables Makepeace to meet tolerances much tighter than specified in MIL-T-85-B. This precision is maintained in the production of components such as rotary joints, crystal mixers, antenna feeds, and many specialized assemblies to meet various requirements.

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Because Makepeace pioneered in the production of solid and laminated precious metal slip rings, a range of sizes and special alloys is available to meet almost any requirement for space, weight, electrical noise, torque, or power handling capability.

In addition to the rings and brushes themselves, Makepeace has utilized its experience in this field in the design and manufacture of complete self contained ring and brush assemblies. The design of such a unit often poses unusual problems. The Makepeace engineering group having met many of these problems, can plan and manufacture a unit to meet your specifications. Before such an assembly is shipped, it is checked out and completely tested for electrical noise, voltage breakdown, impedance matching, power handling capability, and other test specifications as required.

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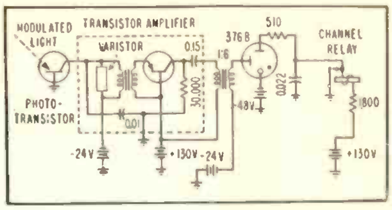
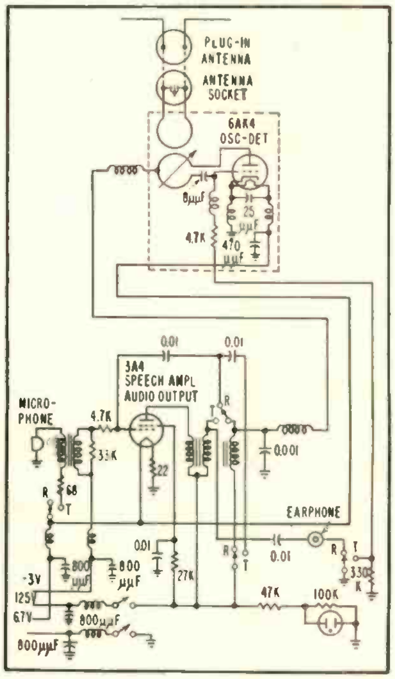


Transistor amplifier boosts signal from phototransistor to trigger cold-cathode tube

transistor is then applied to the transistor amplifier.

The amplifier is a conventional common-base circuit having a voltage gain of 40 to 100. The amplifier output triggers a cold-cathode gas tube operating a relay.

This information has been abstracted from an article "Transistors in 4A Toll Crossbar Switching" by P. Mallery, appearing in *Electrical Engineering*, Feb. 1954.



Portable Transceiver Circuit

Circuit of the portable transceiver described previously (p 204, Electronics, May 1954) is shown above. Stewart-Warner Electric, manufacturers of the Portafone, emphasize that the equipment is furnished as a unit and is designed mechanically as well as electrically to comply with FCC frequency tolerances with service by a licensed operator. Amateur or other equipments based solely upon the circuit diagram are not likely to meet requirements for the Citizens Radio band

(*Continued on page* 220)

PERTINENT PATENTS

By Norman L. Chalfin
Hughes Aircraft Co.
Culver City, Calif.

Information concerning fabrication and use of transistors occupies a large part of technical publication. This same interest and activity is reflected in patents issued. This month's selection summarizes information on three such patents.

Transducer

Patent 2,666,861 for a transducer has been issued to R. D. Campbell, assignor to Reed Research, Inc. of Washington, D. C.

The circuit of this device is

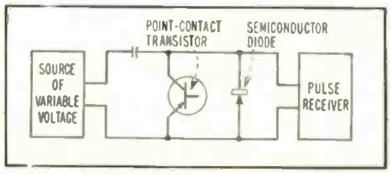


FIG. 1—Transducer changes varying voltage to pulse signal

shown in Fig. 1 and is designed to convert a voltage of varying amplitude into a pulse signal having a repetition rate directly proportional to the applied voltage.

The operation of the circuit is fairly simple and may be followed with reference to Fig. 2. As a voltage is gradually increased from the value *O* to *A* no appreciable

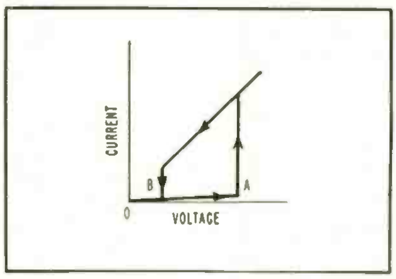


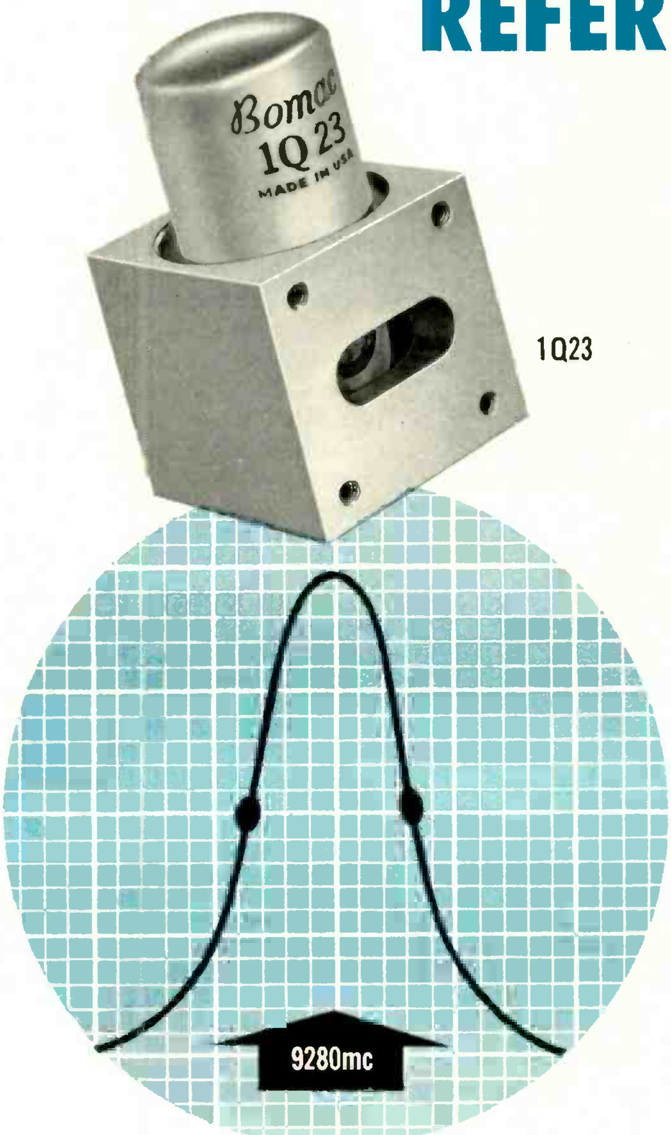
FIG. 2—Operation of circuit of Fig. 1

change in current occurs through the transistor body and little charge appears across the capacitor. When the voltage value *A* is reached a sudden current surge occurs and the capacitor is rapidly charged and the voltage across the transistor is diminished to the value indicated at *B* in Fig. 2 at which time conduction ceases.

Voltage from the source continues

Bomac

REFERENCE CAVITIES



1Q23

Bomac has developed a line of high-precision Reference Cavities covering six different frequencies. Essentially, Bomac cavities are fixed-frequency, vacuum-sealed, transmission-type tubes. They are used primarily as frequency determining references, and frequency stabilizers in radar beacon applications. The performance and stability of Bomac Reference Cavities over a wide range of temperatures is far superior to many other commercial cavities. Stability of the resonant frequency is maintained under severe conditions of shock and vibration by a unique cushioning arrangement that prevents excessive movement of the tube within the block.

CHARACTERISTICS AND RATINGS OF 1Q23 RESONANT CAVITY	
RESONANT FREQUENCY (mc)	9280 ± 0.5 mc
VIBRATION 10 G's	± 0.1 mc
SHOCK 50 G's	± 0.1 mc
AVERAGE Q	2100
INSERTION LOSS	4.0 db – 6.0 db
TEMPERATURE COMPENSATION	
Room Temp. to 100°C	± 0.3 mc
Room Temp. to 0°C	± 0.3 mc
Room Temp. to –55°C	± 1.0 mc
ATMOSPHERIC PRESSURE	
To 45 psi (abs.)	± 0.15 mc
To 5 in. hg. (abs.)	± 0.15 mc
ALTITUDE RATING	50,000 ft. (max.)

CAVITIES FOR OTHER FREQUENCIES

1Q22 — 9250 mc
1Q24 — 93.10 mc
5846 — 9280 mc
6040 — 9308 mc
6041 — 9312 mc

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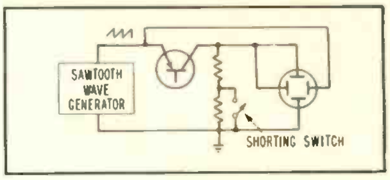

FIG. 3—Circuit used to form semiconductor

to increase, however, and when the difference between the charge across the capacitor and the added voltage from the source again equals a value *A*, across the transistor, sharp conduction occurs, repeating the sequence described above. This continues as long as there is an increase in the source voltage. The resultant, therefore, is a series of pulses that has a repetition frequency determined by the amplitude of voltage applied from the source.

Primarily, a circuit of the type shown has utility in analog-to-digital conversion of data to computers. The recovery time of the transducer is short enough and the voltage steps small enough vastly to increase the accuracy and speed of this device over the prior art. Values indicated in the patent disclosure suggest recovery times of less than 1 microsecond and voltage increments of less than 0.1 volt.

Forming Transistors

From England comes a device connected in similar fashion to the device described in the Campbell patent.

A U. S. patent 2,653,374 has been granted K. A. Matthews and C. D. White of London, England, assignors to International Standard Electric Company of New York; for an "Electric Semiconductor."

The invention herein disclosed is actually a means or method of elec-

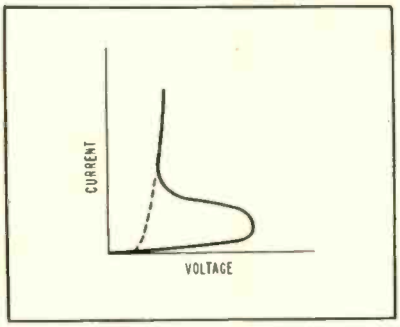

FIG. 4—Linear curve shown by dashed line

After a 5g Turn

IS THE DATA VALID?

The moment an oscillograph is taken out of the laboratory for aircraft flight testing, vehicle road tests, or any application where vibration and dynamic g forces are present, the "balance" of its galvanometers—the measure of their response to gravitational force—becomes all-important. An unbalanced galvanometer can cause deflections—under only moderate g-loadings—large enough to distort a data trace and make accurate record interpretation impossible. It can show deflections even when no data signal is present.

Miller Instruments' *improved* galvanometers are supplied *at no extra cost* with balance so closely controlled that trace deflection is within 0.010" per g in elements of less than 300 cps natural frequency and within 0.001" per g for higher frequencies. The unique open construction allows balancing to be the *final* operation before shipment. No subsequent assembly steps disturb the balance achieved. Trace deflection due to g forces displacing the suspension is negligible.

Sound basic concept and extreme care in manufacturing and testing make Miller Galvanometers unequalled not only in their balance but also in their control of sensitivity, linearity and stability. Inaccuracies have been literally "designed out." The unusual fineness of the traces they produce have long been the standard in oscillographic recording.

Available with natural frequencies from 35 to 3200 cps and a wide range of sensitivities, Miller Galvanometers are described in detailed literature, which will be sent on request.

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trically forming crystal triodes (as they are termed in the specification) to eliminate the nonlinearity of characteristic response generally attributed to transistors.

The heavy curve of Fig. 4 shows the normal input volts vs output current characteristic of transistor units. When treated with a high-current sawtooth wave applied between emitter and collector as shown in Fig. 3, the semiconductor is formed to develop the linear characteristic curve shown in the dashed line of Fig. 4.

If, after a first shot of the high current sawtooth energy is applied, by closing shorting the switch shown to increase the current in the collector output circuit, the loop of the solid curve has not been eliminated, a second and a third shot will finally bring the response to the linear curve sought.

Note that in the circuit of Fig. 3 the base of the transistor is unconnected. The energy is applied only in the emitter-collector path.

Transistor Amplifiers

A number of "Transistor Amplifier Circuits" is the subject of U. S. Patent 2,652,460 awarded R. L. Wallace, Jr. of Plainfield, N. J. and assigned by the inventor to the Bell Telephone Laboratories of New York.

The importance of the present invention lies primarily in its setting forth the duality between transistor amplifiers and vacuum-tube amplifiers and the means whereby the operation and characteristics of the former may be predicted as the characteristics and operation of the latter are now predicted.

In particular the specification of the Wallace patent presents the

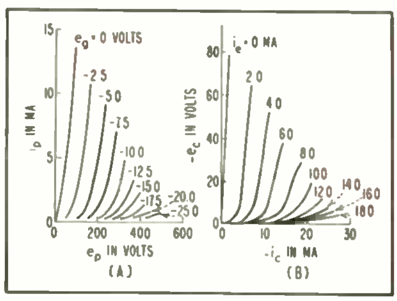


FIG. 5—Plate circuit curves for vacuum triode (A) and type A transistor collector curves (B)

various points of departure from which the analogous operation of vacuum tube and transistor amplifiers may be compared.

In Fig. 5A there is shown a typical family of plate circuit characteristic curves for a vacuum tube and beside it Fig. 5B shows a family of collector circuit characteristic curves of a type of transistor suitable for amplifier service. The analogy in this respect is clear from these curves.

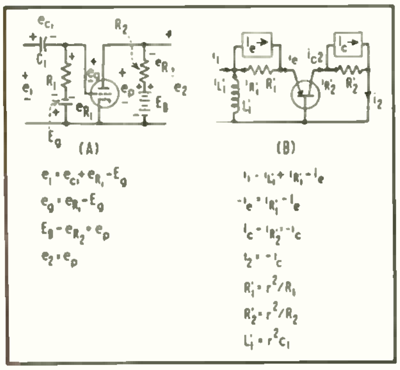


FIG. 6—Duality shown by tube (A) and transistor (B) and accompanying equations

In Fig. 6A and 6B a vacuum-tube triode amplifier and a transistor amplifier are shown side by side to illustrate their duality. The defining equations of each are set forth beneath to show the operating conditions of the two. The equations of the transistor circuit (B) are the transforms of those for the amplifier circuit of (A). The transistor circuit (B) satisfies the

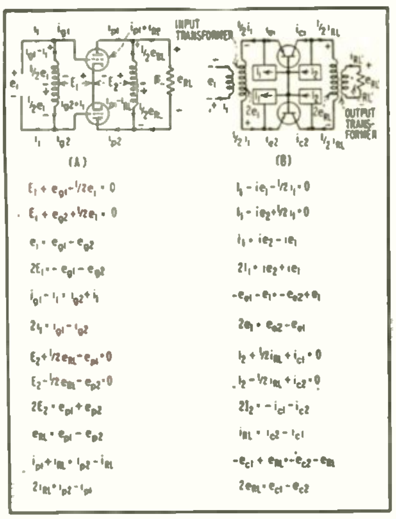


FIG. 7—Duality in push-pull amplifiers shown by equations

transformation equations, shown below it, which make one circuit the dual of the other.

A vacuum-tube class-B push-pull amplifier shown in Fig. 7A has the operative relationships shown in the equations below it. Similarly, the push-pull class-B transistor amplifier, shown in Fig. 7B, is the dual of the circuit of 7A with its operative relationships in the equations below.

To obtain the high efficiency corresponding to class-B operation, the emitters of two transistors are biased toward high emitter current and the collectors toward high collector current so that collector current is cut off during approximately one half of each cycle. These bias conditions are shown in the curves of Fig. 8.

In the diagram of Fig. 8 the family of curves for one transistor are plotted back to back with those for the other transistor. A signal applied to the transistor circuit of Fig. 7B results in a current and voltage swing corresponding to the

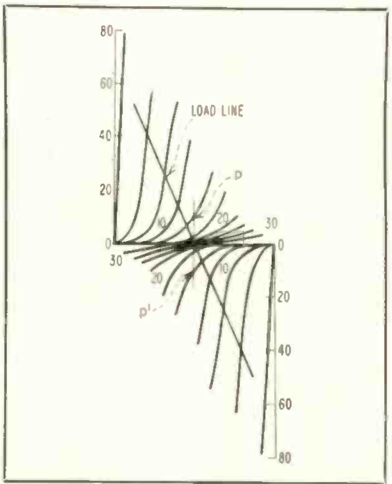


FIG. 8—Family of curves plotted back-to-back for push-pull transistors

load line shown in Fig. 8 while in the absence of signal the collector voltages are both small compared to their values at the peaks of their swings.

To avoid distortion that would result from utilization of the highly nonlinear parts of their characteristics, which lie immediately adjacent to the current axis, the bias currents may be selected to locate the quiescent conditions of the two transistors approximately at points *P-P′* on the curves of Fig. 8.

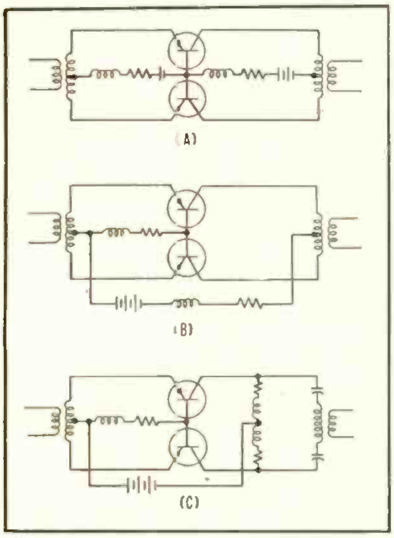


FIG. 9—Variations of the push-pull class B amplifier circuit

Figure 9 shows variations of the push-pull class B amplifier circuitry to provide simplifications of the power supply requirements.

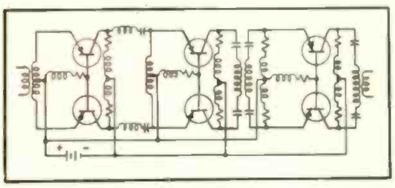


FIG. 10—Cascade of amplifiers employing common power source

Fig. 10 shows a cascade of amplifiers employing a common power source. Each stage of the amplifier may be operated either class B or even class C. Bias currents for the emitters may be obtained from choke coils and resistors in the common power source circuits.

More gain is obtained with the cascaded amplifier. The duality principle calls for feeding the collector current output from a preceding stage to the emitter of the succeeding stage. When each stage must be tuned, the duality principle calls for series-tuned rather than parallel-tuned circuits as may be seen in Fig. 10. In coupling from stage to stage, as shown, the transformer windings are adjusted to give the proper impedance transformation, as required in transistor circuits.

Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

Automatic Fabrication of Resistor Terminal Cards

NEW TYPES of resistor cards and a machine that fabricates the cards automatically serve to eliminate screw machine, drill press and riveting operations to achieve a tenfold reduction in fabrication time at Hewlett-Packard Co., Palo Alto, Calif. The designer is R. M. Kingman.

The resistor-card machine performs three basic operations. It stamps a flat lug out of silver-plated brass ribbon, punches a hole in a phenolic board, and mounts the lug in the hole. The machine can also punch a number of large holes that can be used to mount the resistor card in an instrument.

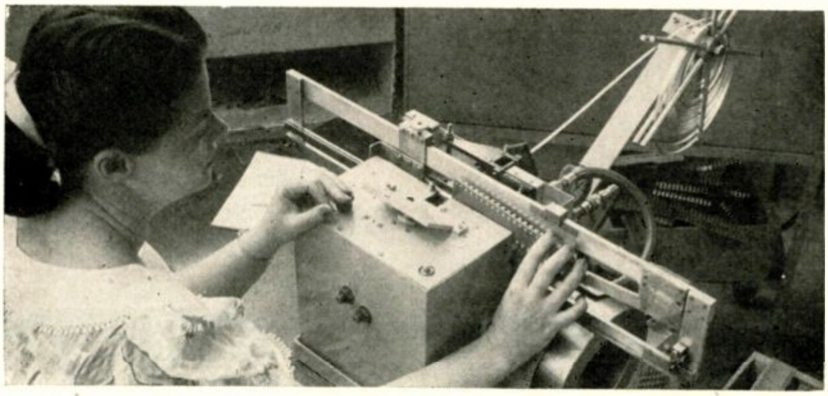
The silver-plated brass ribbon mounts on a spool at the back of the machine and is fed between a punch and die that forms lugs. A phenolic board or card, previously cut to desired size, is manually inserted into a traveling carriage at the top of the machine. This carriage carries the phenolic board past a punch and die in a stepping or indexing motion similar to that of a typewriter carriage. As the board moves through the machine, the punch stamps out small round holes along the edge of the board.

Into each hole the ribbon feed mechanism inserts a stamped lug, leaving the shank of the lug protruding from the back side of the board. A crimping punch crimps the shank, which is then set by a small automatic hammer, thus mounting the lug securely to the card.

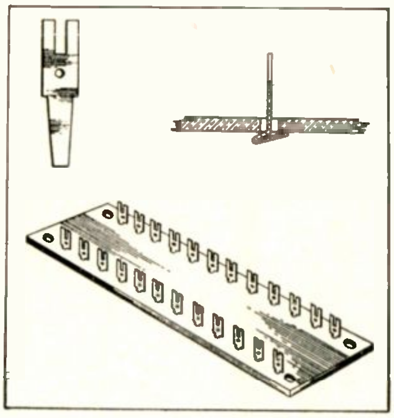
The machine continues this operation along one complete side of the card, after which the card is manually inverted and the process continued along the opposite edge. A separate punch and die are included in the machine so that mounting holes for the card itself can be punched at desired points along the card. A disabling cam prevents the insertion of lugs in these mounting holes.

Lugs are mounted at a rate in excess of 130 per minute. A typical resistor card having 10 pairs of lugs can be completely fabricated in about 15 seconds. Costwise, the machine-made resistor card amounts to only 1/7 to 1/10 the cost of conventional cards and at the same time frees valuable machine shop facilities.

The machine-made resistor card also has a number of advantages



Automatic resistor card machine, which makes its own terminals from ribbon at rear and inserts them in holes punched one by one in plastic card



Details of new resistor card, showing how terminals are punched and staked

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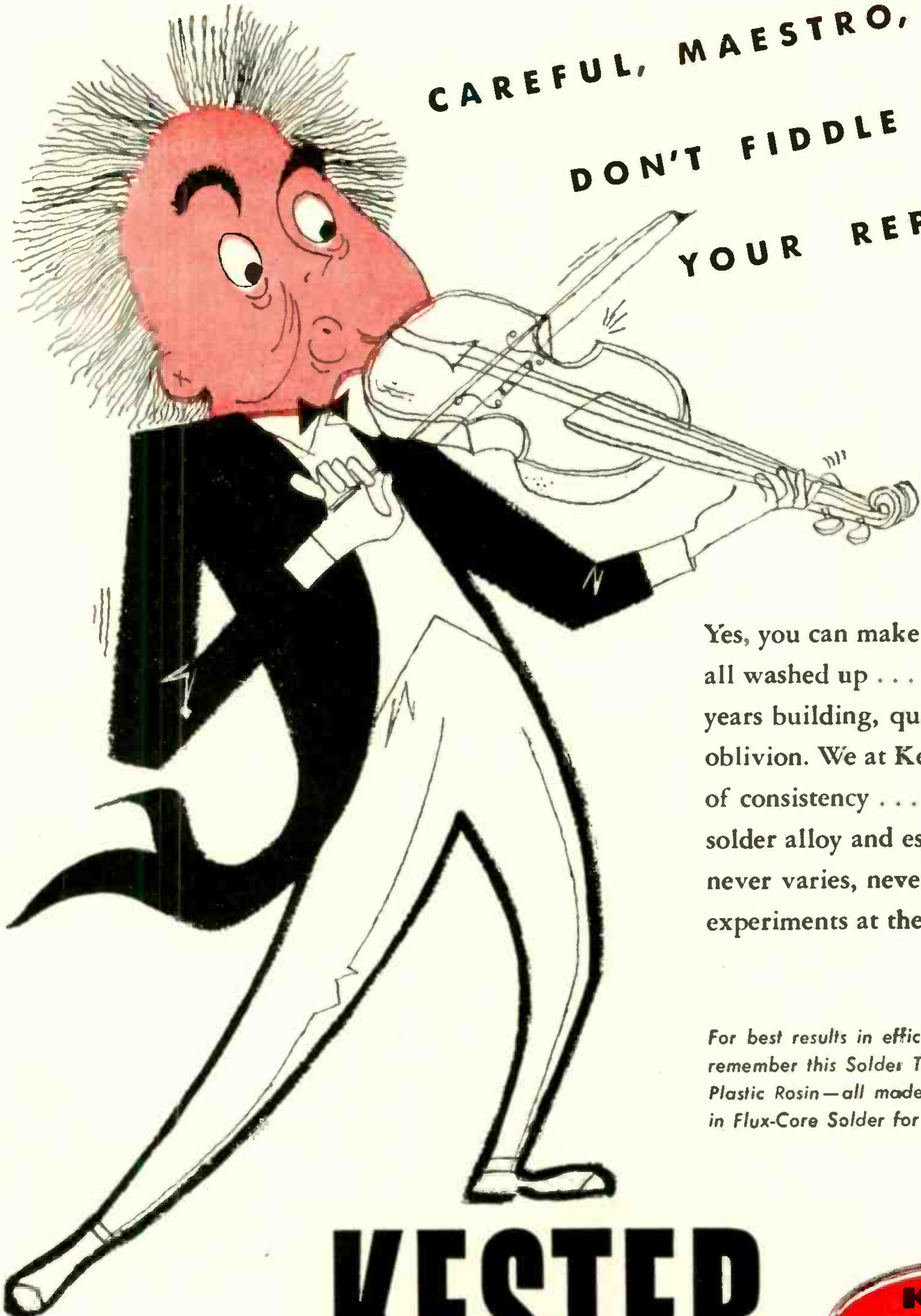

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that improve the equipment in which it is used. The lugs are thin in the direction of resistor strain, so that danger of damage to resistors during and after wiring is minimized. Also, it is not necessary to wrap the resistor lead around the lug. The lead simply drops into the slot at the top of the lug. After the resistor is soldered into place, the excess lead is cut off.

Leads connecting to the resistor card are inserted through the round hole at the bottom of the lug and soldered without wrapping. The mechanical joint formed by soldering is good. Completely fabricated resistor cards with components mounted thereon do not show weakness when subjected to military type vibration and shock tests in finished equipment. The simplicity of wiring also reduces labor costs required for wiring in components.

Since neither the resistor lead nor connecting wire is wrapped around the lug, an otherwise difficult servicing problem becomes easy. Any component can be disconnected by heating the terminal and lifting the lead out of the slot. Connecting wires can be removed by pulling the wire out of the round hole after the lug has been heated.

Wire Spool Rack

USE OF THE PROPER lead wire for tap connections on precision potentiometers is facilitated by a coded spool-holding rack at Helipot Corp., South Pasadena, California. Each of the many alloys and weights of wire is assigned a code number. The 50-peg dispenser holds these wires on individually numbered spools.

Spool rack alongside tap welding setup

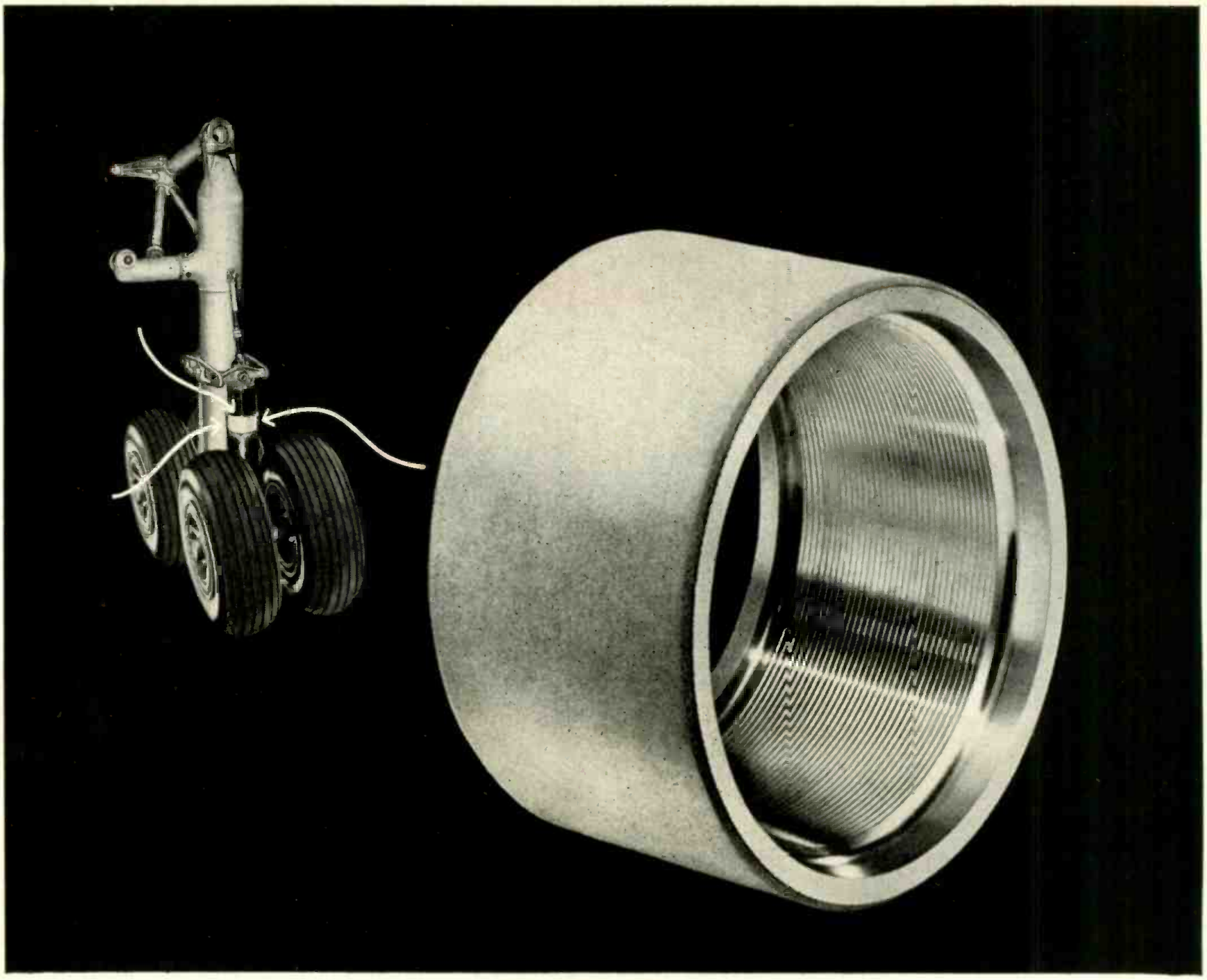
Elasticized-Edge Plastic For Tote Boxes

STANDARDIZED SIZES of boxes for parts and finished components stack and tote with a minimum of inconvenience at Helipot Corp., South Pasadena, Calif. A clear plastic cover with elasticized edges protects contents and keeps them visible. Tickets attached to the box identify contents when boxes are stacked.

Felt-Padded Boxes Hold X-Ray Tubes

INEXPENSIVE wood boxes having felt-padded semi-circular cutouts in the end serve as supports for Amperex type 3000M rotating-anode x-ray tubes during final assembly. Two styles of racks are used in the Hicksville, N. Y. plant of the firm, one for individual tubes and one for a batch of six tubes.

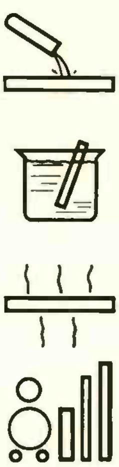
The racks are used to hold the tubes during the final operations of placing spaghetti tubing and nylon caps on the leads at one end, and cementing a cork protective band around the glass envelope at the other end. For the cementing operating, a cork strip is coated with GE No. 1286 Glyptal cement and the strip is wrapped around the tube. A simple metal band



Final Approach to an Easy Touch-Down

Properties of Synthane

In addition to those mentioned in the text, Synthane has the following important properties:



Chemical resistance. *Synthane* resists most acids and alkalis in moderate concentrations. It is also resistant to corrosive atmospheres.

Low moisture absorption. Most grades of *Synthane* are highly moisture resistant. Special grades are available for applications where absorption must be at a minimum.

Thermosetting. *Synthane* will hold its shape under elevated temperatures. It cannot be reheated and reshaped; once formed it is permanent. (If post-forming is essential, special grades are available.)

Availability. In addition to more than 33 grades of sheets, *Synthane* is also supplied in many grades of rods, tubes and special shapes. Molded-laminated and molded-macerated parts are also manufactured. A complete fabricating service is available.

● A major problem in aircraft design since the very beginning has been proper landing gear. The Wright brothers used rigid, sled-like runners. For many years shock cord—giant-sized rubber bands—took up the load. As planes grew larger and landing speeds climbed, the modern air-oil shock strut was developed. An important component in the largest landing gear struts now made is *Synthane*—a laminated plastic.

The pistons used in shock struts must be tough, mechanically strong, shock-resistant, machinable, light in weight, impervious to oil, long-wearing and non-scoring. They must bond securely to aluminum cores. Dimensional stability is necessary over a wide range of operating temperatures. *Synthane* supplies all of these needed properties.

There are hundreds of applications for *Synthane's* electrical, chemical and mechanical properties. More than 33 different grades of this versatile laminated plastic help to fulfil a variety of specifications. If you have need of a material with many different properties in combination, *Synthane* may be your answer. Our catalog supplies full information about *Synthane* sheets, rods, tubes, and fabricated parts. To get your copy, please write us. Synthane Corporation, 12 River Road, Oaks, Pennsylvania.

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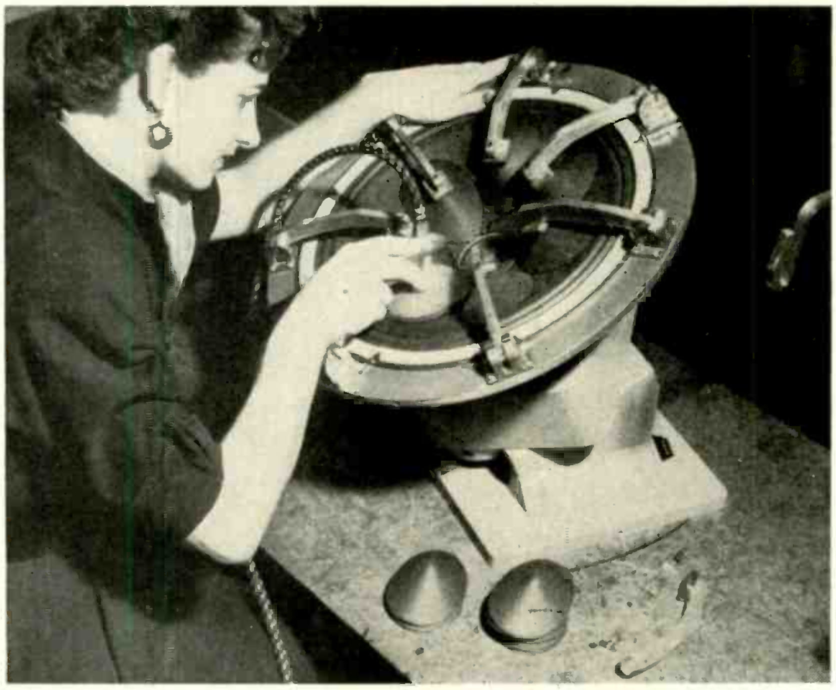
tightened around the strip holds it in place until the cement has set with the aid of heat from a 250-watt infrared lamp. This lamp is in a socket mounted on a board resting on top of the work-bench back, a heavy metal weight being used on the board to counter-balance the weight of the lamp. This simple arrangement permits swinging the lamp to any desired position or moving it.

Vacuum Cup Positions Domes on Speakers



Method of using vacuum-actuated tool for picking up paper dome and placing it in precise position on loudspeaker diaphragm. Projecting studs on handle of tool fit into slot in bracket just under operator's right wrist to determine position of dome

THE PROBLEM of cementing seven sound-diffusing cones on the diaphragm of the RCA type LC1A 15-inch high-fidelity loudspeaker was solved in the firm's Camden plant by devising a vacuum-actuated positioning tool that works in conjunction with an angle-mounted rotating fixture supporting the entire loudspeaker. So perfect is the resulting fit of elliptic-based domes to the conical inside surface of the diaphragm that cement flows under the edges by capillary action to give perfect anchoring, with no gaps to cause rattles.

The first step is trimming the edges of the domes so they will be parallel to the surface of the diaphragm when installed. The domes are molded from paper pulp to a thickness of about 0.015 inch in much the same way as loudspeaker diaphragms are made, and come from the vendor with a surplus flange. Each such dome in turn is placed in an arbor-press fixture having a contoured recess, and the press is operated by hand to bring a mating plunger down into the dome. The top of the fixture and the top of the plunger are then in correct alignment to serve as guides for trimming. The operator simply holds a razor blade over the flange and spins the fixture to cut off the surplus paper. Fixture and plunger are designed to permit this rotation. A razor-blade holder is used, and blades are changed frequently.

For the second step, the operator places a loudspeaker in a large metal holding fixture mounted at an angle on a support that rests on the bench and rotates in a horizontal plane. Spaced around the flange of the fixture are seven supports for the dome-positioning tools, each with its pivot slot spaced a different distance out from the center of the

Applying cement around domes with hypodermic syringe while weighted tools hold the seven domes in position. Entire fixture rotates to bring domes into working position

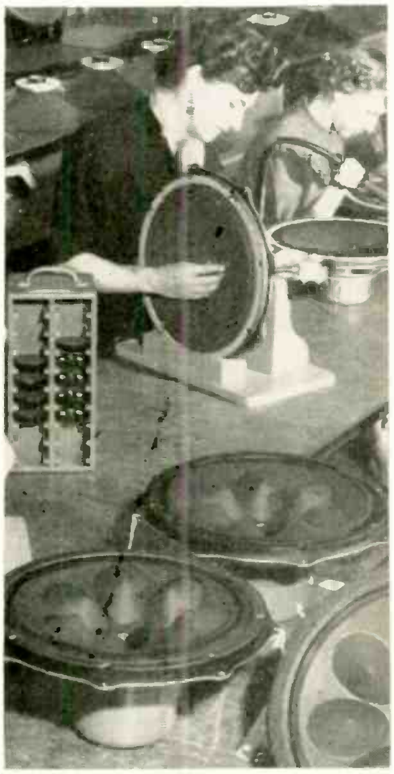
loudspeaker. This serves to place the domes on a spiral rather than a circle, to break up standing-wave patterns.

The operator picks up a trimmed dome with a master positioning tool that is equipped with a vacuum cup. Vacuum is provided by a vacuum pump driven by a quarter-horse-

After placing dome in position, operator hangs vacuum tool out of the way on the overhead support bracket and places a weighted arm on the dome to hold it in position. Vacuum pump is in foreground on bench power electric motor, located on the bench alongside the work position. A foot switch controls the motor to start and release vacuum as desired. The vacuum lifter prevents deformation of the dome such as might occur if picked up with the fingers, and serves to keep the dome clean as well as position it.

Assembly Procedure

Dome positioning is done simply by placing the lifting tool in the bracket nearest the operator and



Type of wood fixture used for holding loudspeaker vertically during assembly of spider, inner tweeter and other components. Wood carrying case with handle serves for transporting and protecting circular corrugated spiders with attached voice coils. Finished loudspeakers can be seen on table in foreground

bringing it forward to press the dome gently against the diaphragm. The vacuum pump is then stopped to release vacuum, the tool is lifted up carefully so as not to disturb the dome, and a plain weighted tool of similar shape is put in place to hold that dome in position. The loudspeaker is then rotated one-seventh of a turn and the procedure is repeated for the next dome.

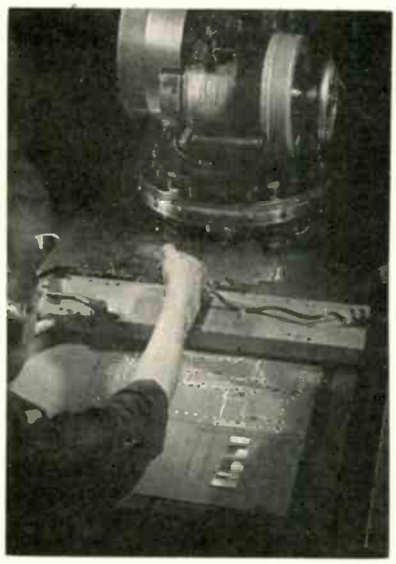
When all seven domes are in position, the operator takes a hypo syringe filled with an air-dry lacquer-type cement and runs it around each dome in turn, to flow cement under the edges of the domes by capillary action. The edges of the domes serve as guides for speeding up application of cement. After this dries, the weighted holding tools are removed and a second coat of cement is applied to form a fillet around each dome.

Although the diaphragm appears to have corrugations, it is actually smooth on the inner side so that a good fit to the domes can be obtained. The effect of corrugations is achieved by molding to give variations in the thickness of the diaphragm.

Use of Turret Press for Short Chassis Runs

THE FLEXIBILITY of the Wiedermann turret press has proved highly advantageous for chassis and other metal punching work associated with production runs of from 100 to 500 a month in the Palo Alto, Calif. plant of Hewlett-Packard Co. Shorter runs can be most economically handled on individual punch presses; more would justify a die set.

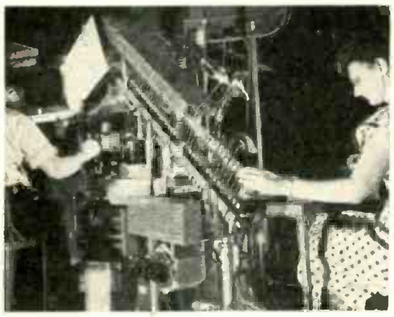
This machine has 20 different punches which can be operated in any sequence. Changes in the



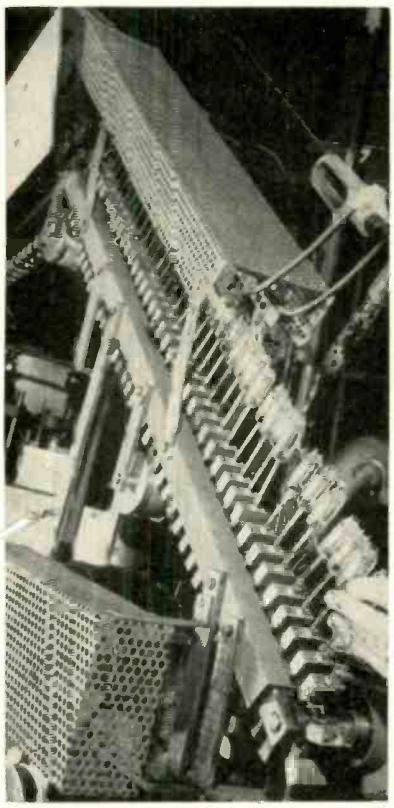
Using turret press with template for punching total of 147 holes of 17 different sizes in chassis blank for distortion analyzer. All holes made with one punch are tied together with colored lines on template, coded to color keys over punches in press master template can be made in 3 minutes simply by plugging up the old holes and punching new ones. At present, some 75 different templates are in active use.

Broken-Back Preheater for Tube Sealers

HIGHER production rates are obtained in sealing radio tube mounts by replacing the slower circular preheater with a new conveyorized oven developed in the New York City Radio Tube Division headquarters of Sylvania Electric Products, Inc. The conveyor has a rather sharp bend in the middle to conserve space, and from this comes



New preheating conveyor, with sealing machine in background



Method of loading tubes on conveyor upside down the descriptive broken-back terminology.

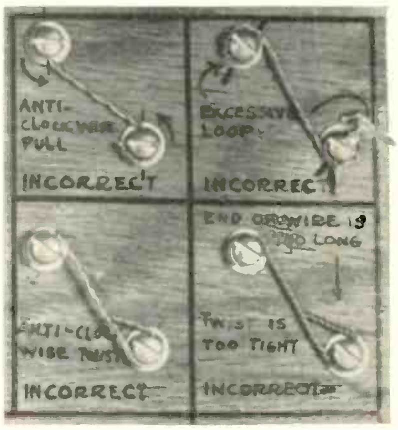
The conveyor operator places tube mounts in bulbs upside down and inserts the pump-off tubulation in a block which is bolted to the bicycle chain that serves as the conveyor. This chain transports each tube assembly through the preheater, which uses an electric heating element.

The output end of the conveyor is only about 4 inches from the right hand of the sealing machine operator. He takes the preheated envelopes off the conveyor and inserts them into his bulb sealing machine.

Display Board Teaches Safety Wiring Techniques

A MODEL safety wiring board, designed primarily to prevent mechanical failures on airborne radar antennas because of dislodged screws, has been developed by Dalmo Victor Co., San Carlos, California.

The unit illustrates common wiring and break-out faults as well as the correct method of providing a locking action for the screws. It



Examples of incorrect wiring on board

also designates the correct gage wire to be used on screws of varying sizes.

The boards were designed by Peter Chang, assemblyman, and have been installed throughout the company's assembly areas. They are proving an excellent aid in training new personnel.

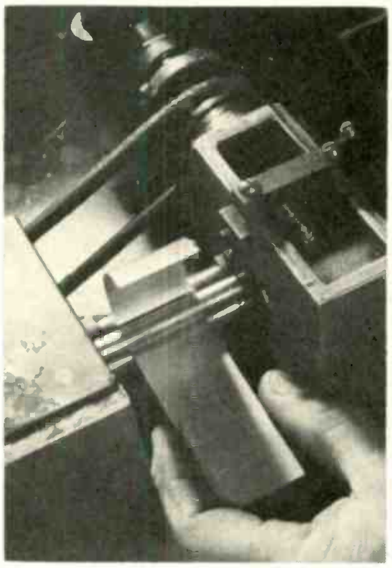
Machining Contact Fingers for UHF Cavities

FABRICATION TIME on ultrahigh-frequency contacts was cut by 80 percent and a better product obtained through development of an ingenious machining operation by Hewlett-Packard, Palo Alto, Calif.

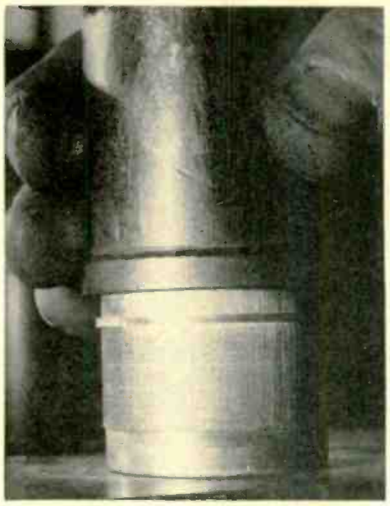
Formerly it had been customary to hog the contact out of a solid slug of beryllium copper. This procedure resulted in only a reasonably satisfactory contact; fabrication cost was high and life expectancy short.

In the search for a better product, production engineers first bonded a solid silver overlay to the ends of the contact fingers to lengthen the life of the contacts. While this gave excellent performance, fabrication costs were still high.

After long study, a completely different fabrication process was



Beryllium copper strip 0.006 in. thick and 1½ in. wide is formed into cylinder on rolling mill. Forming strip into cylinder makes the shape rigid, permits edging with silver ring. Silver wire could not be soldered to flat strip of this material without buckling



Silver ring is sized on mandrel as is shown here, before being placed on cylinder. Silver overlay bonded on ends of contact fingers lengthens life of contacts, gives excellent performance

Brass ring is slipped inside of cylinder and first silver ring is placed on outside. Workman places brass ring to aid in brazing operation. In the oven the asbestos pad retards the melt of the bottom ring. Placing the ring slightly closer to top than to bottom draws heat away from top, evens the melt

worked out. Instead of hogging out a solid slug, the process now starts with a strip of beryllium copper sheet. This is rolled into a cylinder and a silver ring slipped over each end. The rings are then brazed to the sheet in a furnace.

After brazing, the rings are cut at the joint in the cylinder and reopened to a flat strip. Fingers are formed from the strips by grouping eight strips in a packing fixture and slotting the whole pack with a saw

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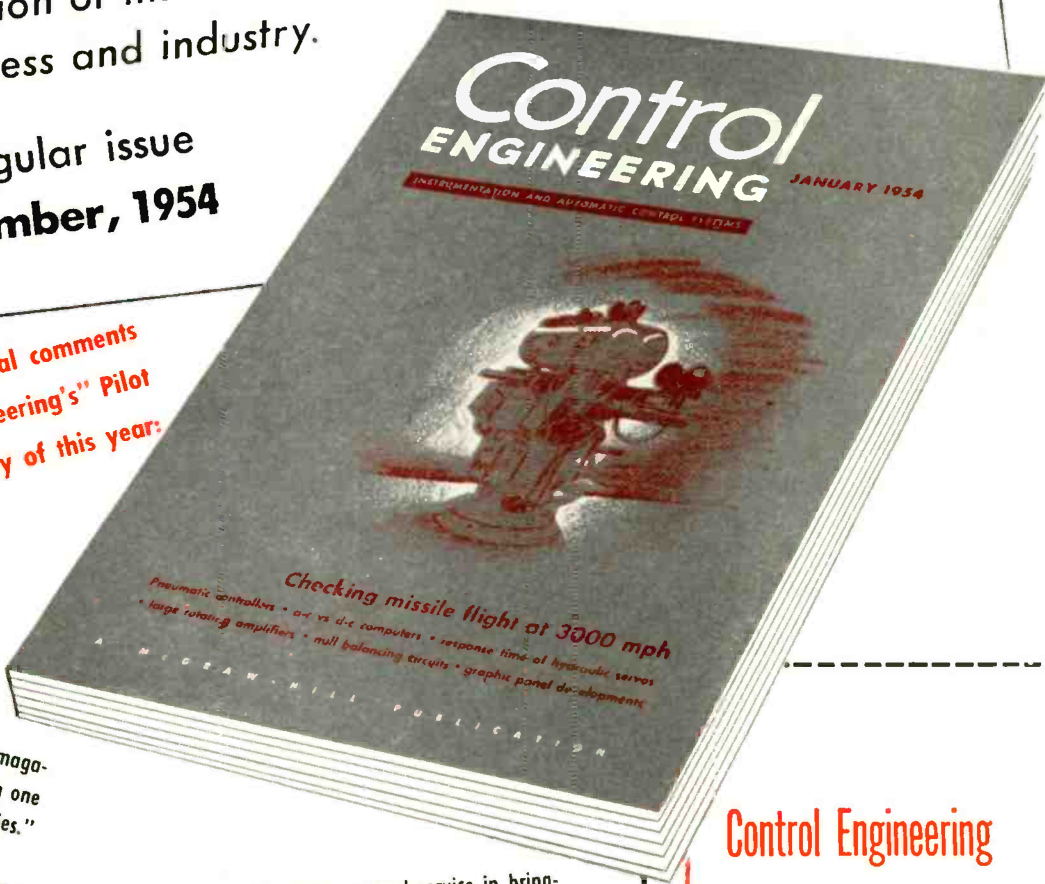
a new magazine devoted to the design and application of instrumentation and control systems in business and industry.

first regular issue
September, 1954



Here are some of the typical comments received on "Control Engineering's" Pilot Issue published in January of this year:

"You have produced an excellent magazine that should be well received in one of America's fastest growing industries."
Instruments Engineer
Textile Manufacturing Company

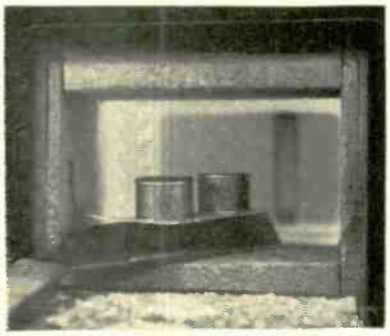
"Control Engineering will perform a good service in bringing all the instrument advertising together under one cover."
Engineer
Manufacturer of Chemical Machinery

"Control Engineering will be useful to those who make and use instrumentation."
Production Manager
Instrument Manufacturing Company

"Control Engineering fills a need and we would most certainly be a subscriber."
Director of Research
Paint Manufacturing Company

Control Engineering
330 West 42nd Street
New York 36, New York

Cylinders are coated with flux and silver rings and silver solder wire positioned on either end

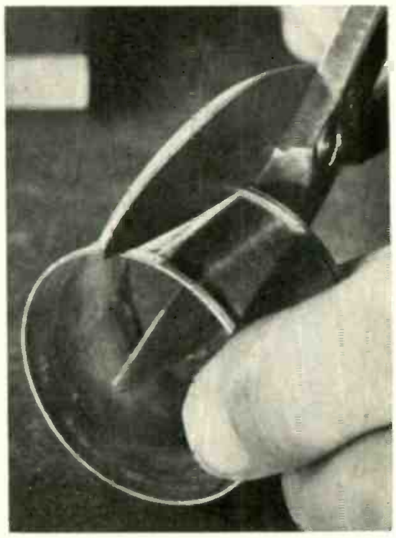


Assembled rings are brazed about 60 sec in an oven heated to 1,450 F, then quenched

Brass ring is knocked out with series of short, sharp blows. This is a critical operation: the annealed copper crumples if hit too hard

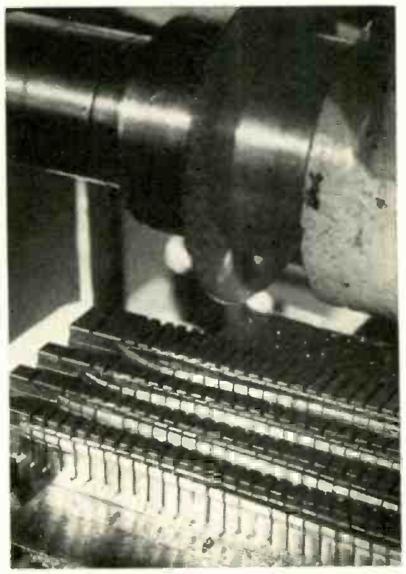
attachment rigged on a horizontal mill, first on one edge, then the other. Afterward, each strip is put through a special roller that gives the necessary set to the fingers to insure good contact.

The contact itself is formed by

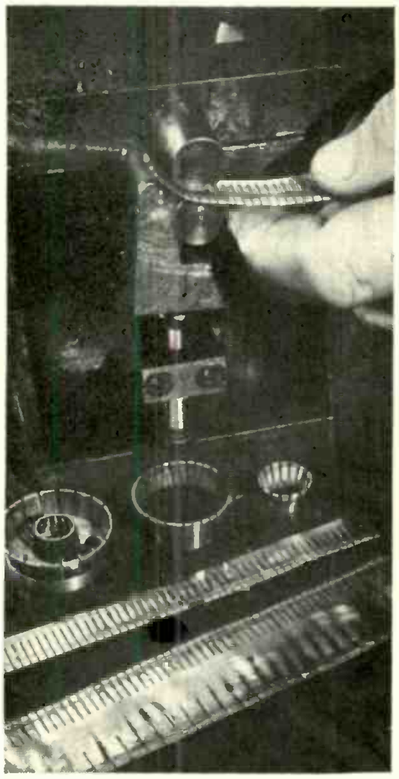


Silver rings are cut at unjoined seam of copper strip with tin snips

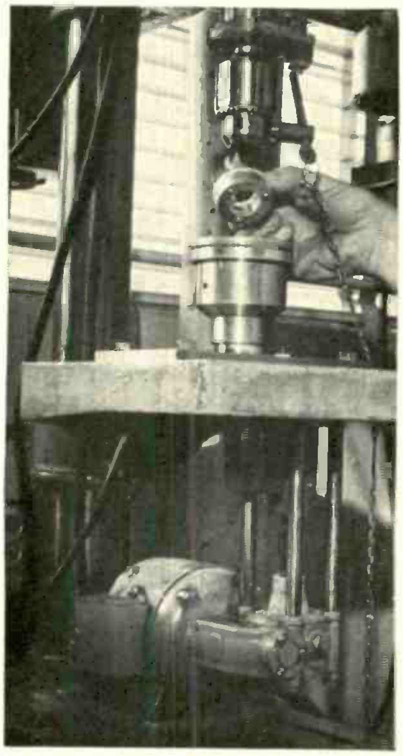
Silver rings are rolled flat with solid metal rolling pin



Eight of the strips are grouped together, two by two, in a packing fixture. The whole pack is slotted top and bottom by a saw attachment rigged on a horizontal mill



Each strip is cut longitudinally, then trimmed to size and put through another roller to shape it for assembly into a simple brass ring. Various types of contacts are made from the basic strips after this cutting operation



A conventional Delta drill press was adapted to lap inner and outer surfaces of contact fingers with simultaneous rotary and up-and-down motion. Reciprocating unit below table gives oscillatory up-and-down motion to specially fabricated carborundum wheel

Lapping operation takes about 10 minutes on modified drill press

assembling each strip into a simple brass ring, and placing this assembly in a furnace to harden the fingers for proper spring action.

The strip is then soldered to the brass ring and the contact lapped inside and out to achieve proper surface contour for the silver overlay contacts.

An adapted drill press does a double lapping job, finishing the inner and outer surfaces of the contact fingers with a simultaneous rotary and up-and-down motion. A drill press chuck holds the contact for the rotary motion; an oscillatory up-and-down motion of the specially fabricated lapping stone is obtained by addition of a reciprocating mechanism.

The lapping operation takes about 10 minutes, with the drill press rotating 5 minutes clockwise and 5 minutes counter-clockwise.

Previously the lapping was done by hand, using Bon Ami as a cutting compound. The operation was time-consuming—15 to 20 minutes —and wasteful, since the delicate fingers could easily be damaged by even a highly skilled worker.

Contacting-type shorts have been used in many instruments that operate at high frequencies. These shorts have been found superior to the choke types in general use, especially in broadband equipment. The contacting short can be designed to be effective with a high vswr and no resonances over wide frequency ranges. Further, life tests of 100,000 cycles show no significant wear. In contrast, the choke type plunger must often be designed with very close tolerances, and when used with extruded waveguide sections these tolerances usually become meaningless.

Two-Contact Test Prod for Germanium Diodes

CONNECTIONS to both leads of a germanium diode are made simultaneously with a simple test prod improvised by the test department of Amperex Electronic Corp., Hicksville, N. Y. The two test leads are taped to opposite sides of a half-inch wood dowel rod. Metal

Details of improvised two-contact test prod for diodes

Setup for checking diodes that are still in their corrugated shipping tray

clips soldered to the ends of the leads are spaced apart the exact length of Amperex type 1N38A germanium diodes, so that the operator merely needs to press the prod over a diode to make both connections. Characteristics are then read on a GE germanium diode checker.

Driving Trimmer Screws in Printed I-F Transformers

DRIVING of self-tapping screws for mounting trimmer-disc heads is combined with rough adjustment to inductance through use of an air-powered screwdriver and an air-actuated combination vise and jig in one plant. The setup speeds assembly of etched i-f components for television receivers.

The operator places a strip in the fixture with the etched coils facing upward. Next, she places an insulating washer in position over the plate coil and operates a foot pedal to close the vise over the strip. This brings steel plates inward to meet and form two holes into which the operator inserts the self-tapping trimmer screws. She then uses a Keller Tool Co. air driver for running these screws into punched holes in the plastic strip until the trimmer discs are stopped by the steel positioning blades of the vise. Another push of the foot pedal retracts the vise jaws so that the part can be removed to complete the operation.

The coil strip is next inserted in

Using air driver and depth-controlling vise jaws to speed assembly of etched i-f coil strips

Method of inserting strip in shield can

its drawn aluminum can, which has length-wise grooves that position and grip the strip so no fasteners are needed.

Combination grounding and mounting lugs are staked to opposite sides of the shield cans when the components are to be assembled into a video i-f strip by dip soldering. These lugs fit into punched slots in the etched i-f circuit strip, in such a way that dip soldering of the entire panel solders the lugs to the etched wiring for simultaneous mounting and grounding.

Tube Inspection Program for Airborne Equipment

By B. A. KLEINHOFER
Supervisor, Electronic Engineering North American Aviation, Inc. Downey, California

AN ELECTRON-TUBE inspection program instituted in November 1951 has given greater assurance that nondefective tubes would be used in the airborne navigation and control equipment in various phases of development and production.

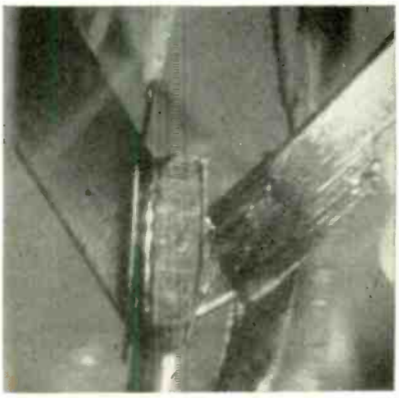
Microscopic inspection revealed melted band supporting tube elements along with tag remnant of unsuccessful attempt to weld band to stake. Such fragments are allowable only if firmly anchored and adequately clear of other electrodes

Incoming electron-tubes are approved on a sampling basis. There must be lot approval and acceptance by the sampling techniques for the military to be assured that average overall quality is maintained; however, little is indicated about individual tubes. A certain percentage of inoperable tubes is therefore accepted.

When these inoperatives are economically rejected from the lot so as not to be stocked and installed in developmental or production equipment, valuable developmental and production-test time is saved. There are also other tubes in the lot which are believed to be potentially defective and should be omitted from airborne installations.

The approach to the problem of

establishing appropriate inspection tests has been to study tube designs and procurement specifications, note departures from intended design or assembly and evaluate the effect of these departures on the reliability of tubes. To date, about 33,000 low-power receiving and transmitting tubes have been inspected by microscopic, polariscopic



Microscopic inspection here reveals possible poor bond between tungsten heater wire and the nickel alloy strap and copper lead. Normally, the tungsten is embedded in the other element by electrode pressure; absence of such deformation can mean that the wire is only lightly stuck and may come loose with vibration

and radiographic techniques.

An adjunct to microscopic inspection is x-ray inspection. The tubes are x-rayed in two positions, with the element supports parallel and perpendicular respectively to the plane of the film.

To obtain maximum radiographic definition and contrast, experimentation is required to determine the material, if any, that is permissible between the tube to be x-rayed and the unexposed film, the distance between the x-ray source and the tube, the focal spot size of the anode, the anode voltage, the exposure time in milliampere-seconds, and the types of film and developer. Experimentation shows that there are only about twelve basic sets of settings for x-raying more than a hundred types of tubes.

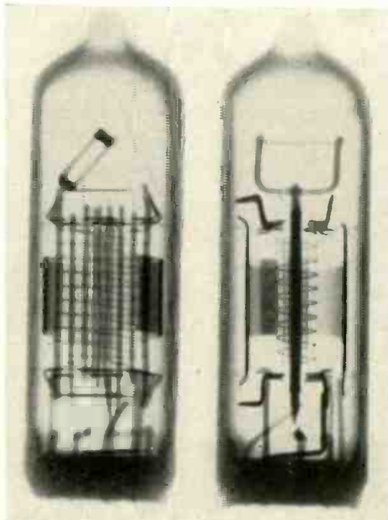
Since the MIL-E-1B ice water test is inconvenient for testing all tubes, polariscopic examination was preferred and is believed to provide adequate protection (RETMA report, March 1951, "A Method for Measuring Strain in Side Walls of

Microscopic inspection here indicated that excessive welding heat formed support rod into a tear drop, impairing tube reliability

Glass Bulbs and Completed Tubes"). Values for allowable stress are determined empirically from laboratory breakage tests.

Tubes are color-coded with a blue tip when they meet all inspection criteria, and with a yellow tip when they have assembly irregularities. Percentage rejection rates for the various examinations are: microscope 17 percent; x-ray 17 percent; polariscope 4 percent; vibration 2 percent; electrical 8 percent. Many tubes exhibit several irregularities, hence the yield of tubes coded blue is 66 percent and yellow 26 percent.

Tubes coded blue are reserved for critical installations. Tubes coded yellow are for use in controlled tests, in noncritical installations, at the discretion of the project engineers



Typical x-ray inspection slides obtained for a good subminiature tube and in laboratory equipment development where shock and vibration are not problems.

As quality is improving and as more and more premium-type tubes are being received, the yield of flawless tubes by the inspection is increasing. During December, 1953, for example, the yield of flawless tubes for critical installations was 77 percent (for 6,600) as compared with 66 percent for the total 33,000 tubes. For subminiature tubes of one manufacturer, for the same month, the yield was 87 percent. Further improvement in yield is expected with the new military-control miniature types which are now just in production.

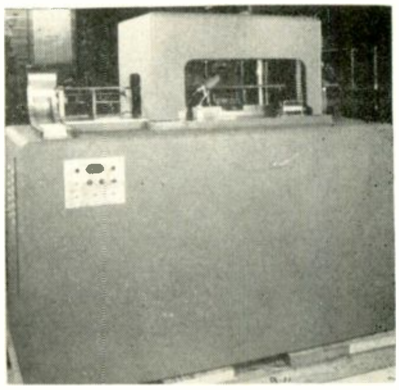
The inspection does not constitute selection in the sense to which the armed services are opposed, for the use of the more rigidly inspected tubes in no way compromises the ability to replace field failures with standard military-approved tubes from stock without selection. The undesirable type of selection-inspection arises from unusual circuit requirements and is not included in the program.

Metal Embossing Machine Makes Identification Tags

EMBOSSED aluminum alloy tags for identifying components are produced at the rate of 90 per minute by a new Databosser model V100 DBM made by Dashew Business Machines, Inc., 1641 McGarry Street, Los Angeles 21, California.

Additional operations that can be

Applying wired embossed tags to electrolytic capacitors that are to be used in electronic control relay panels like those shown in the background. Other tags are used to identify the panel itself



Tag-embossing machine. Blank tags are fed into machine at right and emerge in hopper tray at left

performed simultaneously with embossing include threading and twisting of wires into the tag holes, inking the embossed printing to increase readability and matching of the tags for special classification and coding purposes. An example of the use of the wired tags is identifying the parts for an electronic control relay panel in the stockroom and during assembly at Century Manufacturing Co., Los Angeles, Calif.

Room can be left on the embossed tags for later addition of inspection and quality control markings. These are applied with a fountain-type pen having a felt tip and containing an inky-black quick-drying chemical fluid.

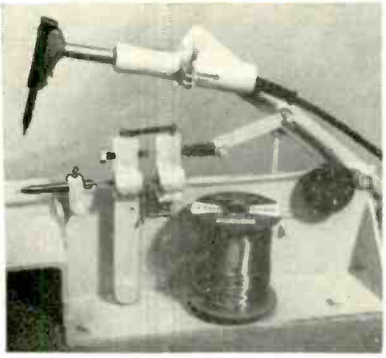
Once a tag is attached, it accompanies the part through all assembly and processing operations, including chemical cleaning baths. These have no effect on the ink markings or on the special 916 aluminum alloy used for the tag. The edges of each tag are automatically beveled by the machine to eliminate sharp points that might scratch people or parts.

The machine embosses with either repetitive or serial part numbers. The finished tags are deposited in a receiving tray ready for use.

Automatic Solderer

REPETITIVE SOLDERING processes of small parts can be performed at high speed on a new Multicore automatic soldering head made by Multicore Solders Ltd., Maylands Ave., Hemel Hempstead, Hertfordshire, England.

Rosin-core solder drawn from a

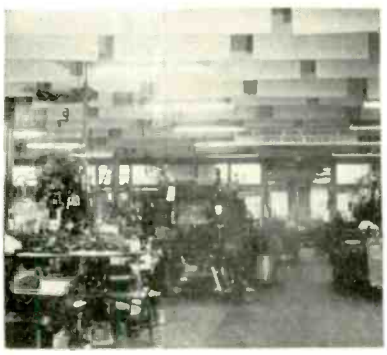


Automatic solderer. Each downward movement of soldering iron actuates solder feed through linkages. Amount of feed is determined by horizontal bolt which serves as stop for feed plunger

7-lb reel is automatically fed above the components to be soldered and an electrically heated iron automatically descends and solders the components held together on the anvil The machine will accommodate various diameters of solder. The amount of solder fed per operation is adjustable between $\frac{1}{32}$ inch and $\frac{3}{8}$ inch. One model of the machine is supplied without motive power, so that it can be linked with an existing manufacturing process. Another is supplied complete with a bench and a foot-operating pedal, while the third model is a motorized version which will make joints at the rate of up to 3,000 per hour.

Hanging Baffles Reduce Punch Press Noise

THE NOISE AND CLAMOR of machinery used in the plant of John Volkert Metal Stampings, Inc., Queens Village, N. Y. for producing precision metal stampings for the electronics industry has been reduced approximately 50 percent by installation of Fiberglas noise-stop baffles. These are rigid fibrous



Method of installing ceiling baffles

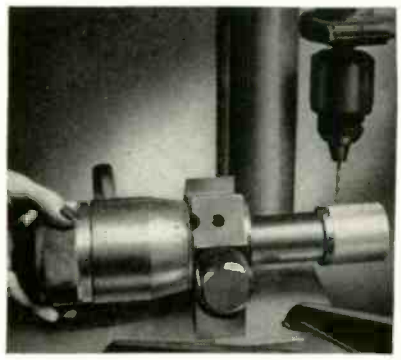
glass boards that hang vertically from ceilings.

In a 5,000-square-foot area, 320 baffles were installed by the Industrial Acoustics Company, Inc., New York, N. Y.

The baffles, manufactured by Owens-Corning Fiberglas Corp., Toledo, Ohio, are 24 by 48 inches in area and one inch thick. They are designed primarily to be hung in factory areas where overhead obstructions prevent the installation of a conventional accoustical ceiling. The baffles are covered with a thin plastic film which transmits sound waves by diaphragmatic action into the tiny, dead air pockets between the fibers of glass. They are noncombustible, washable, moisture-resistant, light in weight and may be painted without lowering the sound-absorbing efficiency.

Drilling Holes for Taps in Precision Potentiometers

A SPECIAL TOOL developed by Helipot Corp., South Pasadena, California, is used in the standard manufacturing process to drill holes for taps in the housings of multiturn precision potentiometers. The hous-



Setup for precision drilling of holes in cylindrical plastic housing of precision potentiometer for computers

ing is mounted in a predetermined position on the armature of the giant vernier fixture. It is then possible, by rotating the barrel of the vernier, to attain great accuracy in drilling tap holes according to specification, as the equipment provides a direct reading of the helical turn in which the hole will be drilled, as well as the angular degrees on the particular turn.

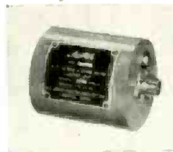
NEW

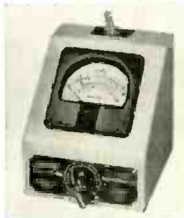
MicroMatch

MEASURES RF POWER AND VSWR IN FREQUENCY RANGE OF 0.5 TO 225 MCS. 0 TO 1 KW.

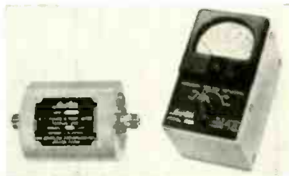
Compact, sensitive and accurate, the MicroMatch 260 Series monitors both incident and reflected power without the necessity of removing the coupler or reversing its connections. Three models are available to meet requirements of transmitter manufacturers and radio amateurs.

MODEL 261 Coupler ONLY, provides VSWR and relative power measurement when used with #261 coupler $14.50





MODEL 262 Indicator ONLY, provides VSWR and relative power measurements when used with #261 coupler. $14.50



MODEL 263 Laboratory type complete coupler and indicator. Coupler equipped with N connectors. Indicator provided with 3 scales calibrated in watts, 0 - 10, 100, 1000. ....$85.00

M. C. JONES ELECTRONICS CO. Inc.
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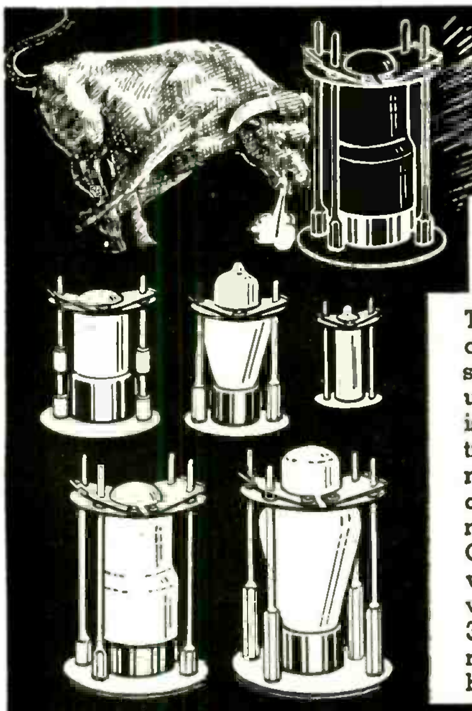

SHOCK PROOF

VACUUM TUBE RETAINERS

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T122DI, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

Manufacturers of Electronic Components

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Plan *now* to take full advantage of *Metex Electronic Weatherstripping's* unusual effectiveness in shielding all types of electronic equipment. Because it is made of *knitted* wire mesh, *Metex Electronic Weatherstripping* is both conductive and resilient. It assures positive metal-to-metal contact between all mating surfaces. And being resilient it accommodates itself positively to surface inequalities.

In reality, *Metex Electronic Weatherstripping* can do more for you than just shield RF leakage. It can cut the cost of machining mating surfaces to close tolerances. It can eliminate the need for extra fasteners and many other costly means of making joints RF tight.

Applications in which *Metex Electronic Weatherstripping* has already proved its effectiveness include pulse modulator shields, wave-guide choke-flange gaskets, local oscillators on TV sets, dielectric heaters, etc.

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METAL TEXTILE CORPORATION
ROSELLE, NEW JERSEY

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

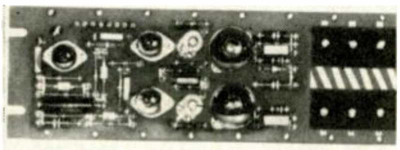
52 New Products and 56 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

OTHER DEPARTMENTS featured in this issue:

DEFLECTION YOKES for radar systems

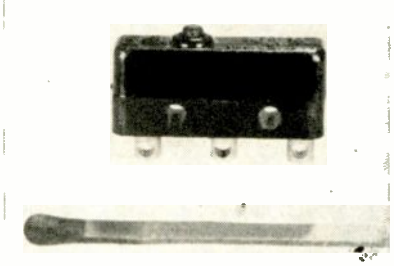
CONSTANTINE ENGINEERING LABORATORIES, Mahwah, N. J. High precision radar deflection yokes now in manufacture include rotating and stationary types for ppi and rectangular displays. High performance core materials such as mu-metal and Molly Permalloy are used. Specifications also include a wide range of inductances using complex winding distributions with h-v insulations. High efficiency, superior linearity and perpendicularity with low distributed capacitance are the outstanding features of the new deflection yokes.

SHIFT REGISTERS operate at 125 kc



MAGNETICS RESEARCH CO., 142 King St., Chappaqua, N. Y. Four new models of magnetic shift registers have been designed for computer and other electronic system applications. They require only normal power supply voltages and a source of clock pulses in addition to the input information. Information rates of 125 kc may be handled. Each shift register contains 20 plug-in magnetic core elements (a portion of which is illustrated) arranged to store 10 bits of information. Since the output of one unit provides directly the input to another unit, these registers may be ganged serially to provide as large a binary storage system as may be required. Units may also be operated in parallel from the same timing source to provide storage for coded decimal numbers. Use is made of both printed wiring and conventional component board construction so as to insure maximum reliability, simplicity and serviceability.

TINY BASIC SWITCH resists shock or vibration

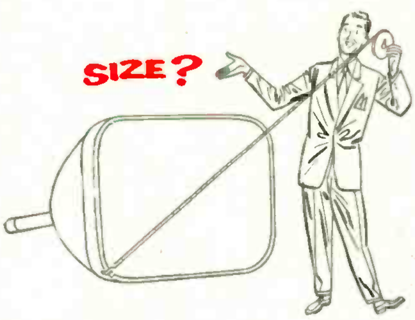


ELECTRO-SNAP SWITCH & MFG. CO., 4217-30 West Lake St., Chicago 24, Ill., has available a subminiature basic switch for use on electronic equipment, guided missiles, rocket launchers and many other military and commercial applications. A patented snap-action S-type spring compression member that equalizes the stress on the switch springs prevents early fatigue commonly caused by concentrated stress on only one part of the spring. Snap-of the speed of actuation. This switch has no dead center and is resistive to shock or vibration. Three standard actuators are available: toggle, pushbutton and leaf-spring. Switches are available normally closed spst, normally open spst or spdt.

GENERATOR produces color test signal

RADIO CORP. OF AMERICA, Camden, N. J., has developed inexpensive equipment for use in tv stations to expedite installation and performance checks of color tv receivers in homes while black-and-white programs are on the air. Use of the

Now Sylvania offers a full line!

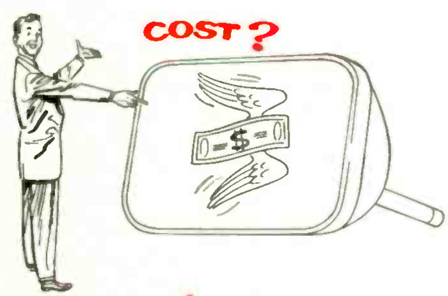


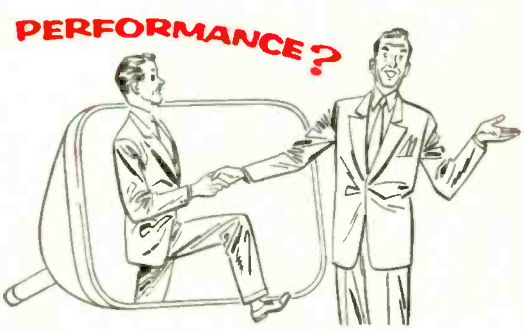
TODAY, because of greatly increased facilities and improved manufacturing techniques, Sylvania is in a position to offer you perfect answers to your aluminized picture tube problems.

And, much more than your physical spec requirements, Sylvania Aluminized Tubes also offer the finest *performance!* These tubes give whiter whites and blacker blacks . . . a 6-times better picture contrast.

This means Sylvania's new aluminized tubes make your sets stand out ahead of competition. The improvement is obvious . . . and immediate. And the low prices will amaze you!

For the full story concerning Sylvania's complete aluminized tube line, and how they can help your future sales, write a note on your letterhead to Dept. 4R-1607 at Sylvania TODAY!





SYLVANIA

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

In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, St. Catherine Street, Montreal, P. Q.

LIGHTING · RADIO · ELECTRONICS · TELEVISION

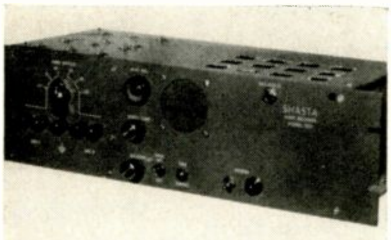
equipment by tv stations will enable service technicians to check color set reception during normal servicing hours, without waiting for color signals which may not be available on a scheduled basis at convenient times. It helps furnish a complete system check from station transmitter to home receiver. It makes possible checking such phases as the air patch from the station transmitter to the home, proper orientation of the roof-top antenna, and whether the transmission line from antenna to receiver is capable of carrying a color signal. The color test signal is a narrow vertical yellow-green bar which is visible at the extreme edge of color receivers but is practically unnoticeable on black-and-white sets.

UNIT PULSER
has varied applications

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Continuously adjustable pulse durations from 0.2 μsec to 60,000 μsec are available from the type 1217-A unit pulser. It is powered by the type 1203-A unit power supply to which it is easily attached. A self-contained oscillator drives the output at 12 fixed frequencies from 30 cycles to 100 kc, and provision is made for external triggering at any frequency below 100 kc. Pulse rise

time is less than 0.05 μsec; and fall time, about 0.15 μsec. The open-circuit output voltage is 20 v for pulses of either polarity. Internal output impedance is about 200 ohms for positive pulses and 1,500 ohms for negative pulses. The 1217-A can approximate all three basic pulse-source waveforms: impulse, step function and periodically repeated pulse of adjustable duration. Typical of its many applications are: square-wave testing of audio systems; gate or time-delay generator in testing computer systems; checking overall transient response of tv video system; and laboratory experiments in transient analysis.

WWV RECEIVER
is crystal controlled



SHASTA DIVISION, Beckman Instruments Inc., P. O. Box 296, Richmond, Calif. Model 1201 WWV receiver is crystal controlled, having six bands at 2.5, 5, 10, 15, 20 and 25 mc, selectable by panel switch. The circuit features dual conversion and narrow-band i-f stages for maximum selectivity and image rejection. Four i-f stages insure adequate sensitivity for good reception under the most difficult conditions. A cathode-coupled crystal oscillator circuit is utilized having fine tuning control for the 6 plug-in crystals. The instrument is expected to find wide application in laboratories engaged in work requiring precise measurements of r-f or audio frequencies, or time signals provided by station WWV.

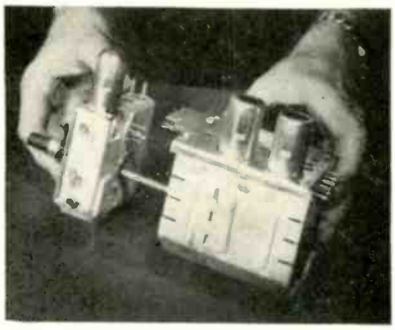
TAPE RECORDER
is professional and portable

AMPEX CORP., 934 Charter St., Redwood City, Calif. Model 600 tape recorder embodies professional recording standards in a truly portable unit. It weighs only 28 lb, and measures 16 in. × 14 in. and is 8 in. thick. Frequency response is 30 to 15,000 cycles at 7½ ips; signal-to-noise ratio, over 55 db; and every machine is tested to meet or exceed specifications. Among the features of the recorder is a built-in mixer that will enable a user to record from a microphone at the same time he is recording from a radio or

record changer. The new unit will find wide usage among broadcast stations, recording studios, schools and home users interested in fine musical reproduction. Price is $545.

UHF-VHF TUNER
combines two separate units

SARKES TARZIAN, INC., 539 S. Walnut, Bloomington, Ind., announces a, compact, tv tuner, the UV-13, covering the full uhf and vhf bands. It is actually two separate tuners mounted coaxially and plugged together to make a single, compact



unit no larger than the standard vhf tuner. Logical straight line electrical sequence of compartmented circuits is the basic design feature. This eliminates regeneration, pickup of spurious signals and other undesired effects due to stray capacitances and inductances. The two units combined measure 3 5/16 in. wide × 3 17/64 in. high × 4 3/4 in. deep. Tube height above the chassis may be kept to 1 7/16 in. The complete tuner consists of a cascode vhf tuner and a capacitance-tuned, resonant coaxial cavity, uhf tuner. Installation consists of slipping one over the shaft of the other, tightening two screws and attaching the proper knobs. Other features include 41-mc single superhet conversion and many circuit stabilizing features such as Invar temperature compensation and gain stabilization. The tuner is suited for use as original equipment in both color and monochrome sets and as a replacement unit for older sets.

POWER SUPPLY
is frequency stabilized

MARYLAND ELECTRONIC MFG. CORP., College Park, Md., announces production of the model ME/PP-11, a 200-w frequency stabilized power supply. It is designed to provide a stable 60-cps 115 or 230-v source to

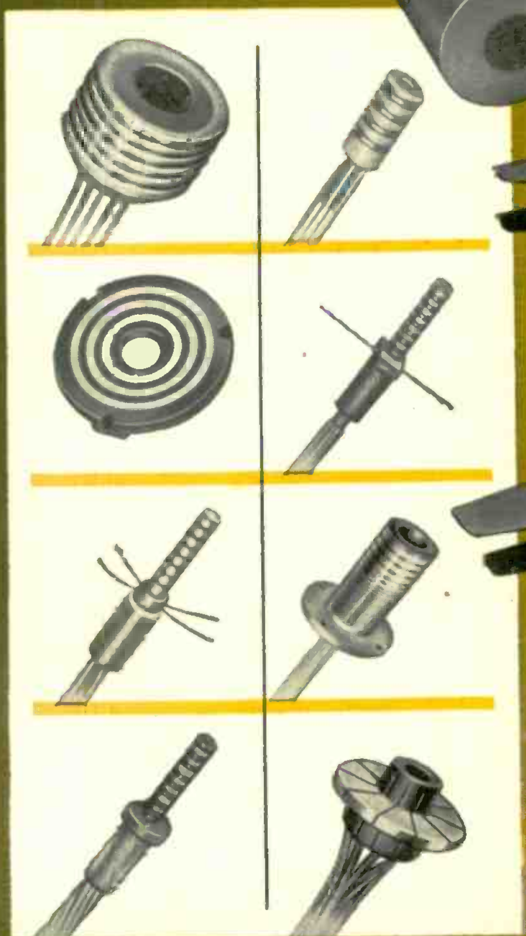
INSTRUMENT CORPORATION OF AMERICA

slip ring & commutator assemblies

One-piece construction* assures high accuracy and super-dependability to the most rigid specifications.

Specify Instrument Corporation of America Slip Ring and Commutator Assemblies for closer tolerances, absolute uniformity and the ultimate in miniaturization. Wherever extreme dimensional precision, accurate concentricity and high dielectric qualities, are required, Instrument Corporation of America assemblies are specified with confidence. One-piece, unitized construction eliminates dimensional variation due to accumulated errors, provides jewel-like finish, uniform ring hardness and reduced weight. Engineering "know-how" resulting from years of specialization and continuous collaboration with leading manufacturers all over the world is at your immediate service.

Proven for performance in precision instruments and equipment including SYNCHROS, GYROS, RADAR, FIRE CONTROL, TEST TABLES and other CRITICAL APPLICATIONS



TYPICAL SPECIFICATIONS

- SIZES: .035" to 24" Diameter, Cylindrical or Flat
- CROSS-SECTIONS: Ring Thickness .005" to .060" or More
- FINISH: 4 Micro-Inches or Better
- BREAKDOWN: 1000 V or More Hi-Pot Inter-Circuit
- RING HARDNESS: 75 to 90 Brinell
- SURFACE PROTECTION Palladium and Rhodium, or Gold Prevent Tarnish, Minimize Wear & Noise

INSTRUMENT CORPORATION OF AMERICA

BLACKSBURG · VIRGINIA

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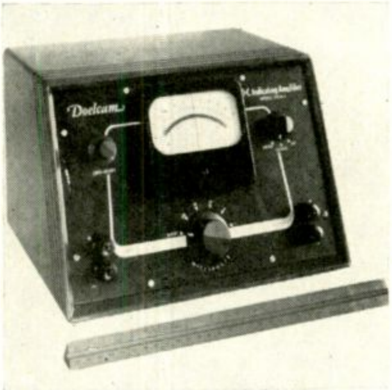
operate frequency-critical devices requiring up to 200 w in areas where the line frequency is not dependable. It consists of three units—a h-v power supply, a 60-cps generator and a 60-cps amplifier. Input frequency range is from 50 to 70 cps; input voltage, 115 v; input power, 850 w. Output frequency may be accurately adjusted anywhere in the range of 55 to 65 cps at either 115 or 230 v. Output impedance is 265 ohms across 230-v output taps, 66 ohms across 115-v output taps. The equipment (three chassis) is contained in a 42 1/16 in. high cabinet.

D-C/A-C CHOPPERS in twenty-two models

STEVENS-ARNOLD, INC., 22 Elkins St., Boston, Mass., announces a completely redesigned line of 60-cycle d-c/a-c choppers for low-level operation at noise levels under 1 μv. Twenty-two models are now available for use as modulators, demodulators or square-wave generators. They are offered for both single-pole and double-pole application in computers, business machines, recording potentiometers, servomechanisms, regulated power supplies and microvolt meters.

D-C AMPLIFIER features magnetic converter

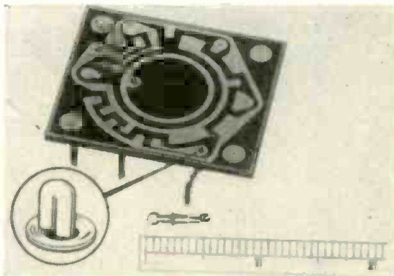
DOELCAM CORP., 1400 Soldiers Field Road, Boston 35, Mass., has released a commercial-type percision instrument that can measure signals as low as 2×10^{-15} w. The 2HLA-3 d-c indicating amplifier incorporates the new principle of the second-



harmonic magnetic converter in the input stage of the instrument. This converter (first of four stages) overcomes limitations such as wear, fatigue, stickiness and other inherent difficulties that often cause failures, sporadic disturbances and shorter life. The second-harmonic magnetic converter replaces the mechanical converter and eliminates all moving parts. In the second stage a very high gain voltage amplifier magnifies the a-c signal received from the converter. The demodulator in the third stage then changes the amplified a-c signal to d-c. At the fourth stage a power amplifier greatly increases the power output to the meter on the face of the instrument or to the output terminals where sufficient power is supplied to drive an inking recorder or a control device. A self-contained power supply furnishes energy to the voltage amplifier, power amplifier and oscillator.

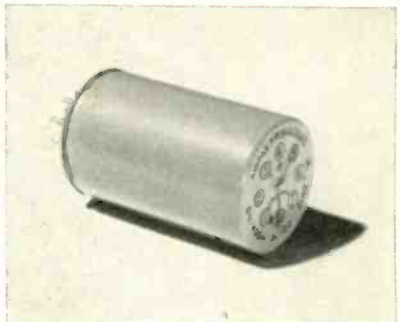
VHF RECEIVER
covers 50 to 200-mc range

SERVO CORP. OF AMERICA, New Hyde Park, N. Y. Model SS50-200 vhf receiver, for a-m and f-m in the 50 to 200-mc range, is ideal for general communication, laboratories, f-m monitoring, direction finding, teletype and telemetering. Bandwidth is variable from 25 kc to 150 kc, power input 125 w from 115/230 v, 50/60 cycle. It features an easy reading directly-calibrated 72-in. bandspread dial.



TINY CONNECTOR is automatic locking

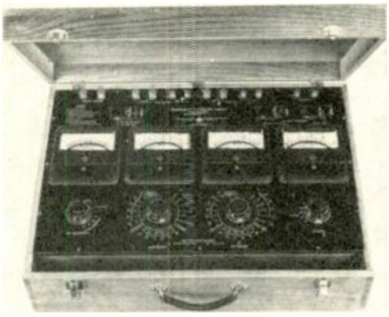
HARVEY HUBBELL, INC., Bridgeport, Conn. This subminiature connector has all the features of the Interlock line—automatic locking, quick disconnect action, vibration-proof lock and low contact resistance. Its size (slightly over ½ in. in length) makes it ideally adaptable for printed circuit use. Illustration shows its application to a rotary switch plate circuit, manufactured by Photocircuits, Inc., of Glen Cove, N. Y. Note how the wired plugs enter through set-in eyelets and lock automatically (inset shows contact magnified). Plug can easily be disconnected, yet never disconnects accidentally.



CHOPPER is hermetically sealed

AIRPAX PRODUCTS CO., Middle River, Baltimore 20, Md., announces the model A-100, a chopper capable of continuous operation in an ambient temperature as high as 200 C. Hermetic sealing is obtained by the use of silver-lead solders and class

C materials are used internally. The chopper will also operate successfully at −70 C, for a total operating range of 270 C. The unit is a 400-cycle, 6.3-v break-before-make chopper, having a nominal phase angle of 65 deg and a dwell time of 135 deg. Complete specifications will be sent upon request.

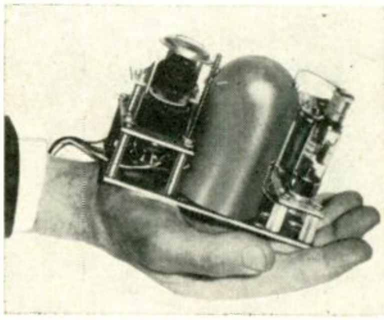


A-C TEST SET
is compact, rugged, accurate

SENSITIVE RESEARCH INSTRUMENT CORP., 9–11 Elm Ave., Mt. Vernon, N. Y. Engineers in research and development laboratories can use the Universal 60 a-c test set for measuring equipment capable of giving the complete picture of 60-cycle voltages, currents, power and power factor. The unit features a compact, rugged and accurate set of instruments that are designed to be used together. There are 4 separate instruments in the set with their necessary switches which create: 36 ranges in watts, 7 current ranges and 4 ranges in volts. All the instrument ranges are completely switch controlled. A four-page bulletin contains illustrations and full description.

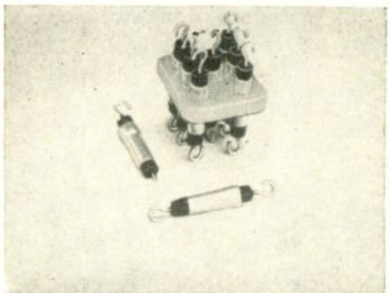
RESISTORS
for high-temperature use

EASTERN PRECISION RESISTOR CORP., 130-11 90th Ave., Richmond Hill, L. I., N. Y., has announced the Hi-Temperatures, a new line of resistors designed to withstand continuous heat up to 100 C. They are completely encased in ceramic with axial lead mounting for easy connecting. Resistance and tolerance markings can be stamped on the ceramic for added convenience. Surpassing all military specifications, the new precision wire-wound resistors are available with glass, silicone or Teflon covered wire.



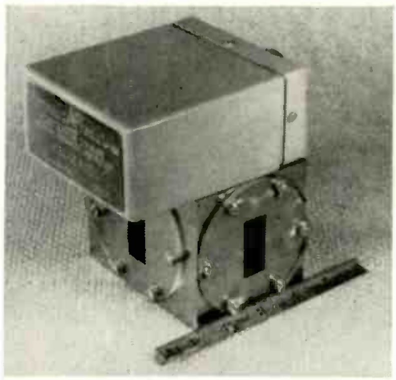
H-V POWER SUPPLY is an all-purpose unit

SERVO CORP. OF AMERICA, New Hyde Park, N. Y. Model PS503 is an efficient h-v power supply weighing only 2 lb and measuring 4 in. × 2⅝ in. × 5½ in. Input of 275 v d-c provides 5,000 v d-c at 300 μa. Lower voltage at higher current can be obtained if desired. The transformer is hermetically sealed in epoxy resin casting and operates on 30 kc. The unit is an ideal all-purpose power supply for applications where size and weight must be kept at a minimum.



RUBBER TERMINALS are hermetically sealed

ROBCO MFG. DIVISION, Pilot International Corp., 27-01 Bridge Plaza North, Long Island City, N. Y., has available new hermetic-seal feed-through rubber terminals. Formed of rubber insulated, copper-clad steel wire, excellent sealing properties are achieved by crimping a tinned copper sleeve over the rubber insulation which is chemically bonded to the wire. These terminals provide high leakage resistance, high dielectric strength and prevent metallic migration under d-c potentials. Oil leakage is prevented even under internal pressures of 30 psi. The rubber insulation also absorbs shock and vibration, affording long service life. These terminals may be mounted on $\frac{3}{16}$-in. centers with a minimum over all length of 1$\frac{5}{64}$ in.

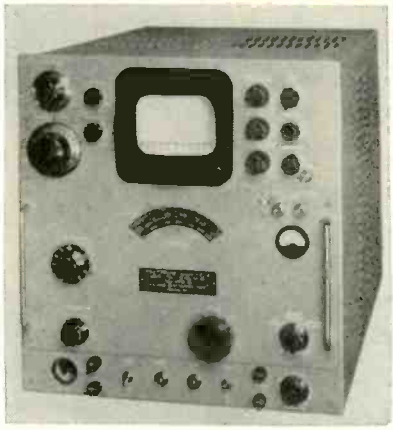


WAVEGUIDE SWITCH
is a compact unit

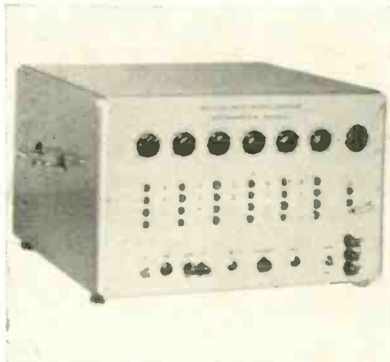
THOMPSON PRODUCTS, INC., Electronics Division, 2196 Clarkwood Road, Cleveland 3, Ohio, has available the model ASWI-X01 waveguide switch with a $\frac{3}{4}$ in. by 1$\frac{1}{2}$ in. guide size. It has the following features: vswr—1.05 to 1 maximum; crosstalk—50 db minimum; actuator—110 v, 60 cycle; actuation time—0.5 sec maximum; vswr during switching—1.2 to 1; and power handling ability — approximately 0.35 megawatt c-w.

SPECTRUM ANALYZER
covers 10 to 22,000 mc

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y., has available model TSA portable all-band spectrum analyzer, covering the range of 10 to 22,000 mc with three interchangeable r-f heads. A single dial, direct-reading, r-f tuning control allows for quick and simple selection of any frequency spectrum. A swept i-f yields constant dispersion characteristics

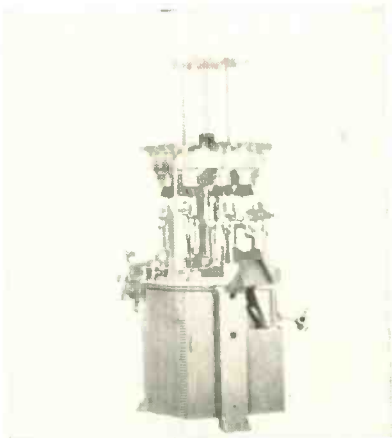


completely independent of frequency setting. Frequency dispersion from 250 kc to 25 mc may be realized with a resolution of 25 kc. An internal marker is provided to measure frequency differences up to ±12.5 mc on a 5-in. crt display, the difference figure being read directly off a calibrated control. Sensitivity is better than −80 dbm over the entire range with a built-in r-f attenuator in the tuning unit to accommodate large signals.



INTERVAL GENERATOR is mc predetermined counter

POTTER INSTRUMENT CO., INC., 115 Cutter Mill Road, Great Neck, N. Y. Model 564 preset interval generator is designed for testing and calibrating systems that rely on precise time measurements for their operation. Radar, sonar and certain types of telemetering equipment are typical examples. Time intervals and delays from 1 μsec to 1 sec may be generated or measured. In essence, the 564 is a megacycle predetermined counter with a built-in time-base oscillator that uses a temperature-controlled 1-mc crystal for long-term frequency stability. Indication is by means of neon lamps arranged to give 6-digit readings directly in microseconds. Intervals of the order of seconds are generated with better than 0.0001-percent accuracy. Manual or automatic reset may be used. A separate amplifier and shaper unit is provided for applications where an external time base source is used for simulating target delays selectable directly in feet or yards.

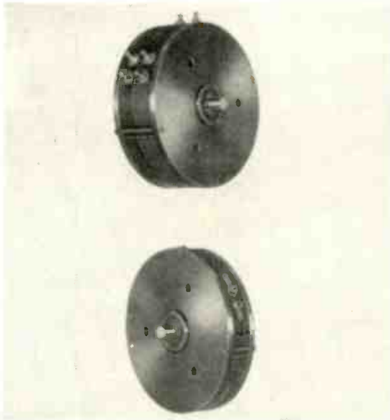


FLARE MACHINE
operates automatically

KAHLE ENGINEERING CO., 1492 Seventh St., North Bergen, N. J., has available model 2310 automatic flare machine for producing flared necks for c-r tubes. It uses standard lengths of tubing, automatically makes the flare, and cuts off to proper length. Two machines were formerly required for these operations. Cutting is by the hot-chill technique. By locking out the flaring mechanism the machine can be used as a glass tubing cutter and can produce all the cut tubing for stems, tubulations and necks used in electronic tube production. Incorporating ball-bearing construction, precision barrel cam index and forced feed oiling, the machine can operate 24 hours a day with a minimum of maintenance.

POTENTIOMETERS
are high resolution type

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. Model HP-300 is a high resolution, low torque linear potentiometer enabling extremely fine settings and



readings. A long winding length and a small diameter cylindrical Kohlrausch winding produce very high winding resolution. The HP-300 series is completely enclosed and designed for use as single or multiple ganged units. Up to 16 taps can be provided. Housings are one-piece molded of high stability Bakelite with precision turned, blue Alumilite finished end plates.

S-BAND WAVEMETER covers 2.3 to 4.5 kmc

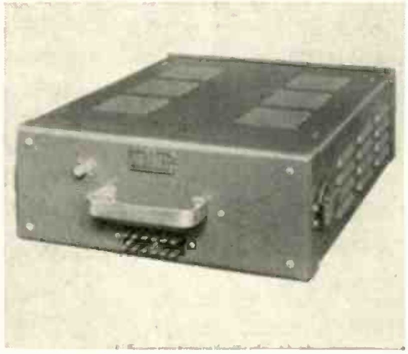
AMERAC, INC., 116 Topsfield Road, Wenham, Mass. Model 229 S-band wavemeter is a coaxial-line type instrument covering the frequency range from 2.3 to 4.5 kmc. Among its features are (1) a precision-ground lead screw that helps give a high accuracy of measurement; (2) a cavity body made from a solid block, precision-machined to close tolerances, giving extreme mechanical stability; (3) the use of Invar in the line displacement portion, affording a high frequency stability throughout the temperature range of 10 C to 40 C; (4) tri-plating of all r-f surfaces; and (5) rugged electrical and mechanical components. Type N constant impedance coaxial connectors are used for both transmission and absorption inputs. The BNC or Selectar fitting provides external video connection. Power-handling capability by absorption method is from 0.5 mw to 1 w maximum; power-handling by transmission method is from 1 mw to 25 w peak power; approximate loaded Q is 2,000; and net weight is 4¾ lb.

VTVM
is a high-impedance unit

FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Model 1060 high-impedance vtvm is especially useful when making tuned circuit measurements at audio and supersonic frequencies. It combines these features: input impedance of 50 megohms in parallel with 25-$\mu\mu$f capacitor; accuracy of 2.0 percent on all ranges, with full-wave average reading meter calibrated in rms; and frequency range, 10 cps to 30 kc. Voltage range is 0.001 v to 100 v in 5 ranges. Effect of variation in line voltage from 100 to 125 v is less than 2.0 percent, while effect in changes of tubes is less than 0.5 percent. Logarithmic voltage scale is calibrated from 1 to 10 plus a linear decibel scale calibrated from 0 to 20 db.

HIGH POWER SOURCE
is a versatile unit

COMMUNICATION MEASUREMENTS LABORATORY, INC., 350 Leland Ave., Plainfield, N. J. Model 1447 variable frequency variable phase electronic generator was developed to meet the need for a power source for use in the development and testing of 3-phase airborne electronic equipment. It consists of one model 1445 generator using one exciting phase from a model 1440 three-phase oscillator. Two model 1446 generators with single phase internal oscillators developing 4.5 kva each complete the system. The model 1447 develops 13.5 kva of power into a resistive load through a frequency range of 50 to 6,000 cycles. Any desired phase relationship can be set up as the 3 outputs of the model 1440 master oscillator have phase shift controls which are adjustable through the full 360 degrees.



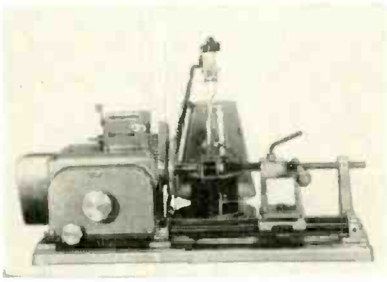
MOBILE RADIO UNIT for 450-470 mc operation

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J., has announced a complete radio system for operation in the uhf 450 to 470-mc band. The type MCA-401A system is rated at 12 w at 450 to 460 mc and 10 w at 460 to 470 mc. A high-efficiency, plug-in power chassis requires minimum primary power. A high degree of stability is maintained through the use of the latest type crystal oscillators. Economical operation is assured by use of low-cost tube types, long-life selenium rectifiers and and other components of proved service records. A special uhf antenna transfer relay improves r-f transfer efficiency. Uhf tv interference is minimized by means of a low-pass filter employed in both receiver and transmitter.

MINIATURE RELAY is hermetically sealed

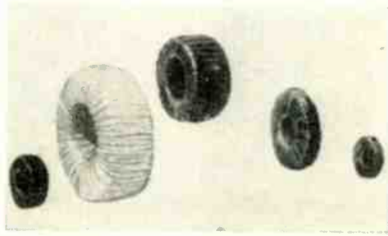
BRANSON CORP., Boonton, N. J., announces a new miniature relay for aircraft and missile application with dimensions approximating those of miniature tubes. Useful at

50 g shock and 20 g vibration up to 500 cps, the type MRH provides 2-ampere contacts in dpdt combinations. It is available for use at ambients of 85 C or up to 200 C for special purposes. All contact insulation is ceramic and glass, which makes the relay very useful in high-frequency switching applications. The type MRH occupies a volume of 0.75 cu in. and weighs 1.4 oz. Coil resistances up to 10,000 ohms are available.



BOBBIN WINDER
features adjustable cam

GEO. STEVENS MFG. CO. INC., Pulaski Rd. at Peterson, Chicago 30, Ill. Model 319-AM bobbin winder winds all types of random wound bobbin coils, solenoids, repeater coils and precision noninductive resistors from 0 to 2½ in. wide and 5½ in. outside diameter. An outstanding feature is the built-in adjustable cam. Calibrations allow instant adjustment of winding traverse to the desired winding width. Another feature is the submergence of the internal gears in a permanent oil bath, resulting in smooth operation and reduced wear. It also has built-in dual power take-offs, a positive stopping magnetic brake, and a time-saving automatic counter that permits instant resetting of the winding cycle by merely touching a lever. Winding speed is up to 7,000 rpm.



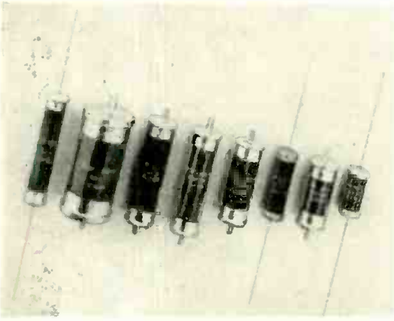
TOROIDAL COILS
meet close tolerances

UNIVERSAL MFG. CO., INC., Michigan & Monroe Aves., Kenilworth, N. J., has announced toroidal coils that meet exacting design requirements. Sizes range from 1 in. i.d. with No. 17 wire and 2 in. i.d. with No. 10 wire. Coil sizes range from $\frac{1}{4}$ in. i.d. to 10 in. i.d.—height to $3\frac{1}{2}$ in. Wire sizes No. 10 (0.1019 in.) to No. 42 (0.00249 in.) have been handled efficiently on production runs with 100-percent turns accuracy or an inductance of ±2 percent. These toroidals are wound, impregnated and cased (if required) to customer or MIL-T-27 specifications.

SPEED REDUCERS
of small size and weight

BOWMAR INSTRUMENT CORP., 2415 Pennsylvania St., Ft. Wayne, Ind., has announced a new series of precision miniature speed reducers for general laboratory and product design use. Two basic units, 1062 and 1687, measure 1.062 and 1.687 in. in diameter respectively, and 1.656 and 1.859 in. in length, exclusive of shaft length, which can be specified. Ratios range from 12.5 to 10,000-to-1. Specifications include backlash of less than 0.5 deg. Series 1062 is designed for output torque loads up to 25 oz. in.;

1687 is rated at 100 oz in. maximum. Both units feature ABEC class 5 ball bearings throughout. They are especially applicable for electronic controls, actuators, servos and similar equipment where very small size and weight are vital factors.

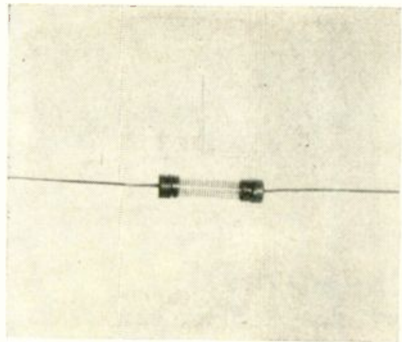


CAPACITORS
are glass tubular type

CORSON ELECTRIC MFG. CORP., 540 39th St., Union City, N. J., has available a new line of glass tubular plastic dielectric capacitors, type G-6 Glascaps. The units feature light weight and compactness not attainable in other types of capacitors and are particularly useful in high-voltage d-c, and low-frequency, low-voltage a-c applications. They are available in a complete range of ratings from 0.01 μf at 600 v through 0.0015 μf at 60,000 v. All sizes are available from stock for immediate delivery.

SLOTTED SECTIONS
from 2,600 to 40,000 mc

F-R MACHINE WORKS, INC., 44-14 Astoria Blvd., Long Island City 3, N. Y. Type 100A series of microwave slotted sections feature: (1) tapered slot for low residual vswr; (2) stable carriage movement for true readings; (3) precision ball bearing action for low wear; (4) easy fingertip control. The waveguide and coaxial sections are milled from solid aluminum blocks and the ball-bearing races are ground from oil-hardened steel. The units are available in all waveguide sizes from 2,600 to 40,000 mc.



PRECISION RESISTOR
is hermetically sealed

BALCO RESEARCH LABORATORIES, 49–53 Edison Place, Newark 2, N. J. A new type of precision resistor utilizes a pure noble-metal film coated on the inside of a rugged, heat-resistant glass tube. The resistor is hermetically sealed. Characteristics are its high stability, low temperature coefficient, negligible reactive effects (out to 10 mc) ruggedness and compactness. The typical 1-w size measures 1 in. long and $\frac{5}{16}$ in. overall diameter. Ratings of ½ w, 1 w and 2 w are available in values from 10 to 100,000 ohms (higher values on special order) and tolerances of 1 percent, 0.5 percent and 0.25 percent. Popularly priced precision resistors, they exceed the requirements of MIL-R-10509A.

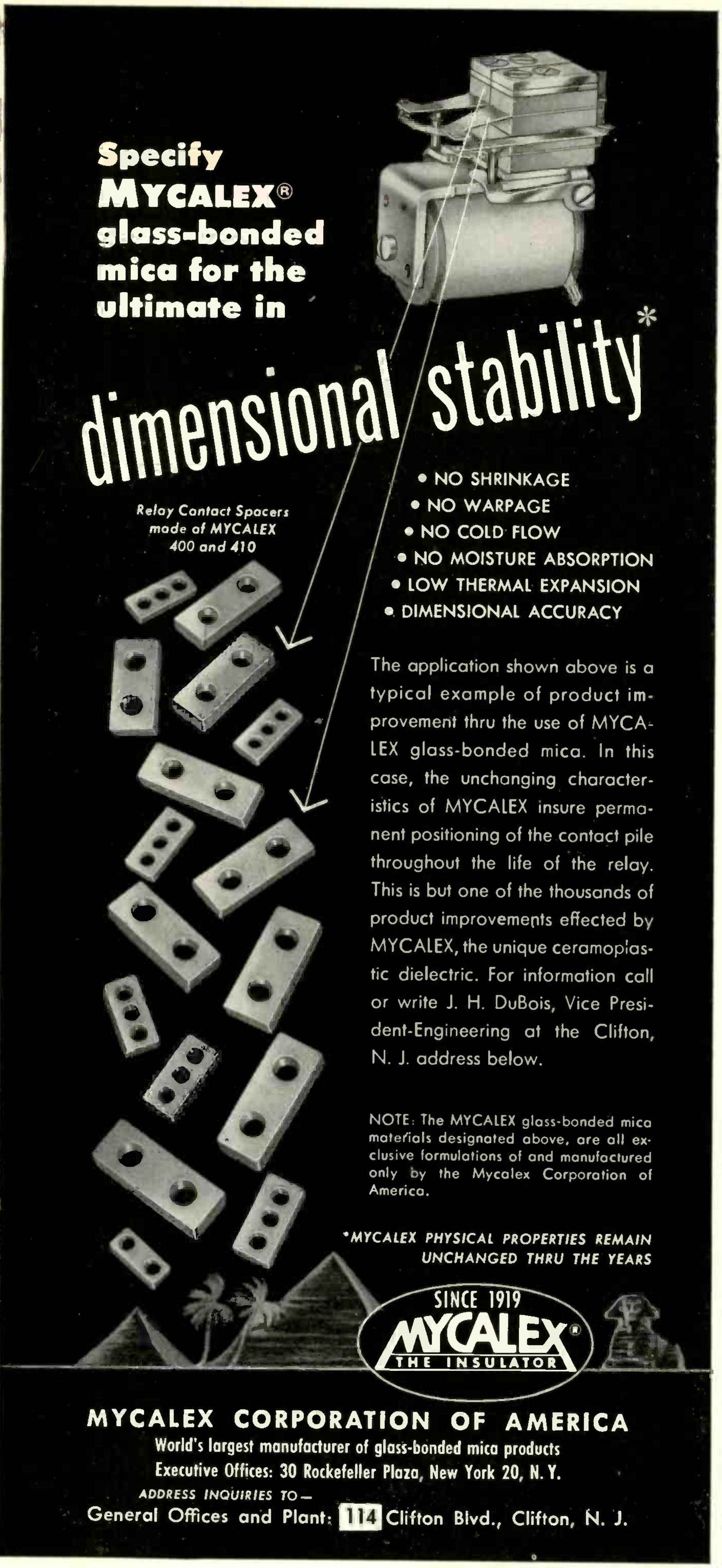
NETWORKS
of twin-T rejection type

WHITE INSTRUMENT LABORATORIES, 203 Riverside Drive, Austin 4, Texas. The series 500 networks of standard R-C twin-T rejection type, are now available in hermetically sealed enclosures. Stable components with low temperature coefficients insure stability with time and temperature. Circuit parameters are selected for optimum notch sharpness and voltage output, with

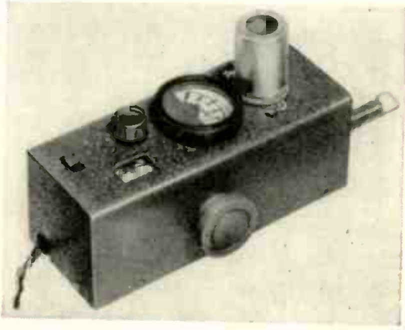
impedance levels permitting matching to typical circuits. All of the standard and many special null frequencies are available. Bulletin 500 gives full engineering information.

CATHODE FOLLOWER
is tiny, dual-type

The Walkirt Co., 145 W. Hazel St., Inglewood, Calif. Type M1523 is an improved, high-efficiency, dual-type cathode follower specially designed for coupling low output impedances with high input impedances. It is miniature resin encapsulated and designed for plug-in operation. The unit is ideally suited for joining high-impedance sources, such as flip-flop oscillators and voltage amplifiers, with low-impedance devices such as transmission lines, matrices, filters, or capacitive circuits where fast rise times are desired. The dual feature allows extreme versatility. Each cathode output impedance is 100



ohms, tapped at 1,000 ohms, with the signal amplitude at the tap approximately 65 percent of the cathode signal amplitude. Output impedances of approximately 50 and 500 ohms are available by paralleling the two sections.

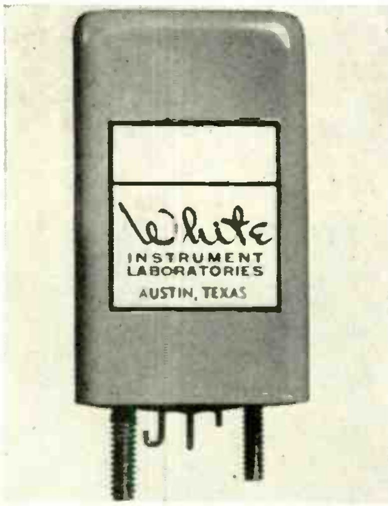


GRIP-DIP METER
for use in uhf-tv band

LINEAR EQUIPMENT LABORATORIES, Brightwater Place, Massapequa, L. I., N. Y. Model U-4 is a new type grid-dip oscillator-wavemeter specifically designed for use in the uhf-tv band. It covers the 450 to 900-mc range, which is in excess of that allocated for uhf video transmission. The tuning element uses a low loss cavity which is resonated to the desired frequency by means of a split-stator type capacitor. No wiping or sliding contacts of any kind are used. Coupling to the resonant cavity is accomplished by the use of a small external loop which, in itself, is not part of the tuned circuit. The unit is so designed as to permit ready access to other cavities, transmission lines, or virtually any type of uhf tuned circuit. A meter is provided for resonance indication.

LEAD NETWORKS
for servo amplifier use

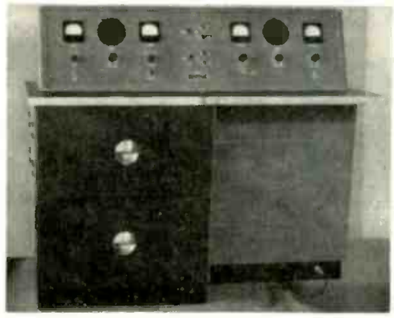
WHITE INSTRUMENT LABORATORIES, 203 Riverside Drive, Austin 4, Texas. The series 410 lead networks, now available in hermetically sealed enclosures, are resistance-capacitance filters for servo amplifier applications. Inserted in the d-c stage of a control amplifier, these networks combine lead or derivative action with high frequency and ripple filtering. The response is equiv-



alent to the standard R-C rate circuit in the low-frequency control region. Beyond the control band the attenuation increases to reject unwanted signals. Full engineering data are available in bulletin 410.

POTENTIOMETER
is hermetically sealed

FORD ENGINEERING Co., 129 East A St., Upland, Calif. This hermetically-sealed multiturn potentiometer, series H, has a diameter of 1 in. and weighs on $1\frac{3}{4}$ oz (10-turn unit, nitrogen filled). All static metal-to-metal joints are solder sealed. Rear header is solid metal with glass inserts through which the tin-dipped terminals project. The rotary seal design has been successfully tested at 100 psi at − 55 C and at 100 C and after 100,000 revolutions. These potentiometers have a power rating of 4 w at 40 C and a maximum torque between 0 C and 100 C of 2 oz in. Since neither moisture nor air can enter these units they are permanently free from electrical leakage and the effects of corrosion. Five-turn units, ¼ in. shorter than the 10-turn units, are also available.

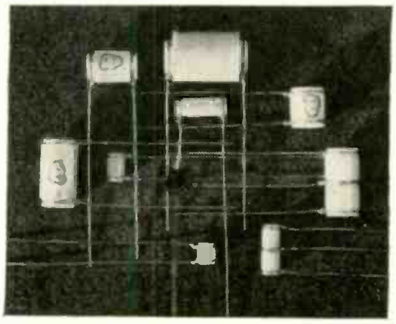


RADIO PAGING CONSOLE
is fully automatic

INDUSTRIAL ELECTRONICS, INC., 127 Light St., Baltimore 2, Md., is now in production on the new QSM radio paging control console. It was designed in answer to the demand for a simple, automatic compact piece of equipment fulfilling all the requirements of the radio paging operator. It records and repeats message sequences, remotely controls one or more paging transmitters, has a built-in field-strength and modulation meter and an automatic alarm that sounds if any part of the system fails. Fully automatic, it is normally operated by means of just one pushbutton.

PENTODE
is multiunit tube

RADIO CORP. OF AMERICA, Harrison, N. J. The 6AS8 is a general-purpose, multiunit tube of the 9-pin miniature type containing a high-perveance diode and a sharp-cutoff pentode in one envelope. It is intended for diversified applications in tv receivers. The pentode unit with its high transconductance may be used as an i-f amplifier, video amplifier and agc amplifier. The separate grid-No. 3 base terminal facilitates the use of an unbypassed cathode resistor to minimize changes in input loading and input capacitance with change in bias without causing oscillation which might otherwise occur if grid No. 3 were internally connected to the cathode. The high-perveance diode, entirely independent of the pentode unit, is especially useful as a picture detector or d-c restorer. The base pins for the diode unit are arranged so as to reduce the capacitance between its plate and cathode.

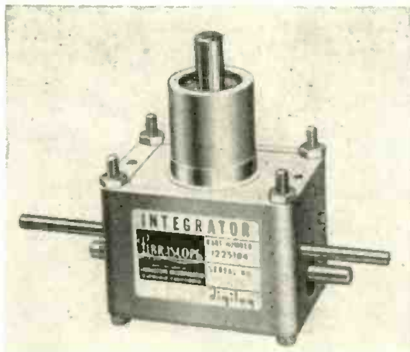


RESISTORS
are precision noninductive

K-F DEVELOPMENT CO., 2634 Spring St., Redwood City, Calif. Available in exact resistance values to accuracies of 1 percent, 0.5 percent and 0.1 percent, a new line of precision resistors is offered in a series of standard value ranges from 0.1 ohm to 1 megohm. Wound noninductively on nonhygroscopic ceramic bobbins and impregnated for moisture protection, these units exhibit low thermal emf and a temperature coefficient of 0.000025 ohm per deg C. Nine sizes are supplied ranging in power capability from ¼ w to 1 w; in diameter from ¼ in. to ¾ in., and in length from 5/16 in. to 1¼ in. In the standard units, values under 800 ohms are wound of Manganin wire while values over 800 ohms are supplied in Evanohm. Special alloys can be used where their characteristics are required and also special units can be produced with resistance values under 0.1 ohm and over 1 megohm.

ACCELEROMETER
is self-generating unit

GENERAL SCIENTIFIC CORP., Los Angeles, Calif., has developed a highly compact self generating accelerometer especially designed to determine frequency and amplitude at high voltages. Despite its small size, the unit provides power output as high as 2 v, without external excitation. Sensitivity is as low as ± 0.003 g, and frequency response is from 2 to 350 cps. The unit operates with extreme accuracy at temperatures up to 550 F.

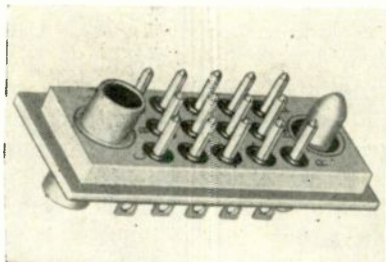


INTEGRATOR
with new oiling device

LIBRASCOPE, INC., 1607 Flower St., Glendale, Calif., has announced an improved ball and disk integrator for use in totalizing, rate determination, differential analyzers, or as a closed loop mechanical servo element or precision variable speed drive. Improvements include the addition of a permanent lubrication device which greatly increases the life of the unit, and the use of a lubricating oil which meets Army, Navy and Air Force specifications. Other specifications include: precision, 0.01 percent; width, 7⅞ in.; length, 3¾ in.; height, 3¼ in.; and weight, 21 oz. Superfinished balls and tungsten carbide disk are employed for high performance and long life.

PULSED RECTIFIER
of 9-pin miniature type

RADIO CORP. OF AMERICA, Harrison, N. J. The 3A2 is a half-wave vacuum rectifier tube of the 9-pin miniature type designed for rectifying the high-voltage pulses produced in the scanning systems of color tv receivers. Utilizing an indirectly heated cathode, the 3A2 is rated to withstand a maximum peak inverse plate voltage of 18,000 v. It can supply a maximum peak plate current of 80 ma and a maximum average plate current of 1.5 ma.



CONNECTORS
for sealed units

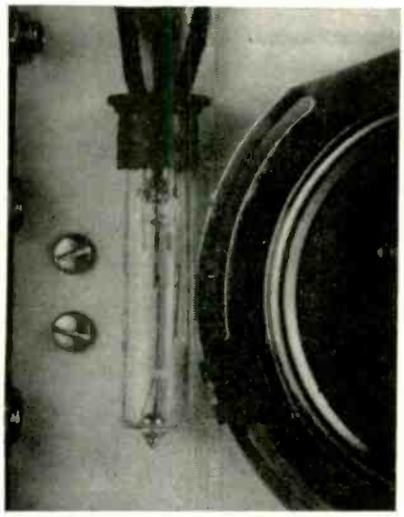
VIKING ELECTRIC, 1061 Ingraham St., Los Angeles 17, Calif., has available miniature, hermetic-sealed rectangular connectors especially designed for electronic apparatus where sealed units are used. The new line, designated series HVT, features an all-glass seal fused to each individual contact and to the body. In use, the connector, shaped to serve as a plug, is soldered into the top of the container which holds the component and its wiring. The glass seal prevents leakage in gas and fluid-filled units, and shuts out dust, air and moisture. These new-type connectors are especially useful with pressure-type of vacuum-type housings. The body of the hermetically sealed connector is precision-machined steel. Contacts and body are gold-plated over silver, for maximum conductivity, soldering ease and corrosion resistance. The series HVT connectors mate with standard VT receptacles and are available with 7, 14, 20 and 34 contacts. Other contact arrangements are available on special request.

TIMER
for spot or seam welders

VACUUM TUBE PRODUCTS, 506 South Cleveland St., Oceanside, Calif. Model F-216 fractional cycle timer is designed to meet the more specialized requirements of resistance welding when used for timing spot or seam welders, or other timing operations in industrial service where extreme reliability is required. The extremely fast time setting insures spatter-proof, oxide-free welds, and allows positive welding of such materials as molybdenum and tungsten. Positive adjustment in the fractional cycle range also allows welding of materials of less than 0.001 in. thickness with reliability and uniformity. The timer is packaged in a compact unit measuring $10\frac{1}{2} \times 9 \times 10\frac{1}{2}$ in. All controls are readily accessible from the front panel and consist of an on-off switch with pilot indicator, a cathode protection pilot, a high-low heat range switch and a variable time control. Peak current output of the standard unit is 40 amperes.

PENTODE AMPLIFIER is color demodulator tube

WESTINGHOUSE ELECTRIC CORP., 401 Liberty Ave., Pittsburgh 30, Pa., announces a new pentode amplifier tube (type 6DB6) designed for use as a color demodulator synchronous detector in color-tv circuits. The 6DB6 is a sharp-cutoff pentode amplifier of the 7-pin miniature type. Grids 1 and 3 are control grids for color demodulation use. The chrominance signal is applied to grid 1 and the output of the 3.58-mc oscillator is applied to grid 3. The tube output, when used as a color demodulator, is linear for high levels of grid 3 drive. The 6DB6 may also be used as a sync separator with the accompanying advantages of a pentode-type tube. The tube can be used in black-and-white tv circuits as a mixer.

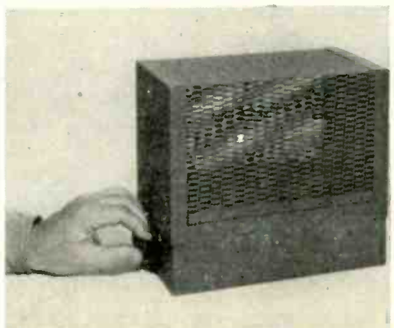


MERCURY SWITCH requires very low loading

HAMLIN, INC., 1315 Sherman Ave., Evanston, Ill., has available a new hermetically sealed mercury switch which requires exceptionally low loading of the activating system. This provides for optimum accuracy when the switch is used as a position indicating and limit switch in conjunction with precision equipment. Enclosed in a glass tube, all contacts are visible for quick inspection. The switch is a spdt magnetically actuated mercury type. As a small moving magnet approaches the armature within the switch, the electrodes are moved in and out of the mercury. No mechanical friction is involved. Standard operating ranges are from 12 v at 0.25 ampere to 120 v at 1 ampere.

D-C VTVM is a package unit

RESEARCH ELECTRONICS LABORATORY, Roslyn, Pa., has released a new package d-c v-t voltmeter unit that transforms any standard 1-ma d-c meter into a high-impedance voltmeter or microammeter. All connections are made through the octal plug-in base, and it is particularly adaptable to building into testing equipment. The unit is designed for 95-125 v a-c, 60-cycle operation.



FOUNDATION CHASSIS for electronic applications

INSULINE CORP. OF AMERICA, Manchester, N. H. A series of five new foundation chassis, suitable for amplifiers, transmitters, power supplies and other electronic applications, has been introduced. The units feature perforated covers that provide both ventilation and protection for parts mounted inside. Made of heavy steel, the chassis depth is 3 in. Overall dimensions of the five models are as follows: No. 3965—5½ × 10 × 9 in.; No. 3966—8 × 12 × 9 in.; No. 3967—7 × 17 × 9 in.; No. 3968—10 × 14 × 9 in.; and No. 3969—10 × 17 × 9 in. Special sizes are obtainable to order.

SYNCHRONOUS MOTOR is rated 0.3 oz in. torque

HOLTZER-CABOT MOTOR DIVISION, National Pneumatic Co., Inc., 125 Amory St., Boston 19, Mass., announces introduction of a polarized synchronous motor which always pulls into synchronous speed with the rotor in the same position with respect to polarity of the motor field. This motor, designated RBCP-2510, is rated 0.3 oz in. torque, 3,600 rpm, continuous 40-deg C rise for use with 115 v, a-c, 60-cycle, 12-w input.

Literature

Microphone Sensitivity Conversion Chart. Shure Brothers, Inc., 225 W. Huron St., Chicago 10, Ill. As an aid in the interchange of values of the three most commonly used systems, the company has issued a microphone sensitivity conversion chart with an explanatory guide. This easy-to-read nomograph shows the relationship between open-circuit voltage response, open-circuit power response and the RETMA sensitivity rating. The chart is especially recommended for use by all those persons engaged in buying, selling, installing or using microphones. The relative ratings can be determined in a few seconds.

Precision Wire-Wound Resistors. The Daven Co., 191 Central Ave., Newark, N. J., has published a catalog intended as a guide to basic data on resistors for the application and designer engineer. It also presents, in the most concise and usable form, information on precision wire-wound resistors in adequate detail to permit their accurate selection and application for any specific purpose. The catalog includes new charts and data on resistance wire, Seald-Ohm, hermetically sealed and encapsulated types. The book is replete with engineering drawings and photographic illustrations. MIL and other government ratings are listed.

Magnetic Servo Amplifiers. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y., announces their new bulletin S235-1-54 summarizing in table form the standard line of 60 and 400-cps magnetic servo amplifiers. Also listed are magnetic amplifier servo systems and their servo performance. Many new amplifiers and servo systems have been included. The company also has available standard as well as specially designed magnetic voltage regulators for motor generator and motor alternator sets.

Microwave Dielectrometer. Central Research Laboratories, Inc., Red Wing, Minn., has published a 4-page brochure on the microwave dielectrometer. The unit described, designed to measure the dielectric constant and loss of a wide variety of materials at microwave frequencies, is pictured on the front of the literature, and a rear view of the dielectrometer with access door removed is shown on the inside. Graphs of the waveguide and a block diagram of the instrument are included with the specifications. Factual information and performance data on the theories and applications of the dielectrometer complete the brochure.

Electronic Components. I-T-E Circuit Breaker Co., 19th and Hamilton Sts., Philadelphia 30, Pa. Catalog R-200 is a new 36-page guide to the company's electronic components. It fully describes subminiature resistors, precision and power resistors, camera-and-receiver-type deflection yokes, focus coils, and i-f and r-f transformers and coils. Charts, tables, drawings, as well as selection and application information round out the contents of this useful book.

Computer Elements. Librascope, Inc., 1607 Flower St., Glendale, Calif., has available four catalog sheets on a line of computer elements. Items covered are a sine-cosine mechanism, a ball and disk integrator, a hollow shaft differential and read and record heads. Included in each sheet is an illustrated description, specifications, application information and dimensional drawing.

Dynamic Headphone. Telex Inc., Telex Park, St. Paul 1, Minn. A two-color, $8\frac{1}{2} \times 11$ in. catalog sheet on the Dynaset, an under-the-chin dynamic headphone, has recently been published. The sheet lists specifications and advantages of this high fidelity, $1\frac{1}{4}$ oz. unit and explains its many professional, business and technical uses.

Synchro Instruments. Clifton Precision Products Co., Inc., Marple at Broadway, Clifton Heights, Pa., has published a 20-page, 2-color brochure titled "The Synchro Story." It describes in detail the materials, processes and operations going into the manufacture of a precision synchro instrument. Photographs and line drawings illustrate the text and show many of the operations from raw materials through final testing of the finished synchro instrument.

Replacement Transformers. Chicago Standard Transformer Corp., Addison and Elston, Chicago 18, Ill., now has available the 1954 Stancor tv transformer replacement guide. Listed in the new reference are transformer replacement data on over 6,800 tv models and chassis of 115 manufacturers, including information on many private label sets. Also included in the guide is a complete catalog listing of 172 Stancor tv replacement components as well as manufacturers' cross reference charts.

Germanium Diodes. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin N-1 describes the type 1N series germanium diodes, giving comprehensive data on standard and replacement types. Included are information on construction, application and dimensions, as well as charts.

Servo Motor Catalog. G-M Laboratories Inc., 4300 N. Knox Ave., Chicago 41, Ill. A new 4-page catalog on a-c servo motors and tachometer generators has been announced. Sizes of servo motors listed range from 0.980 in. to 1.70 in. diameter and are for use on 60 and 400 cycles at voltages from 26 to 115. Applications of units covered range from gun sights and guided missiles through altimeters, direction finders and servo circuits in general. Ask for catalog No. 4.

Precision Potentiometers. DeJur-Amsco Corp., 45-01 Northern Boulevard, Long Island City 1, N. Y. Complete features and specifications for the company's new HP-300 series, 3-in. high resolution potentiometers, are now available in a new 2-page illustrated catalog

TV Broadcast Products. Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J. A new, revised 36-page bulletin lists the complete tv broadcast products manufactured and distributed by the company. Prices of the 480 items listed range from 10 cents per foot of a coaxial cable to $168,-750 for a 50-kw, channel 7-13, transmitter. Products covered by the price list bulletin include: transmitter equipment; r-f load and wattmeters; antennas; frequency monitors; transmission lines; transmitter control units; microwave relays; image orthicon camera chains; Vidicon camera chains; film, slide and opaque equipment; sync generators and pulse distributors; video monitoring equipment; video switcher and mixer equipment; video distribution, patch and power panels, and accessories; racks and consoles; connectors; test equipment; coaxial cables; audio equipment; lighting equipment; and mobile field units.

Sensitive Relays. Hedin Tele-Technical Corp., 640 W. Mt. Pleasant Ave., Livingston, N. J. A recent bulletin outlines the chief features of relay No. 100, one of a line of sensitive relays for electronic and atomic instrumentation, transistors and germanium diodes, telephone and thousands of applications. A dimensional diagram is included.

Close Tolerance Capacitors. Electronic Fabricators, Inc., 682 Broadway, New York 12, N. Y., has available a technical bulletin containing complete information on the EFCON type MH miniature plastic film close tolerance capacitors. Designated Technical Publication 154, the 4-page bulletin is printed in two colors for maximum readability of the data contained which will be of primary interest to design and application engineers. The bulletin contains complete descriptions, specifications, dimensions, test data and characteristic curves.

Electrical Windings and Magnet Coils. Jeffries Transformer Co., subsidiary of Leach Corp., 1710 East 57th St., Los Angeles 58, Calif., has published a comprehensive, 2-color bulletin illustrating typical coils and windings. It covers applications, manufacture, conductivity and resistivity, complete magnet wire characteristics table, tables on temperature coefficient of resistance, reactance, impedance, current, voltage and power factor.

Microwave Tube Catalog. Microwave Associates, Inc., 22 Cummington St., Boston, Mass., announces a new 8-page, 2-color catalog 54T, giving full data on its magnetron, t-r and atr tubes. This brochure is a useful reference manual for design, standards, production and purchasing personnel in the radar and allied fields.

Null Detection. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y., has available a brochure on the model 100A null meter. It gives applications, principle of operation, features and specifications. Also available is an article entitled "Null Detection of Complex Waveforms." This demonstrates its usefulness for nulling bridges, potentiometers, synchros, resolvers and allied devices.

Titanium Tubing. Superior Tube Co., 1523 Germantown Ave., Norristown, Pa. Properties, applications and advantages of titanium tubing are presented completely in bulletin No. 42. Some of the research and development which went into the product is outlined, together with the properties of titanium which make it a promising material for many new applications. Tube sizes of seamless titanium and Weldrawn titanium are listed. Tubing tolerances, chemical analysis and finishes are other topics discussed. An interesting and informative section is written on processing and fabricating characteristics of titanium tubing.

Electronic Components. Erie Resistor Corp., Erie, Pa. A complete, new 16-page catalog of electronic components for distributors, service departments, laboratories, industrial's, product engineers, and amateurs, has been issued. This catalog, D-54, supersedes previous catalogs and includes the new line of temperature compensating tubular Ceramicons and disk Ceramicons, together with the long-time standard numbers. It is complete with up-to-date listings, illustrations and descriptions.

Recommended Tube Types. General Electric Co., Schenectady 5, N. Y. A 12-page, 3 color booklet (ETR-886) lists recommended receiving and c-r tube types for a-m, f-m, and tv receivers, compiled in tabular form to cover essentially every requirement of the radio and tv manufacturer. Included are characteristics reference charts on the tube types listed and interpretation of technical data.

Color Picture Tube Wall Chart. Sylvania Electric Products Inc., Seneca Falls, N. Y., has prepared an educational wall chart showing basic construction and operational features of three types of color tv picture tubes. The chart describes the flat aperture mask, curved aperture mask and field deflection types of color picture tubes. It is particularly timely as a training aid.

VOR Systems. Collins Radio Co., Cedar Rapids, Iowa. A 12-page brochure deals with the company's low-cost, packaged VOR installation for any field—municipal, commercial or private. Illustrated descriptions are given of the antenna, r-f phase shifter, circuit breaker panel, modulation eliminator, VOR monitor, local control unit and transmitter. Accessory information and specifications are included.

Microwave Tubes and Components. Bomac Laboratories, Inc., Beverly, Mass. A 4-page folder covers gas switching tubes, shutter tubes, hydrogen thyratrons, magnetrons and diodes. Illustrations and technical specifications are included. The company invites inquiries regarding engineering, development and production.

Video Control Equipment. Allen B. DuMont Laboratories, Inc., 1500 Main Ave., Clifton, N. J. Bulletin TR-570 deals with the TA-178-B video switching and mixing equipment. The 4-page bulletin illustrates and describes the type TA-178-B video switching and mixing equipment. Included are features, operation, electrical and physical specifications, power requirements and tube complements.

Electronic Parts. The Electran Mfg. Co., 1901 Clybourn Ave., Chicago 14, Ill. Bulletin No. 530 is a 6-page folder illustrating and describing a line of custom-made transformers, reactors, chokes, special windings and electronic devices. The folder incorporates a helpful check list for anyone considering electrical or electronic components. Twelve guiding questions are suggested to make a more comprehensive inquiry for a quotation. A brief, interesting note is made of the company's experience in the field.

Selenium Rectifiers. Sarkes Tarzian, Inc., Bloomington, Ind., has published a 72-page selenium rectifier handbook outlining manufacturing processes, characteristics and how-to-use information. It also contains a guide for replacements in radio and tv chassis, along with many circuits and much practical matter.

Germanium Diodes and Transistors. Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y. Bulletin No. G-23 is an 8-page catalog describing a complete line of germanium diodes and germanium transistors. The catalog is fully illustrated with charts voltage curves and diagrams, and lists product applications. Thirty-two different germanium diodes are listed, including 4 JAN types, and 9 hermetically sealed diffused *pnp* junction transistors.

Environmental Chambers and Liquid Chillers. Conrad Inc., Holland, Mich., has issued new data sheets on environmental chambers and liquid chillers. The sheets on the front-opening, and the chest-type, chambers show the interior dimensions and the various combinations of environment available from the company's equipment. The information on the portable laboratory type liquid chillers give the gross Btu capacity per hour for 8 standard models. Specifications of the chambers are also listed.

Duplex Function Plotter. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Data sheet 10.0-17 describes a new ElectroniK recorder for the automatic plotting, on a single chart, of a curve that continuously evaluates two variables in terms of a third. The instrument described incorporates three complete measuring and balancing circuits that can be energized by any d-c millivolt source. Expressed mathematically, the duplex function plotter continuously plots x, $x' = f(y)$. Included in the data sheet are an illustration as well as information on application and operating principle. Specifications are also given.

Cross-Guide Coupler. Microwave Development Laboratories, Inc., 220 Grove St., Waltham 54, Mass. Bulletin DC-1 describes the first of a series of directional couplers with a new design concept which permits superior operating performance. Specifications and operating characteristics are given.

Microwave Absorbents. The Sponge Rubber Products Co., Shelton, Conn., has available a bulletin illustrating and describing microwave absorbents for indoor radiation pattern measurements. The absorbers discussed have been used by both government and commercial laboratories to construct anechoic chambers or darkrooms and for screens to shield small areas. Instructions for installation and physical characteristics are given for both the 12-cm and 30-cm types.

Services, Products and Facilities. Allied International Inc., Connecticut & Richards Aves., South Norwalk, Conn. An 8-page catalog describes and illustrates the design-development-production-assembly work done by the company's engineering division for the electronics industry. Product photographs and descriptive text point up Allied's ability to miniaturize entire assemblies, redesign products to meet user specifications, or manufacture to precise tolerances. Besides offering facilities for the production of a variety of electronic and electromechanical devices, the brochure explains, the company also manufactures a number of its own, noncompetitive products. These include complete lines of power supplies, power plants, dry batteries and telecommunications equipment for U. S. and overseas markets.

Pressure Transducer Bulletin. Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif., has available a 12-page bulletin, No. PT-1, describing instruments for the measurement of gage, differential and absolute pressures. The transducers discussed are based on the principle of the unbonded strain gage which translates pressure into an exact electrical analog output by means of a complete balanced bridge of strain-sensitive resistance wire. The bulletin includes drawings, specifications, and selection tables for eight designs for pressure measurements from 0-0.05 to 0-10,000 psi.

Crystal Catalog. Standard Crystal Co., 1714 Locust, Kansas City, Mo. Catalog 354, a new 12-page illustrated brochure recently issued, incorporates an unusual military chart, designed for customers' guidance in selecting proper crystal types for particular requirements. The catalog features the company's complete line from subminiature, hermetically sealed, plated units to crystal ovens.

Screen-Room Filter Attenuation. Aerovox Corp., New Bedford, Mass., has available a descriptive bulletin giving attenuation characteristics of six different models of standardized and stocked screen-room filters. The bulletin deals with a line of single, double and triple-section filter units developed and produced by the company's subsidiary, Acme Electronics, Inc.

Pulse Transformers. Utah Radio Products Co., Inc., 1123 East Franklin St., Huntington, Ind., has announced a new catalog that lists the electrical and physical characteristics of 33 blocking oscillator, or regenerative driver pulse transformers. The publication will supply the Utah catalog number, pulse voltage, pulse duration, maximum duty ratio, load impedance, rms test voltage, induced voltage and d-c resistance. The catalog lists a few high power pulse and guided missile transformers. Several views of the laboratory list the test facilities available for use on new projects.

Selenium Rectifiers. Fansteel Metallurgical Corp., North Chicago, Ill., recently issued engineering information bulletin 6.400. The 24-page illustrated booklet contains much information useful to the design engineer who uses selenium rectifiers: standard cell sizes and ratings; typical rectifier circuits, formulas and constants; elementary operating principles; typical characteristic curves; typical test circuits; operation of rectifiers at higher than normal temperatures; installation and care; and typical applications with circuit diagrams.

Relay Catalog. Leach Relay Co., Division of Leach Corp., 5915 Avalon Blvd., Los Angeles 3, Calif. A new 44-page, 2-color, loose-leaf catalog illustrates and describes the company's standard relays, and also suggests some of the many modifications that can be made to accommodate special requirements. Details include characteristic, schematics and dimensions. The catalog lists types of relays as follows: midgets, circuit controls, special purpose, radio and high-frequency, aircraft relays and contractors. Also illustrated and described are expanded facilities for engineering, tooling, fabrication, assembly, electrical and environment testing, hermetic sealing and final inspection.

Resistors and Power Rheostats. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind. Form 79-8 is a 27-page catalog for the equipment-design engineer, and devoted to wire-wound fixed and adjustable vitreous-enamel power resistors and power rheostats. It tells the engineer how to specify his power resistor and power rheostat requirements so that quotations and samples can be prepared in the most efficient manner. The catalog contains data about characteristics of available military and commercial designs in the forms of descriptions, line drawings with dimensions, charts, curves and large clear photographs. Also included are hardware, accessories and formulas required in making various resistor calculations.

Laboratory Report. Technology Instrument Corp., 531 Main St., Acton, Mass. Laboratory Report No. 9, now available, features applications of the type 310-A Z-angle meter and the type 320-AB phase meter in school laboratories. Enclosures with this report include several representative experiments conducted at various colleges. These suggest methods of use for certain instruments to simplify common electrical measurements for students.

O-Ring Brochure. Goshen Rubber Co., Inc., Goshen, Ind. A 12-page brochure on O-rings gives detailed information on compounds, groove dimensions and sizes. It contains diagrams of typical applications, and is intended to be helpful to designers and to users of O-ring seals for almost every type of application.

High-Reliability Tubes. General Electric Co., Schenectady 5, N. Y. A 20-page, 3-color booklet (ETD-548C) covers the developmental history of the Five-Star line of high-reliability receiving tubes for critical applications, and design and manufacturing features of the tubes. Also included are technical data and average characteristics on the 22 miniature and 11 subminiature types currently available in the line.

Capacitor Catalog. Astron Corp., 255 Grant Ave., E. Newark, N. J. A comprehensive 48-page capacitor catalog shows latest available types, complete listings and technical data on electrolytic, paper foil and metallized-paper capacitors. The catalog arranges paper-foil and metallized-paper units according to operating temperature and performance characteristics as well as by case types. This makes it easier for the user to determine, select and specify capacitors to meet specific electrical and mechanical requirements. Several new types are shown—plastic encased and sealed paper units with a special patented "blue-point" seal which makes the capacitors completely impervious to moisture, humidity and soldering iron heat. The AC-4 catalog also features one of the most extensive selections of Metalite metallized paper capacitors in subminiature metal and cardboard cases, including a wide variety of high-temperature Hy-Met capacitors for operation at 125 C. Electrolytic units feature Astron "safety margin" construction, and complete listings of miniature metal-can, twist-prong, bathtub and cardboard tubulars for the service trade as well as for original equipment.

Audio Catalog for Broadcasters. Radio Corp. of America, Camden, N. J. A 146-page catalog contains straight-to-the-point information about all the company's audio equipment and accessories designed for broadcast and tv station operations. The book covers more than 200 professional audio items —and includes data, specifications, response curves, typical station equipment lists and studio layouts.

Insulating Varnish. Irvington Varnish Insulator, Division of Minnesota Mining & Mfg. Co., 6 Argyle Terrace, Irvington 11, N. J., has issued a new insulating varnish catalog. A special feature is the section on how-to-use these materials. Included in this section is not only valuable general-use information, but special instructions on the dipping, vacuum, pressure, brush, spray and baking types of application. Another section contains many useful charts such as conversion tables, solvent charts, tank capacities and specific gravity correction tables.

Relay Catalog. Magnecraft Electric Co., 1448 W. Van Buren St., Chicago 7, Ill., recently issued a new relay catalog. It contains complete engineering and dimensional data on long and short form telephone-type relays, new midget subminiature relays, latching and low capacitance relays, open, plug-in, dustproof and hermetically-sealed relays.

Product and Facility Brochure. Servomechanism, Inc., Port & Stewart Aves. Westbury, N. Y. A 12-page illustrated product brochure describes an expanding line of electronic computers and plug-in components. It also provides a brief summary regarding the company's history, design philosophy, general facilities and services available. A concise, yet informative description covers many of the company's latest developments such as mach computers, master air data computers, accelerometers and positioning mechanisms.

Germanium Crystals. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y., has published a 42-page booklet entitled "Industrial Uses for Germanium Crystals." Each application offered introduces the germanium crystal to the most exacting of users. The four main chapters in the booklet cover: relays and relay applications; timing circuits; power supply applications; and applications to industrial instrumentation.

Printed Circuits. Photocircuits Corp., Glen Cove, N. Y. Printed circuits, their function, fabrication and application are comprehensively outlined and described in a new 8-page brochure. The brochure includes information on methods of application, materials, electrical characteristics, components such as capacitors, resistors, tube sockets, switches and transformers. Assembly with dip soldering and plated-through holes is described. Design improvement and lower production costs are amply suggested in this engineering brochure.

Electrical Indicating Instruments. The Hickok Electrical Instrument Co., 10527 Dupont Ave., Cleveland 8, Ohio, has announced a 48-page catalog of electrical indicating instruments, laboratory portables and panel meters of finer accuracy. It provides illustrations and specifications of the more popular sizes of round, square, flush, semiflush, switchboard, horizontal edgewise and fan type meters as well as 250-deg arc-angle sealed and ruggedized types presently available. Typical listings are ammeters, decibel meters, frequency meters, microammeters, milliammeters, millivoltmeters, voltmeters, wattmeters, shunts, transformers and special developments.

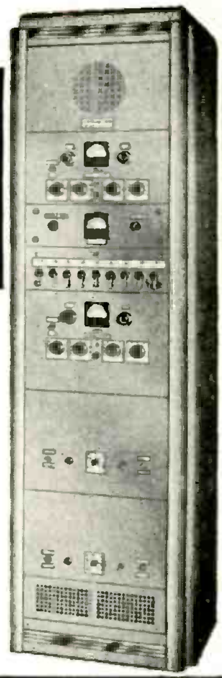
Resistors and Power Rheostats. Tru-Ohm Products, 2800 N. Milwaukee Ave., Chicago 18, Ill. A 20-page catalog features the complete line of the company's resistors and power rheostats. Standard and special size resistors are illustrated as are resistor mountings. A section of the catalog is devoted to power rheostats—25, 50, 75, 100 and 150 watts. Information also includes data on special rheostat shaft and bushing assemblies, taper wound rheostats and tandem rheostat assemblies. The Tru-Ohm ceramic welding nozzles are also included.

Decade Pulse Capacitor. Aircraft-Marine Products, Inc., 155 Park St., Elizabethtown, Pa. Catalog sheet No. 831357 illustrates and describes the Capitron 8-kv decade pulse capacitor. Included are a schematic, characteristics and specifications and price.

Decade Shunt. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio, has published a single-sheet bulletin covering the model 2008 decade shunt, an accessory that clips easily over the input terminals of an electrometer, quickly converting it to a wide-range micromicroammeter. Besides an illustrated description of the unit, the bulletin contains specifications, typical uses and ordering suggestion.

F-M Ring Antenna. Collins Radio Co., Cedar Rapids, Iowa. A six-page folder illustrates and describes the 37M series f-m ring antennas that consist of only two basic parts: (1) radiating rings and (2) connecting inter-ring transmission line. It points out such features as ease of installation, mechanical stability, high gain, low vswr and power capacity. A page of engineering data contains complete mounting information.

Improved Lighthouse Tube. General Electric Co., Schenectady 5, N. Y. An 8-page, 3-color booklet (ETD-881) describes the new GL-2C39-B metal-and-ceramic Lighthouse tube, an improved version of the metal-and-glass GL-2C39-A. The new high-mu triode discussed is designed for use in vhf-uhf circuits as a grounded-grid class-C power amplifier, oscillator, or frequency-multiplier, at frequencies up to 2,500 mc. Technical data and typical operating conditions are included.



PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

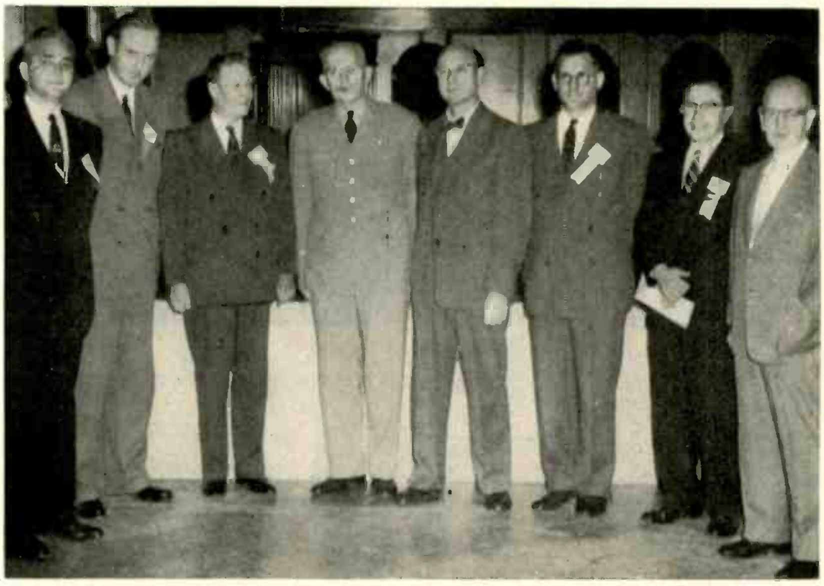
Engineers attend industry meetings and symposiums . . . Associations name new officers and honor industry leaders . . . Manufacturers plan plant expansions, promote engineers . . .

OTHER DEPARTMENTS
featured in this issue:

Electronic Components Symposium Draws Top Engineers

BETWEEN 800 and 1,000 electronic engineers and scientists assembled in Washington for the fifth of a series of national meetings on electronic component parts and materials.

The theme of the 1954 Electronic Components Symposium was "Technical Progress in Component Development, Fabrication and Use, With Emphasis on New Advances in the Art." The meetings were sponsored jointly by the AIEE, IRE, RETMA, WCEMA, with participation by agencies of the Department of Defense and NBS.



Leaders of industry and government who spoke during the opening session of the symposium on the topic "The Executive Views Components" were, left to right: M. Barry Carlton of the Department of Defense, chairman of the symposium committee; R. S. H. Hylkema of Philips Industries, Eindhoven, Holland; Robert C. Sprague of Sprague Electric and chairman of the RETMA board of directors; Brig. Gen. W. Preston Corderman, Chief of the Signal Corps Engineering and Technical Division; D. E. Noble of Motorola; C. H. Elmendorf of Bell Telephone Laboratories; A. W. Rogers of Signal Corps Engineering Laboratories and W. H. Martin, Deputy Assistant Secretary of Defense (Applications Engineering).

Armed Forces Communications Group Elects Bailey President

GEORGE W. BAILEY, executive secretary of the IRE, was elected president of the Armed Forces Communications Association for the one year term.

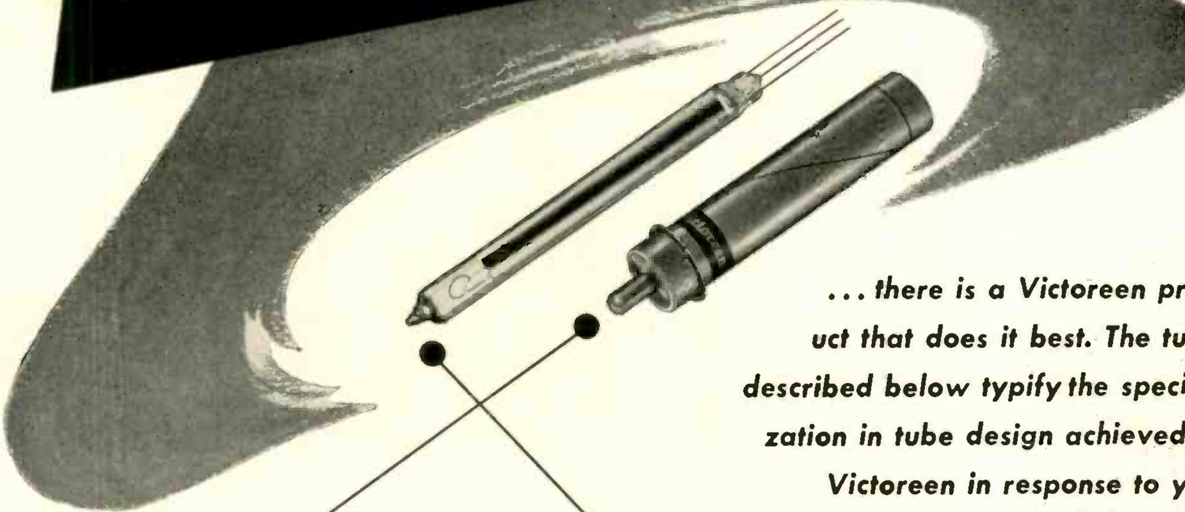
During World War II, he served in Washington, D. C. as Chief of the Office of Scientific Personnel under Dr. Vannevar Bush, Director of the Office of Scientific Research and Development. He received the Certificate of Merit from President Truman for his work there.

Bailey was appointed executive secretary of the Institute of Radio Engineers in 1945 and heads the national headquarters office of the society in New York City.

From 1940 to 1952 he held the offices of president of the American Radio Relay League and president of the International Amateur Radio Union.

The following men were elected vice-presidents of AFCA: Major General G. A. Blake, Chief of Air Force Communications; Major General G. I. Back, Chief Signal Officer;

for COUNTER TUBE needs



... there is a Victoreen product that does it best. The tubes described below typify the specialization in tube design achieved by Victoreen in response to your ever increasing requirements.

For measuring I-131, Co-60, and Ra we offer the type 6306 bismuth-coated cathode counter tube. It is six times as efficient on gamma radiation from I-131 as regular counter tubes, and from two to five times as efficient on Co-60 and Ra. The 6306 has an aluminum wall and coaxial type base for quick mounting.

For all around general use our type 1B85 is recommended. It is a beta-gamma sensitive tube. High uniformity from tube to tube of the 1B85s simplifies instrumentation since a fixed-voltage power supply is adequate for their operation. Such uniformity eliminates the need for individual voltage compensation. This aluminum wall tube may be used interchangeably with the 6306 tube.

Our type 1B86 glass wall counter is a gamma sensitive tube which operates at one-third the voltage required by most counters. This means fewer batteries. It is an ideal detector for compact, light-weight applications at lowest cost.

Type VG-18 is a halogen-filled counter tube in a glass envelope with tinned leads. This tube can be used in ordinary counting circuits or as an integrating tube. This tube is widely used where good performance is necessary and low cost is the prime factor.

Victoreen's rigid standards and ample production facilities assure GM type counter tubes of the highest quality at very low cost. Your inquiries are invited

The Victoreen Instrument Co.

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

Rear Admiral W. B. Ammon, Chief of Naval Communications; W. W. Watts, vice-president of RCA and Rear Admiral E. W. Stone, president of American Cable and Radio.

Medal of Honor Goes To Robert C. Sprague

ROBERT C. SPRAGUE, chairman of the Radio-Electronics-Television Manufacturers Association's board of directors, has been chosen to receive the "Medal of Honor" for his outstanding contributions to the radio-electronics and television industry during the RETMA annual convention in Chicago.

He has been a director of RETMA since 1943 and was chairman of the Association's Parts Division for two terms, 1944–45 and 1945–46. Subsequent to his Parts Division chairmanship, he served as head of the RETMA "Town Meetings" committee which directed activities in the interests of radio and television dealers and service technicians.

He was a member of the War Production Board Advisory Committee on electric condensers, 1942-45; chairman of the Office of Price Administration Industry Advisory Committee for the radio parts industry, 1944; and a member of the Massachusetts Committee on Post-War Reconversion, 1942.

The award was established in 1952 to provide industry recognition of outstanding contributions to the advancement of the industry.

Computing Group Elects Officers

SIBYL M. ROCK of ElectroData Corp. was elected chairman of the Southern California chapter of the Association for Computing Machinery at the first meeting of the newly organized group recently held in Los Angeles.

Other officers named to guide activities of the unit of national ACM, which was founded in 1949 to foster exchange of information in the analog and digital computing fields, include: Irving Lieberman of Hughes Aircraft, secretary and Paul Armer of Rand Corp., treasurer.

TV Sets Makers See Du Mont Color Tube

ATTENDING a demonstration of Du Mont's 19-inch color television picture tube at the firm's research laboratories are, left to right: Robert Capadano, vice-president of engineering of Emerson Radio; H. Leslie Hoffman, president of Hoffman Radio; Allen B. Du Mont, president of Du Mont Laboratories; Dorman Israel, vice-president of Emerson Radio; Frank O'Brien, vice-president of purchasing for Motorola and Harvey Tullo, v-p of purchasing for Emerson.

GE Expands For Military Electronics

TWO NEW buildings now under construction in Syracuse, N. Y. Industrial Park development are to be leased by GE's heavy military electronic equipment department. The structures will provide 100,000 sq ft of floor space and allow for consolidation of some of the department's shop and office facilities. They will be ready for occupancy this fall.

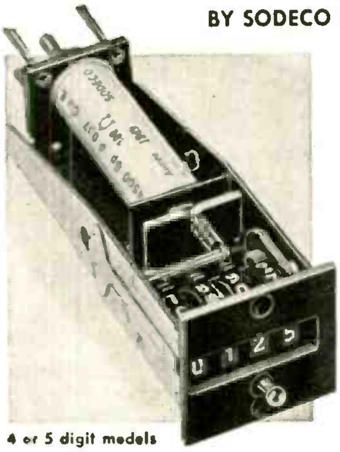
Indication of plant and equipment facilities needed for the production of military electronic equipment is seen in GE's light military electronics plant in Utica, N. Y., shown above.

The plant has been in operation

— the Counter —

YOU'VE BEEN WAITING FOR!

BY SODECO GENÈVE



4 or 5 digit models

INSTANTANEOUS RESET... to zero. Single-stroke lever action.

COMPACT... flush-mounting plate measures only 1-5/16" x 1-3/16".

FAST... standard models count up to 10 Impulses/sec. (Special models available with speeds up to 25 impulses/sec.).

TELLS AT A GLANCE... when coil is energized. Half numbers indicate this condition.

ACCURATE · DEPENDABLE · FLUSH MOUNTING

Write for Bulletin 22

LANDIS & GYR, INC.

45 West 45th Street · New York 36, N. Y.

SODECO

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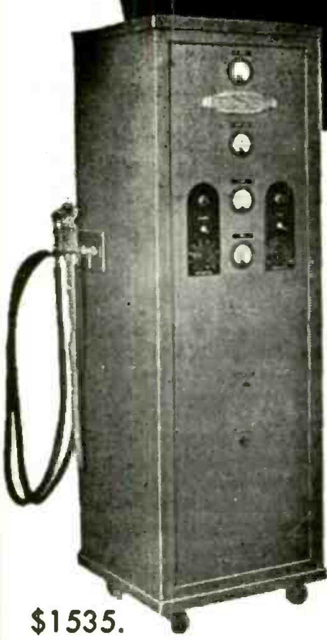
for maximum economy... 5KW VACUUM TUBE BOMBARDER OR INDUCTION HEATING UNIT



$1535.

Simple... Easy to Operate... Economical Standardization of Unit Makes This New Low Price Possible.

Maximum economies can be obtained only by use of correct frequency and power combinations when applying the techniques of induction heating to manufacturing processes.

It is significant that only Scientific Electric in the present market, can offer you a selection of frequencies depending on power required, in wide power range. 2-3½-5-6-7½-10-12½-15-18-25-40-60 KW (all units above 60 KW are considered custom built). This means that electronic heating equipment produced by Scientific Electric is tailored to your needs... fitted perfectly to the task entrusted to it, enabling you to keep your initial investment in equipment to a minimum while affording you all the proven advantages of electronic heating.

Write now for complete information or send samples of work to be processed. Specify time cycle for your particular job. We will quote on proper size unit for your requirements.

DESIGNERS AND MANUFACTURERS OF HIGH FREQUENCY AND HIGH VOLTAGE EQUIPMENT SINCE 1921

Scientific Electric

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WHEN DESIGN ENGINEERS TALK SHOP TODAY THEY TALK *miniaturization*

... because *miniaturization* meets today's demands for increased performance from smaller, lighter equipment. It saves vital space and weight on aircraft, guided missile and many similar applications . . . and it is bringing new portability and usability to countless types of commercial and industrial equipment.

If your miniaturization problem involves instrumentation, we can help. International Instruments is devoted exclusively to the design, development and production of miniature instruments and has created many important "firsts". We offer a complete line of 1" and 1½" Meters featuring accuracy and dependability comparable to conventional sized meters . . . plus far greater resistance to shock and vibration. Special scales and ranges can be provided to meet practically any electrical measuring requirement. Use the coupon below to send for data sheets covering our standard instruments — or ask our Engineering Department to help with your special needs.

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for approximately eight months on the design, development and production of military radar and electronic equipment.

The building has a single-story factory section, 842′ long and 352′ wide; and a two-story office and laboratory section 632′ long and 75′ wide.

Space on the first floor of the office-laboratory section is devoted to executive and administrative offices, cafeteria, dispensary and personnel offices.

The second floor is devoted to engineering and research laboratories and offices, drafting rooms, photo-reproduction facilities and an engineering conference room.

Of the total 372,000 sq ft of floor space in the factory section shown on p 304, approximately 250,000 sq ft of space is used in manufacturing which is essentially a bench assembly of component parts.

Automation

An automatic and remotely controlled conveyor system is used to transport components to and from the assembly-bench area. Spanning the factory among the structural members, the system includes some two dozen sections, each section having its own drive motor. Tie-ups at intersection points of the system are prevented by photo-cell controls, activated by material on the conveyors, to halt the drive motors temporarily through electronic relays.

Parts from the main conveyor are shunted to various branch lines in the stockroom area by solenoid-controlled deflectors. Deflector selection is determined by a steel ball placed in various holes in the conveyor basket bottom, the ball making contact with a particular deflector switch. Packages are stopped by limit switches.

The production assembly areas have their own test facilities. They consist of eighteen 11′ x 13′ cubicles mounted on platforms secured to building columns approximately 8 feet above the production floor level.

Feature of the plant is the distribution network for the supply of electrical power for research and development testing and production testing which cost $1.5 million.

Climatic test equipment in the

plant includes two climate chambers with a free inside volume of 12 x 8 x 9 feet; and four of 6 x 8 x 7½ feet. Temperature range from −85 deg. F to 248 deg. F; and relative humidity from 39% to 95%. Pressure can be reduced to simulate an altitude of up to 100,000 feet. There are additional chambers for temperature and humidity tests only and for special heat tests.

Physical stress test facilities include a water immersion pit, six feet square and 18 feet deep; a medium-impact sand shock machine which, by dropping a 1200-lb load for 36-in. provides the equivalent of a 70-G maximum deceleration; a tilt-test machine which inclines 45 degrees to each side of level with variable frequency, simulating a ship's roll; and a hammer shock test machine, with a 400-lb hammer and 5-foot swing span.

Vibration testing equipment is provided. It includes three small and one large mercury reaction vibrators and two other testers.

WESCON Program Events Take Form

PLANS ARE moving ahead for the 1954 WESCON (Western Electronic Show and Convention) to be held on Aug. 25-27 in Los Angeles' Pan-Pacific Auditorium and Ambassador Hotel.

WESCON will be sponsored jointly by WCEMA (West Coast Electronic Manufacturers' Association and the Los Angeles and San Francisco sections of I.R.E.

According to W. D. Hershberger, chairman of the WESCON board of directors, this year's show and con-

W. D. Hershberger

Thomas P. Walker

vention is expected to surpass all previous western records in both attendance and exhibitor participation.

More than 500 exhibit booths have been reserved compared to a total of 370 occupied in last year's show.

According to Thomas P. Walker, WESCON vice-chairman representing WCEMA, it has been necessary to add an 11,000 square foot annex to the Pan-Pacific Auditorium in order to accommodate exhibitors desiring space.

Nearly 20,000 people are expected to attend the three-day conclave.

Work has been underway on the convention since the first of the year under the leadership of C. F. Wolcott, vice-chairman representing IRE.

Twenty-eight technical sessions are on the program. Tentative plans call for sessions on audio, antennas and propagation, circuit theory, vehicular communications, broadcast and TV, telemetering, airborne electronics, information theory, management, electron devices, computers, microwave theory, and component parts.

Sessions and panels are arranged in a general schedule of ten sessions per day with additional sessions of special interest in the evenings. More than 100 technical papers will be presented in all.

Several special events will also be held. At the annual all-industry luncheon on Aug. 27 the featured speaker will be William R. Hewlett, national president of I. R. E.

WCEMA Scholarship Awards will

C. Frederick Wolcott

be presented at this time to outstanding students of accredited western engineering universities, and the 7th Region I. R. E. annual Achievement Award will be presented to the I. R. E. member in the Pacific Region adjudged to have contributed the most to electronics in the West during the past year.

Magnecord Names Witte And Boylan

MAGNECORD has appointed Roy Witte as chief mechanical engineer and William F. Boylan as chief electronic engineer.

Witte joined Magnecord in 1953, as a project engineer. Previously he was with Hallicrafters as chief mechanical engineer and spent seven years with Motorola as assistant engineering service manager.

Boylan joined Magnecord in 1950 as an electrical engineer, later becoming senior electrical engineer on commercial production. He previously served as an instructor of electronics and mathematics at the DeForest Training School in Chicago.

RETMA Charts Actions, Adds New Members

AT THE 11TH JOINT conference of RETMA and the Radio-Television Manufacturers Association of Canada, steps were taken to increase the Association's revenue by voluntary contributions, to implement its program for industry self-regulation of TV interference, and to set up policy committees which will direct activities with respect to the radio-TV excise tax and UHF television.

Robert S. Gates, executive vice-president of Collins Radio, was elected a director-at-large.

After hearing a report by W. R. G. Baker, chairman of the Special Committee on Spurious Radiation, on the response of set manufacturers to a RETMA proposal for voluntary submission of tv and f-m receivers to an independent testing laboratory for measurement of radiation characteristics, the engineering department was authorized to select a testing laboratory and establish operating procedures as promptly as possible.

Dr. Baker was authorized to report to the FCC the names of all set manufacturers who agree to adhere to RETMA radiation limitations and the RETMA intermediate frequency engineering standard and who will submit sample receivers to the testing laboratory for certification.

Appointment of a Tax Policy Committee was authorized. This committee will have authority to plan a long-range program designed to persuade Congress that the excise tax should be repealed.

Ultrahigh Frequency

Creation of a uhf Policy Committee also was authorized.

The UHF problem was discussed by members of the Set Division Executive Committee and the Radio-Television Industry Committee which recommended the creation of both the uhf Policy Committee and the Tax Policy Committee.

RETMA membership reached a new high of 383 with the following 17 new members:

ACF Electronics (Division of American Car and Foundry Co.), Alexandria, Va.; Boeing Airplane Co., Seattle 14, Wash.; Calvideo Tube Corp., Los Angeles 45, Calif.; Cargo Packers, Inc., Brooklyn 11, N. Y.; Collins Radio Co., Cedar Rapids, Iowa; Condenser Manufacturers, Inc., Nashville 4, Tenn.; Connector Corp., Chicago 30, Ill.; Consolidated Vultee Aircraft Corp., Pomona Division, Pomona, Calif.; Elcon Electronics Inc., Brooklyn 32, N. Y.; Elgin Metalformers Corp., Elgin, Ill.; Hy-Gain Television Products, Lincoln, Neb.; International Telemeter Corp., Los Angeles 25, Calif.; Maurice I. Parisier & Co., New York 36, N. Y.; Southern Electronics Co., Greeneville, Tenn.;

versatile

Multi-channel -- telegraph Al or telephone A3.

FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Operates in ambient -35° to 45°C. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

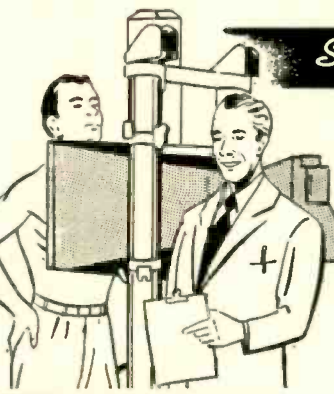
Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

A-100

AER-O-COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

Reg. U.S. Pat. Off.



Speeding X-Ray Photography

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EEPCO-DESIGNED MOTORS

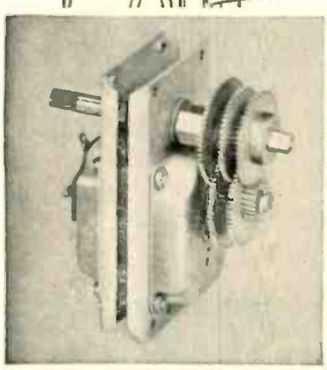
Manufacturing X-Ray equipment calls for precision and dependability in every part.

That's why, when the nation's three leading manufacturers of X-Ray machines chose the motor that moves the delicate negative holders, they selected motors designed and built by EEPCO.

These tiny motors of 1/500 h.p. (intermittent service) provide the reliable, steady source of power that revolves the negative changing mechanism. After a photo is made, the exposed negative with its lens and shutter, are automatically moved aside and a new unit moved into the ready position. Handling this task demands an even, slow application of power to avoid damage to the delicate mechanism. This is typical of the many unusual applications to which EEPCO-designed motors have been put.

If your particular problem calls for special design, or merely for standard motors that can handle the toughest service, you'll find that EEPCO is the source on which to depend. Out of the many unusual requirements filled by EEPCO engineers has come experience unsurpassed in industry and always at your disposal.

Equally important, the EEPCO plant is well-equipped and staffed to turn out motors for you on a mass-production, low-cost basis when necessary.



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(Advertisement)

ULTRA* SENSITIVE RELAYS—

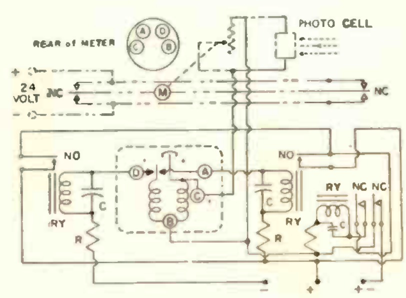
High Speed Operation—
A customer came in recently bringing with him a breadboard using one of our non-indicating meter-relays. We were astonished to see this relay working at 60 times per second. Until then we had thought it impractical to run one faster than 5 per second.

We haven't permission to use his name which is too bad. We'd like to give him credit. His circuit is reproduced here. It is like our drawing 2396-32 (Bulletin 112) with modifications. Delay on all relays is cut way down. Each has 1.0 Mfd for time delay. Load relays hold just long enough to prevent fluttering with the interrupter. The interrupter is connected through contacts on the load relays so it works only when needed.

All spring action is taken out of the meter contacts so they will follow at this speed. Contacts carry 15 milliamperes for strong locking action. Spacing between contacts is .05" for short travel—still there is enough separation to prevent false operation under shock or vibration.

Input is from a photocell. The equipment is self balancing. It maintains fixed output from the cell under varying light intensities. Contacts in the meter actuate a reversible motor (through intermediate relays*) which drives a rheostat in the cell output.

15 microamperes holds this relay in center position. Low limit contact makes at 14—high at 16. A change of 1 microampere starts the correction motor. Response time is less than 4 seconds for full rotation.



*See page 12 Scientific American, April 1954. This leading maker of infra sensitive relays refers to ours as "a couple of orders more sensitive." Hence "ULTRA."

ASSEMBLY PRODUCTS, INC.

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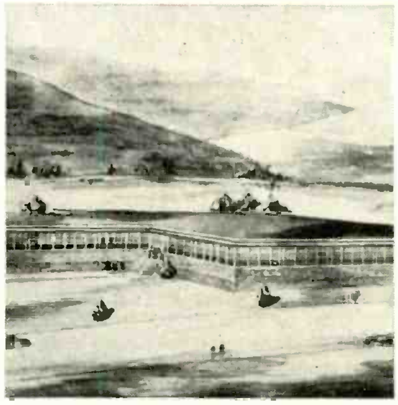
TRESCO (Transformer and Electronic Specialties Co.), Philadelphia 28, Pa.; Viking Electric, Los Angeles 17, Calif.; Wire Company of America, Santa Barbara, Calif.



Micamold Radio Opens New Factory In Virginia

MICAMOLD RADIO opened the first of two branch factories to be built in Tazewell, Virginia. Production is already underway at the new plant.

The Tazewell site occupies 70,000 sq ft of space. Nearly 500 employees will be employed there and another 500 will work at the proposed second Micamold plant when it is completed.

Daystrom Instrument Promotes Mageoch

NELSON H. MAGEOCH was promoted to vice-president of Daystrom Instrument.

Mageoch has been director of engineering and research at the instrument plant since 1951. He has held executive positions with Atwater Kent, Philadelphia Electric and Western Electric before joining Daystrom.

In his new capacity he will continue to direct engineering and research activities at the Archbald, Pa. plant, together with industrial engineering, equipment installation, inspection and test.

Apparatus Makers Elect Officers

EDWARD J. ALBERT of Thwing-Albert Instrument was re-elected president of the Scientific Apparatus Makers Association.

T. M. Mints of E. H. Sargent was also re-elected to another term as treasurer of SAMA.

Newly elected chairmen of the association's six sections include: Industrial Instrument, J. Robert James of James G. Biddle Co.; Laboratory Apparatus, E. J. Rhein of Kimble Glass; Laboratory Equipment, O. L. Lethander of Leonard Peterson & Co.; Optical, L. B. McKinley of Bausch & Lomb; Nautical, Aeronautical & Military Instruments, P. R. Bassett of Sperry Gyroscope and B. H. Bristol of The Foxboro Co.

Directors-at-large of SAMA for the following year include: C. G. Campbell of Kewaunee Mfg. Co.; H. F. Dever of Minneapolis-Honeywell; A. W. Fisher of Fisher Scientific; H. B. Richmond of General Radio; G. W. Tall, Jr. of Leeds & Northrup and R. E. Welch of W. M. Welch Manufacturing.

Johnson Named By Purdue

STUART JOHNSON, professor of electrical engineering and assistant dean of engineering at the University of Florida, will succeed D. D. Ewing, who is retiring, as head of Purdue's School of Electrical Engineering.

Dr. Johnson served on the teaching and research staffs of the Iowa State College and at the Missouri School of Mines. In 1946, he was appointed associate professor of electrical engineering at the University of Florida, and in 1947 he was promoted to professor of electrical engineering and was assistant dean of engineering.

During World War II, he served

in the U. S. Navy as an electronics officer.

His industrial experience covers employment with Century Electric, General Electric, Westinghouse Florida Power and Light.

Briggs Opens Consulting Offices

THOMAS H. BRIGGS has opened offices in Norristown, Pa. as an electronics consultant in the fields of materials, processing and applications of electron tubes and also in the field of automation and printed wiring.

Briggs' recent professional experience was with the Burroughs Research Center as manager of the engineering services department. For five years he was head of the electronics laboratory at Superior Tube in Norristown, Pa. Previously he had served as chief factory engineer at the RCA special purpose tube factory and at Raytheon's receiving tube plant.

AMF Promotes Engineering Executives

RODNEY C. GOTT, a director and vice-president of American Machine & Foundry, has been named executive vice-president of the company. R. A. Kimes, former manager of the company's general engineering laboratories in Greenwich, Conn., has been named director of engineering of the electronics division in Boston. T. R. Dreyer has been appointed divisional vice-president and general manager of the firm's

Rodney C. Gott

R. A. Kimes

manufacturing division. George F. Crosby, formerly works manager of Pyrene Manufacturing, has been named works manager of the electronics division.

Gott has been vice-president in charge of AMF's general products group and commercial research development since April, 1951. He was elected to the board of directors two years later. He joined the firm in 1946.

Kimes served as manager of the general engineering laboratories since their establishment in Greenwich in June, 1953. Prior to this appointment, he was manager and assistant manager of the company's engineering division's special products department.

In 1949 he was appointed director of overseas project contracts for AMF's International Division. Kimes joined the firm in 1946 as assistant to the works manager of the Buffalo plant. He was previously with Western Electric in engineering activities.

Dreyer directs the manufacturing activities of AMF factories in Buffalo, Boston, Glen Rock, Pa., New Haven, Conn., and Brooklyn.

He joined the company in 1952 as works manager of two plants. Last year he was named director of manufacturing of five plants for the firm.

Prior to joining the firm he was with American Type Founders as project manager. Immediately before that he was on the staff of the consulting engineering firm of Morris & Van Wormer. From 1940 to 1950 he was associated with the E. W. Bliss Company of Canton,

T. R. Dreyer

Ohio, serving as general superintendent of the Brooklyn plant and also as factory manager of the Salem, Ohio plant.

Crosby was previously associated with Pyrene Manufacturing as works manager from 1948 to 1954. Before that, he was executive assistant to the vice-president of manufacturing of M. W. Kellog.

IRC Changes Name Of California Subsidiary

INTERNATIONAL RESISTANCE changed the name of its California subsidiary, Gorman Manufacturing, to Ircal Industries.

Edward A. Stevens, vice-president and treasurer of IRC, has been elected president of the Los Angeles concern. Purchased by IRC in June of 1953, Ircal Industries is specializing in the manufacture of encapsulated wire wound precision resistors.

Eutectic Opens New Plant In Canada

A NEW FACTORY with an area of 10,000 sq. ft. has been acquired by Eutectic Welding Alloys of Canada in Montreal.

Production will begin almost immediately and goods will be shipped direct from the plant.

City Takes Title To Federal Plant

THE CITY OF NEW YORK has taken title to Federal Mfg. & Engineering's main plant in Brooklyn to make way for a housing and college development program.

The company will continue operating at the plant indefinitely while seeking a new manufacturing site covering approximately 100,000 sq ft.

Neptune Acquires Cox and Stevens

COX AND STEVENS Aircraft, maker of electronic scales, has been acquired by Neptune Meter.

The move is part of Neptune's program of diversification and expansion in the field of measurement.

Other subsidiaries acquired by Neptune this year are Revere Corporation of America in Wallingford, Conn. and Electronic Instrument and Signal Co., of Meriden, Conn.

Automatic Electric Appoints Clark

DANIEL E. CLARK, engineer in charge of transistor development for Automatic Electric, has been appointed chief electronics engineer, a newly created executive position.

He will give executive direction to the use of electronics in Automatic Electric's products.

Dr. Clark has served on the faculty of Northwestern University as an instructor in electronics.

In addition to his ten years' employment at Automatic Electric, Clark has been employed by R. W. Hunt, Armour Research Foundation

AIRCRAFT SERVO COMPONENT

The Type 71-5 Baroresistor is a pressure actuated potentiometer designed for operational use in aircraft. It features:

HERMETICALLY SEALED MECHANISM

The potentiometer winding and operating parts are hermetically sealed in a vacuum. Pressure is applied inside the bellows only. Therefore, the Type 71-5 Baroresistor is not affected by dust, fungi, or moisture.

RUGGEDIZED CONSTRUCTION

A special high force mechanism was developed for the Trans-Sonics Baroresistor to avoid the necessity for employing micro force potentiometer elements. Shock of 30g in any direction will not cause electrical discontinuity.

MACHINE CALIBRATION

Each instrument is calibrated by machine and its performance is automatically recorded as a graph of resistance versus pressure. Every turn of the winding is inspected. All electrical characteristics are automatically checked in an eleven stage inspection cycle.

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Resolution: ⅓%
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Servos—Vary servo loop gain as a function of altitude.
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5 Forest Street Bedford, Mass.

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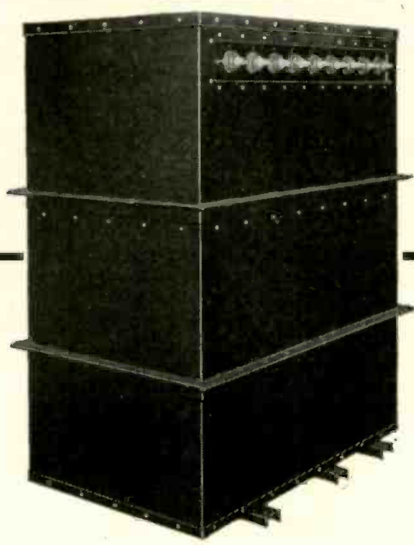

Here is an example of the type of equipment we can build to specifications for research, laboratory or experimental work. This Acme Electric custom built transformer has a primary that can be varied from 12 volts thru 115 volts, with a frequency range from 7 cycles thru 60 cycles. Nominal output voltage, 33,000 volts. This unit was built for use in connection with high voltage electrostatic separation and collection of various types of atmospheric particles. Designing a Dry Type transformer in this voltage class that provides safe and efficient performance, is another notable example of Acme Electric transformer engineering.

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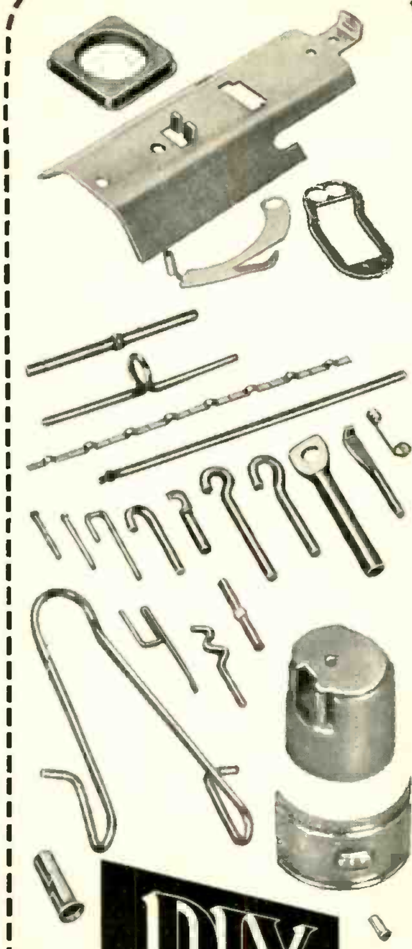

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and the Shakeproof Division of Illinois Tool Works. For the past two years he has devoted his time to the manufacture, evaluation, and application of transistors. Under his direction, laboratory facilities and pilot plant production of transistors have been established to provide the basis for study of transistors and their application in products manufacturer by the company.

Mansol Ceramics Moves Into New Plant

MANSOL CERAMICS moved into its new quarters in Belleville, N. J. With over 15,000 sq ft of new production space, the firm expects to increase production of its products.

The new factory and offices include a modern drafting and blueprinting department and a 1,000 sq ft explosion-proof room for experimentation. All new machinery has been installed in the plant.

Metal Powder Group Elects Officers

THE METAL POWDER ASSOCIATION elected officers and directors for 1954–55. Paul E. Weingart of American Metal Company was elected president succeeding T. R. Moore of General Dyestuff; William E. Cairnes of Radio Cores was elected chairman of the board; Robert L. Ziegfeld, secretary-treasurer of the association, was re-elected; Morris Boorky of The Pressmet Company was elected head of the fabricators division and vice-president of the association. Paul Weingart was elected head of the powder producers division. Carl Johnson of The Pressmet Company and Ralph B. Quelos of the Glidden

Company were both newly elected directors.

The balance of the board of directors consists of George Roberts of Vanadium Alloys Steel; Fred Lux of Lux Clock Manufacturing; B. T. duPont of National Radiator and Harrison Stackpole of Stackpole Carbon.

National Company Appoints Ruttenberg

ELLIOTT H. RUTTENBERG has been named price administrator for the National Company.

He was formerly with Raytheon as products manager in charge of the navigational aids division.

Previously, he was associated with Hallicrafters in Chicago as a senior project engineer. Earlier he was with Rauland as a project engineer.

Westinghouse Starts New Plant, Names V-P

A MULTI-MILLION dollar Westinghouse metals plant is now under construction in Blairsville, Pa., which is to bridge the gap between research and commercial application of new metals in the field.

The plant, which will be in operation by June 1955 will provide basic equipment for melting, forging, hot-rolling, cold-rolling, conditioning, pickling and heat-treating.

Donald C. Burnham has joined Westinghouse as vice-president in charge of manufacturing. He succeeds T. I. Phillips, who is retiring after 39 years of service.

Burnham comes to Westinghouse from the General Motors, where he has recently held the positions of manufacturing manager and assistant chief engineer of the Oldsmobile division. He previously was with Westinghouse from 1915 to 1952 and was on the president's staff in charge of manufacturing.

Condenser Products Expands Facilities

CONDENSER PRODUCTS of Chicago has expanded its production facilities by taking over 150,000 sq ft of space in the plant of New Haven Clock & Watch, the parent company, in New Haven, Conn.

The bulk of the production of the division's regular line of capacitors and high voltage power supplies has been transferred to New Haven along with the main sales and purchasing offices. Production of the regular line of pulse forming networks as well as all special work will continue to be carried on in the division's Chicago plant. The research and engineering department also will remain in Chicago.

Charles Bramble Joins Norden Laboratories

CHARLES C. BRAMBLE, former director of research at the Naval Proving Ground in Dahlgren, Va., has been named to the technical staff of the research and development division of Norden Laboratories.

In his capacity with Norden, Dr. Bramble will be a technical consultant in the fields of applied mathematics, mechanics, ballistics and computation. He will also be connected with technical coordination of major laboratory projects.

He was an instructor at the

United States Naval Academy, and in 1939 he was transferred to the Naval Postgraduate school where he rose to the rank of senior professor of mathematics and mechanics. While at the postgraduate school he developed and introduced courses in ballistics and mathematical statistics.

During World War II he was called to active duty with the Navy and attained the rank of Captain. In 1942 he was placed in charge of the Exterior Ballistics Section of the Naval Proving Ground at Dahlgren. For this work he received a commendation from the Secretary of the Navy.

Lambda Names Weston Executive Vice-President

SIMEON WESTON, former chief engineer of Amperex Electronic Corp. of Hicksville, N. Y., has been elected executive vice-president of Lambda Electronics of Corona, N. Y.

Weston also has been associated with Federal Telephone and Radio, Radio Navigational Instrument and De Jur-Amsco.

He has been an instructor at Rutgers University and adj. professor of electronics in the Graduate School of Engineering of New York University.

Reps Elect National Officers

WALLY B. SWANK of the Empire State Chapter of "The Representatives" of Electronic Products Manufacturers, was elected national president of the organization.

Dean A. Lewis of the California Chapter moved from second vice-president to first vice-president. Ross C. Merchant of the Wolverine Chapter moved from third vice-president to second vice-president and John J. Kopple of the New York Chapter became the newly elected third vice-president.

Harry Halinton of Chicago will serve as national treasurer for the coming year and Dave M. Lee of the Pacific Northwest Chapter as national secretary

Hadden Named V-P Of Minshall Organ

GEORGE HOWARD HADDEN has been promoted to vice-president in charge of engineering at the Minshall Organ Co. of Brattleboro, Vermont, manufacturers of electronic organs.

Hadden has been chief engineer of the Brattleboro plant since 1950. Prior to that he headed the engineering department of the company's plant in London, Ontario, Canada. He has been with the company since 1941.

DuKane Holds Standards Meeting

ROBERT LARSON, chief audio-visual engineer of DuKane Corp. was chairman of the firm's industry-wide meeting held in Chicago to review recommended minimum standards for recording 30-50 cycle automatic sound strip-film productions. New recommended standards will be available from the company.

Transonics Plans Plant Expansion

TRANS-SONIC of Bedford, Mass., manufacturer of electrical and electronic instruments, plans to relocate at Burlington, Massachusetts. The company plans to construct a new plant with 26,000 sq ft of space to house all of its research, engineering and manufacturing activities. The initial unit of the new plant will be built immediately and will double the company's present operating area. Two additional units of similar size are tentatively planned for future construction.

Taylor Receives Janeway Award

LAURISTON S. TAYLOR of the National Bureau of Standards has been presented the Henry Harrington Janeway Award given annually by the American Radium Society for outstanding accomplishments in the field of applications of penetrating radiations in medical science.

Taylor, chief of the NBS atomic and radiation physics division, is responsible for direction of the research programs covering atomic and nuclear constants, electron physics, mass spectrometry, spectroscopy, radioactivity, X-rays, nucleonic instrumentation, high-voltage generators and accelerators such as the betatron and synchrotron, and the evaluation of radiation hazards and protective measures.

Before coming to the Bureau in 1927, Taylor served as a research fellow at Cornell University and worked briefly at the Bell Telephone Laboratories.

Edison Elects Houck, Names Engineer

HARRY W. HOUCK was elected president of Measurements Corp., a subsidiary of Thomas A. Edison.

Houck joined Measurements shortly after its formation in 1939. The company currently produces standard signal generators and other electronic testing equipment. Holding a number of patents in the electronic field he has been responsible since 1941 for the operation of the firm which was purchased by Edison in June 1953. Made vice-president and general manager at that time Houck, as president, succeeds Henry G. Riter 3rd who continues as president of the parent company.

Alan P. Stansbury, formerly with the National Bureau of Standards

Alan P. Stansbury

in Washington, D. C., has joined the Edison Research Laboratory to initiate electronic research and design as required by the various research programs carried out by the laboratory.

He started to work for the Department of Terrestrial Magnetism of Carnegie Institution of Washington, D. C. in the Fall of 1943, and was an observer at the University of Alaska Observatory.

In 1945 he transferred to NBS and was named assistant engineer in charge of the radio wave propagation field station in Trinidad, BWI.

He was made head of the Equipment Development and Supply Group of the Field Operations Section of the Central Radio Propagation Laboratory in 1947.

Raytheon Plans Ceramics Plant

RAYTHEON plans to build a new plant in Waltham, Mass. to provide advanced development and production facilities for ceramics.

The new structure is to be attached to the present administration building and will provide 20,000 sq ft of floor space. Construction cost is estimated at somewhat more than a quarter-million dollars. A greater sum will be represented in the value of the equipment to be housed in the completed building.

The new building will house approximately 125 employees. It will have one of the largest conveyer kilns of its type for the firing of ceramics, plus many special types of furnaces for such processes as sintering, reducing and fusing of powdered alloys, alumina, barium titanates and true ceramics.

Raytheon also announced that it will participate in MIT's cooperative course in electrical engineering.

Under the plan, engineering students of the school are selected for practical experience in the firms' laboratories and factories. Paralleling their academic pursuits with actual work in their chosen careers, these students upon graduation will be awarded simultaneously the degrees of Bachelor of Science and Master of Science.

RCA Cites Ned Owyang

NED K. OWYANG, right, manufacturing engineer at RCA's Tube Division explains changes in tube design to L. S. Thees, general commercial manager of the division, which won him citation in a company program to improve performance and life potential of RCA receiving tubes.

General Instrument Promotes Klabin

ROBERT L. KLABIN has been named vice-president and general manager of the newly-created Elizabeth Division of General Instrument.

The Elizabeth Division, for which Klabin will have full responsibility, is devoted largely to metal fabrication and processing, both on government and civilian contracts. Creation of the new Division is part of an overall company expansion program and is designed to increase operating efficiency.

Klabin joined the company in 1935 as a cost accountant and rose through the ranks to controller and general manager of the F. W. Sickles Division plant in Danielson, Conn., his most recent posts.

Benson Elected V-P By Gyromechanisms

GYROMECHANISMS of Halesite, L. I., N. Y., has elected Robert Benson as vice-president for its western division

Previously Benson was responsible for the design and development of American Gyro's products, and for the organization and management of their engineering department. In the last two years, he has been responsible for the design of miniature rate gyros for more than 60 different applications. He is co-inventor on three patents issued as a result of his work at North American Aviation on "isoelastic" ball bearings, a flotation gyroscope, and on an advanced stable platform for automatic navigation.

TV Plants Planned For Australia

ELECTRONICS INDUSTRIES of Melbourne plans to spend about $1.9 million on new factories and plants for the manufacture of tv receivers and tubes. The announcement followed a report by the Royal Commission on television in Australia, which suggested that tv be introduced without delay.

The managing director of the company, L. G. Warner, is in Europe studying developments in the field. He will visit England and then the U. S. to investigate further improvements. A branch office will be

opened in England so as to keep in touch with new developments in the field.

Eliason Named By Air Associates

M. C. ELIASON was appointed sales manager of the electronic equipment division of Air Associates, in Orange, N. J.

Eliason has been associated with the firm for more than seven years, having served as electronic engineer (1942–44) and electronic project engineer (1945–49) at the company's branch in Los Angeles and later at the company's Teterboro plant.

Earlier in his career, he was engaged in technical engineering and applied research for the California Institute of Technology. Just prior to his present appointment, he was systems engineer for the technical staff research and development laboratories at Hughes Aircraft.

Lueck Joins EMC Recordings

LAURENCE B. LUECK, formerly of the magnetic products division of Minnesota Mining and Manufacturing, has been appointed vice-president and general manager of E. M. C. Recordings of Saint Paul. He has been closely associated with the magnetic products division since its inception in 1948. Basic patents in the field of magnetic tape construction have been issued in his name.

E. M. C. Recordings (Educational—Musical—Cultural) will initially issue educational pre-recorded tapes in the school field. Plans later this fall call for an initial offering of pre-recorded musical tapes. The firm will also issue a series of the great literature of the world on tape accompanied by background music. In addition, a tape playback unit will be marketed, to be offered under $40 retail.

Lear Readies California Plant

LEAR has completed a new administrative and manufacturing facility in Santa Monica, Calif.

The new 50,000 sq ft plant will be used for the manufacture of electronic equipment and is to serve as the administrative offices of the company's LearCal and research and development divisions.

The plant will provide manufacturing area, an engineering department, testing laboratories, office space and special quarters for development work on classified government contracts.

Pelavin Joins Simmonds

BERNARD J. PELAVIN was appointed project manager of the electronics development group at Simmonds Aerocessories.

Pelavin was design staff engineer for electrical and radio at Piasecki Helicopter. He has also been on the engineering staff of Glenn L. Martin and Fairchild.

From 1942 to 1945 he served with the U. S. Navy in the development of radar homing equipment for guided missiles.

Catholic University Names Killian

THOMAS J. KILLIAN, chief scientist of the office of ordnance research, U. S. Army, has been appointed Dean of the School of Engineering and Architecture of Catholic University of America in Washington, D. C. Dr. Killian will assume the position at the beginning of this academic year.

Gudeman Acquires Ceramic Condenser

GUDEMAN COMPANY of Chicago has purchased the ceramic condenser division of Radio Ceramics of Angola, Indiana. The Indiana company disposed of the division in order to expand other lines. Gudeman will absorb it for expansion of its own line of capacitors. Thermflex division of Radio Ceramics will operate as Thermflex Corporation.

Ruge-deForest Names Childerhose

S. RICHARD CHILDERHOSE has been appointed works manager of Ruge-deForest.

He was formerly manager of production of analog computers for ship-borne gun fire control and air-borne bombing systems at Norden Laboratories.

Bruno-New York Industries Expands

THE ASSETS of Computer Corporation of America have been purchased by Bruno-New York Industries. Computer has been established as a new division of Bruno to continue the manufacture of IDA analog computers, precision voltmeters and other products.

Active personnel of Computer Corp., will be retained, and Seymour Bosworth, formerly a vice-president of Computer, has been appointed general manager.

Bacon Opens Impregnation Facility

BACON INDUSTRIES has set up a new department to handle the vacuum impregnation of coils, trans-

formers and other electrical components.

The department is set up to do both prototype work and large lot impregnations using standard or special impregnating compounds.

Bendix Promotes C. M. Granger

C. M. GRANGER, formerly assistant to the general manager, has been promoted to general factory manager of the television division of Bendix. A company veteran of 14 years' service, he will be responsible for all manufacturing departments and facilities of the division.

Yardney Electric Acquires New Building

A FIVE-STORY BUILDING in New York City, containing almost 70,000 sq ft of floor space, has been acquired by Yardney Electric, producer of silver-zinc batteries. The building contains facilities for engineering, research and consolidates production and engineering facilities under one roof. The firm employs approximately 250 production workers.

Federal Names Tube Head

FEDERAL TELECOMMUNICATION LABORATORIES appointed Albert G. Peifer as a department head in charge of low voltage vacuum tube development.

Peifer joined the Laboratories in 1950.

Syntronic Instruments Names Cahill

SYNTRONIC INSTRUMENTS of Addison, Ill. has appointed Bernard S. Cahill vice-president and chief engineer.

Cahill formerly was associated with Pioneer Electric and Research Corp. of Forest Park, Ill. He will supervise Syntronic's deflection yoke division.

Stokes Machine Plans Expansion

F. J. STOKES MACHINE CO. has launched a $1 million expansion program that will enlarge its production facilities by another 40 percent. The new program follows closely an expansion of about the same scale which was completed early in 1951.

Ground will be broken for a 50,000 sq ft addition to the present Stokes plant in Northeast Philadelphia which will provide additional manufacturing space and larger office and engineering department accommodations. The new building is due to be completed by the end of the year.

Page Communications Engineers Organize

PAGE, CREUTZ, GARRISON AND WALDSCHMITT, consulting engineers in Washington, D. C., have formed a corporation, Page Communications Engineers, to take over the design, procurement, construction, installation, testing and operation of radio communications plants, systems, and equipment in the U. S. and foreign countries. The officers of the new corporation are: Esterly C. Page, president; Joseph A. Waldschmitt, executive vice-president; John Creutz, vice-president and treasurer; Charles J. Seeley, secretary and James L. Hollis is the chief engineer.

Jenner Named By Micro Switch

R. R. JENNER has been appointed director of airborne products for Micro Switch of Freeport, Ill., a division of Minneapolis-Honeywell.

Jenner was chief radio and electronics engineer at Beech Aircraft for 14 years.

Gillam Appointed Chief Engineer At Marconi

MARCONI WIRELESS TELEGRAPH announces the appointment of C. Gillam as chief engineer in the communications department. Gillam first joined the company in 1930. He has worked with the transmitter test section and the aerial design and systems divisions. He also spent 4 years in Turkey installing and maintaining high power broadcasting transmitters.

NEW BOOKS

Thermionic Valves—Their Theory and Design

By A. H. Beck. *Cambridge University Press*, 1954, 539 *pages*, $12.00.

This book is divided into three sections. The first section covers the physical theory of electronics, the second covers the mathematical theory of electronics and the third discusses types of tubes. The information contained in these three sections represents the careful condensation by the author of the mass of information on the subjects considered.

In the first section, the basic theory of emission is discussed. Consideration is given to the theory of emission from pure metals and from oxide-coated emitters. Under the latter heading semiconductor theory and its possible application to oxide-coated cathodes are reviewed. Secondary emission, field emission and photoelectric emission are also discussed. In this presentation the Frohlich-Woodbridge theory and the Kadyshevich theory of secondary emission are presented in brief. This section concludes with a discussion of the properties of phosphors such as fluorescence and phosphorescence.

The section on the mathematical theory of electronics includes some analytical solutions of Laplace's equation with regard to potential problems. The solution of potential problems by conformal transformations is briefly considered. The rubber-sheet and electrolytic-trough techniques for determining potential fields are discussed. In this section, the basic theory of electron motion in magnetic fields and the principles of electron optics are also considered. Fluctuation noise in tubes is discussed, and the results of investigations by such men as Johnson, Nyquist, Campbell and North are briefly reviewed.

Section three, on types of tubes, constitutes one half of the book. In this section, the basic formulas for triode characteristics are derived. In addition, a very informative discussion of the theory of triodes for high frequencies is presented. The

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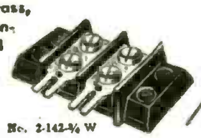

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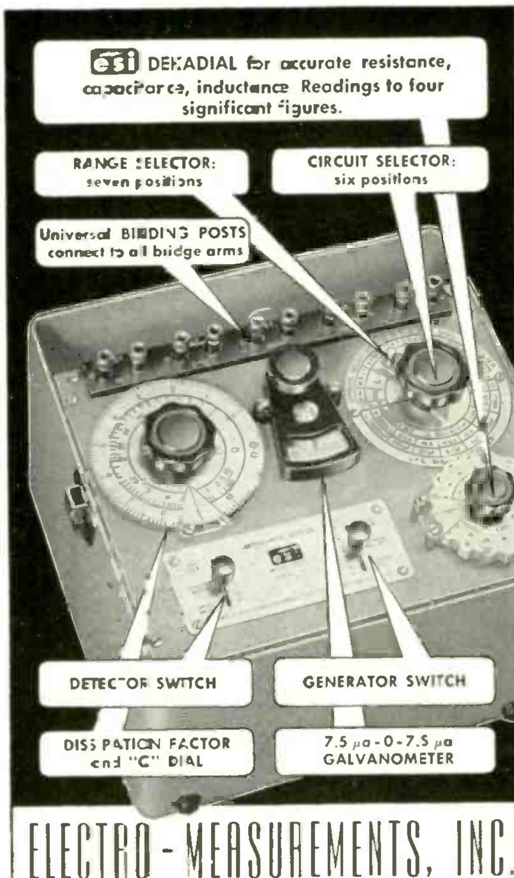

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effect of grid-to-cathode spacing on tube characteristics is discussed. The general theory of multigrid receiving tubes is reviewed. A short section is devoted to transmitting-tube problems. A large portion of the tube section deals with high-frequency types such as velocity-modulated tubes, klystrons, magnetrons and traveling-wave tubes. The theory of each high-frequency type is discussed.

A portion of section three is devoted to triodes for ultrahigh frequencies. Plane-parallel constructions such as the lighthouse series are discussed. This section is not quite up to date in that the cylindrical construction used in such ultra-high frequency tubes as pencil-type triodes has been omitted. In addition to a review of uhf triodes, theoretical discussions of grounded-grid amplifiers and oscillators are presented. The electron behavior at uhf frequencies and its effect on tube characteristics are discussed. The concluding portion of the tube section is devoted to picture converters and storage tubes. The principles of the iconoscope, image iconoscope, orthicon, image orthicon, graphecon and barrier-grid storage tube are discussed.

This book clearly and concisely presents the basic theory of thermionic tubes and the design features of conventional receiving tubes. Those interested in electronics will find it basic. The book is well written and should prove useful to any tube engineer.— C. M. MORRIS, *Tube Division, Radio Corporation of America, Harrison, N. J.*

Introductory Circuit Theory

BY ERNST A. GUILLEMIN. *John Wiley and Sons, Inc., New York,* 1953, 550 *pages,* \$8.50.

THIS IS a very difficult book to review. It has many virtues, a thoroughly modern point of view, and as far as "linear, passive, lumped, finite, bilateral circuit theory" is concerned, is a complete and exhaustive treatment.

It is "intended to be an introductory course in circuit theory" and is taught to sophomores in both physics and electrical engineering.

The first three chapters represent a quite elaborate discussion of d-c circuits in 188 pages and serve to lay a philosophical or geometric basis for network analysis. Chapter 3 introduces the use of determinants and works out the basic transformation and reciprocity theorems, including a study of invariance for resistance networks.

Chapters 4 to 8 are intended as a possible one-semester course on linear circuit theory, including transients. Chapters 4 and 5 introduce the volt-ampere relations for inductance and capacitance elements, largely in terms of the unit step and impulse functions, including generalization of some of the basic network theorems. Chapter 6 studies the behavior of simple circuits in the sinusoidal steady state, including an initial discussion of the complex frequency plane. Chapter 7 discusses the energy and power relations in such simple circuits. The final chapter (8) in this group generalizes the sinusoidal steady-state condition for more general passive networks. It introduces the concept of mutual inductance and the analysis of polyphase networks.

For students able to take a full-year course, it is recommended that some of the material be transferred to the semester in which Chapters 1 to 3 are studied and that Chapter 9 be added to complete the year's work. In this chapter, the subject of transient response is generalized, and the complete solution for any finite lumped network is developed. Here the concept of complex frequency is fully developed and frequency and time domains are introduced and illustrated by means of numerous interesting examples.

Even for a full year's course the author suggests that "Chapter 10, which rounds off and generalizes some of the previous discussion, remains as a collateral reading assignment, or as a reminder that the study of circuit theory has no ending". This chapter "supplies a certain generality and completeness to the derivation of the general equilibrium equations and energy relations".

The examples are numerous and well chosen. The book is profusely illustrated. The index is adequate. The format is clear and easily read.

The main complaint of this reviewer is that such an exhaustive introduction to circuit theory tends also to be exhausting. If, as seems necessary to cope with the expanding technology, it is going to be necessary to teach the fundamental theories at an earlier age, it would seem to be an obligation on the part of an author to be selective both in what he presents to the student and in how he presents it. Hard writing makes easy reading, and over-elaboration in material dilutes comprehension. To such comment as the last, Professor Guillemin replies: "In answer to such comment I can only say that. . . . I could see no point in deliberately stopping before I had finished what I had to say and what I consider to be a minimum of necessary material to form a good background on which to build later". The first result of this frame of mind is a preface fifteen pages long.

The next serious complaint is a carelessness of subscript notation throughout the book which will force the student to unlearn much when he undertakes the study of active networks. While it may be satisfactory to define

$$Z\,12\,(s) = E_1/I_2 \qquad (109$$

in one equation and

$$Z\,12\,(s) = E_2/I_2 \qquad (163)$$

in another, this reversal will quickly bring one to grief in an analysis of an active nonlinear network.

This second flaw could be readily cured by careful editing, but I fear that the first one would require a completely new approach. It is highly desirable that at long last someone write a simple, straightforward, closely written introduction to modern circuit theory. Unfortunately, this book, which is in many ways so excellent, is not it. —KNOX MCILWAIN, *Hazeltine Electronics Corp.*

THUMBNAIL REVIEWS

Materials and Processes. By James F. Young. John Wiley & Sons, Inc., New York, Second Edition, 1954, 1074 pages, $8.50. Expanded coverage of

structure and properties of rubber, ceramics, porcelain, glass and other nonmagnetic materials, along with new sections on tarnishing, electric contacts and nondestructive testing, are features of this new edition of a General Electric Series text for design engineers.

Receiving Tube Substitution Guide Book. By H. A. Middleton. John F. Rider Publisher, Inc., New York, Second Supplement, 1954, 48 pages, $ .99. Television receiving tube substitutions, including picture tubes; many are applicable to industrial electronic equipment and communication equipment.

Introduction to Color TV. By M. Kaufman and H. Thomas. John F. Rider Publisher, Inc., New York, 1954, 140 pages, $2.10. Basic principles and basic circuits, for engineers not now familiar with color television processes.

History of American Industrial Science. By Courtney R. Hall. Library Publishers, New York, 1954, 453 pages, $4.95. Includes one 34-page chapter on The Electrical and Communications Industries, summarizing major developments.

Six-Figure Mathematical Tables. By L. J. Comrie. Chemical Publishing Co., Inc., Brooklyn, New York, 387 pages, 1954, $6.50. Trigonometrical functions and logarithms thereof, circular functions, exponential and hyperbolic functions.

UHF Conversion, Installation, Service. Westinghouse Electric Corp., 36 pages, 1954, $1.00. Antennas and lines. conversion data, graphs and charts. For the service man and anyone wanting medium-technical material.

UHF TELEVISION WITH SECTION ON VHF TUNERS. By Edward M. Noll. Paul H. Wendel Publishing Co., P. O. Box 1321, Indianapolis; 72 pages, 1953, $1.00. Practical technical data on vhf-uhf tuners, uhf antenna performance, uhf propagation characteristics and uhf converters. A nicely arranged, well illustrated large-format book for the serviceman.

Television and Radar Encyclopedia. Edited by W. MacLanachan. Pitman Publishing Corp., New York, N. Y., 1953, 216 pages, $6.00. Definitions of terms in common use in Great Britain and U. S., including new coined words that may or may not pass into the recognized terminology of television and radar. Primarily intended for technicians and laymen, but contains sufficient data to have reference value for engineers as well.

Electric Control Systems. By Richard W. Jones. John Wiley & Sons, Inc., Third Edition, 511 pages, 1953, $7.75. For senior college students. Motor control systems of all types, with excellent chapters on gaseous electronic switching devices, electronic switching circuits and power amplifiers of the dynamoelectric and magnetic amplifier types.

BACKTALK

Silicon vs Germanium

DEAR SIRS:

I SHOULD like to call your attention to two statements which appear in the article titled, "Silicon Invades Junction Diode Market", on page 12 of May ELECTRONICS.

First, you state that "silicon diodes do everything that germanium diodes do and do it better." Actually, recovery time and cut-off frequency for comparable d-c characteristics are poorer in silicon than in germanium. Furthermore, the very low carrier mobilities in silicon appear to be a fundamental obstacle to further improvement in the characteristics of silicon devices.

Second, you state that "germanium diodes tend to break down under ambient temperatures between 65 and 75 C." You may be interested in learning that we have made germanium point-contact diodes which have over 200,000 ohms back resistance at 100 C, and over 50,000 ohms at 125 C. Also, we can manufacture these diodes with sufficient control so as to be able to sell them at prices only slightly higher than ordinary germanium diodes.

Your article does not refer to point-contact diodes by name and does, in fact, use the term "junction diodes" in the title, but in the text the all-inclusive term "germanium diodes" is used; hence this letter.

L. S. PELFREY
Manager
Germanium Division
International Rectifier Corp.
El Segundo, California

(Editor's Note: We agree, we did mean junction diodes, but are glad to present data on improved point-contact germanium diodes at this time.)

Teacher Speaks

DEAR SIRS:

SINCE I am responsible for the conduct of a very large operation in undergraduate electronic engineering education and currently searching the country for "qualified" engineering teachers, I would like to comment on your current teacher vs engineer discussions.

First, since man seems "to live by bread alone", let's look at the salary picture. Mr. McMurtrey, in the May issue *Backtalk* column, states that his colleagues are making from 2 to 4 times their former annual teaching salaries. Average teaching salaries amongst my colleagues are around $500 per month, payable for 12 months, for nine months of resident work. Our scale is neither the highest nor the lowest in engineering colleges.

From this I have to conclude (very unscientifically) that Mr. McMurtrey and his colleagues are earning from 12,000 to 24,000 dollars a year, with the usual two-week vacation. (That doesn't give much time to spend this dough.) I am sure the readers (engineers and teachers) of ELECTRONICS are able to judge the accuracy of this claim.

I believe the old engineering adage "salary is secondary" plays a more important role in this matter than most of us are willing to admit. Having spent an equal number of years in industry and teaching, I find that teaching is harder if you want to really do something about it. Both teachers and colleges (vs industry) tend to idealize every situation. One of the results has been some arbitrary hiring requirements which have chased some good men away from teaching. We are being forced to be more realistic in this matter.

C. RADIUS
Head of Dept., Electronic Engineering
California State Polytechnic College
San Luis Obispo, California

(Editor's Note: Welcome to the discussion. Further comments are invited from engineers and teachers on any of the various factors involved, such as money, job satisfaction, achievements, surroundings, social aspects, and so on.)

Range Control

DEAR SIRS:

WE HERE at Victory Engineering Corporation have come to look upon ELECTRONICS as the leading technical magazine in the electronics field.

In your March, 1954 issue, on page 12, under the heading "Industry Report" we note the following:

"Range-top thermostats that use a phototube to sense pan temperature and avoid scorching food were introduced last year on Westinghouse's top model electric range. The device is available this year on both double and single-oven models in the premium line."

This statement by your own good selves happens to be entirely erroneous since neither a thermostat or a phototube are utilized in the Westinghouse range to sense pan temperature and avoid scorching the food. The sensing element utilized is a thermistor, and we are proud to state that the thermistors used in this connection were a development of our Engineering Department in connection with Westinghouse engineers and are VECO thermistors.

B. J. OPPENHEIM
General Manager
Victory Engineering Corporation
Union, New Jersey

(Editor's note): First mention of the sensing element in ELECTRONICS (Industry Report, p 18, April, 1953) identified it as a thermistor but the editors were misled by recent news stories which stated that the Westinghouse range line featured "a new automatic Corox with Electronic Eye surface unit on Commander double-oven range . . . Electronic eye unit measures temperature of food cooking in pan and maintains it automatically by turning current off and on as needed . . .Electronic Eye unit holds deep fat frying temperature."

Transistor Amplifier

DEAR SIRS:

READING the article "High Frequency Transistor Amplifier" by W. F. Chow in April, 1954, ELECTRONICS (p 142), I encountered Eq. 11 which expresses the conditions for maximum power transfer from one amplifier stage to the next one.

I should like to point out that this condition is not correct, and that it should be

$$g_i' = g_o'$$

as can be seen from the following. It will also be demonstrated that more favorable conditions than those indicated by Eq. 12 can be achieved.

Using the notations of the paper

$$Q = \frac{\omega_o C'}{g_o' + g_l + g_i'} \qquad (13)$$

$$\text{and } Q_o = \frac{\omega_o C}{g_l} \cong \frac{\omega_o C'}{g_l} \qquad (14)$$

Now the power supplied to the load g_i' is

$$P_o = \frac{i'^2}{(g_o' + g_l + g_i')^2}\, g_i'$$

$$= \frac{i'^2}{4g_o'} \frac{4g_o' g_i'}{(go' + g_l + g_i')^2}$$

$$= \frac{i'^2}{4g_o'} \frac{4g_o' g_i' Q^2}{\omega_o^2 C'^2}$$

in view of Eq. 12.

As $\frac{i'^2}{4g_o'}$ = Power available = P_{av}

$$P_o = P_{av} \frac{4Q^2}{\omega_o^2 C'^2} go' g_i' \qquad (1)$$

For a given Q

$$g_o' + g_i' = \text{constant} \qquad (2)$$

The constancy of Q and the condition expressed by Eq. 2 will make P_o maximum when

$$g_o' = g_i' \qquad (3)$$

as stated previously.
from Eq. 13, 14 and the writer's Eq. 3,

$$\frac{1}{Q} - \frac{1}{Q_o} = \frac{2g_o'}{\omega_o C'}$$

$$g_o' = g_i' = \frac{\omega_o C'}{2} \left(\frac{1}{Q} - \frac{1}{Q_o} \right)$$

$$= \frac{C'}{2} (\Delta\omega - \Delta\omega_o) \qquad (4)$$

substituting Eq. 4 into Eq. 1,

$$P_o = P_{av} \left(\frac{Q_o - Q}{Q_o} \right)^2 \qquad (5)$$

Therefore the loss factor

$$F_p^* = \left(\frac{Q_o - Q}{Q_o} \right)^2 \qquad (6)$$

I call the loss factor F_p^* to distinguish it from that in Eq. 12 in the article.

Using the author's Eq. 11, 12, 13 and 14,

$$F_p = \frac{Q_o - 2Q}{Q_o} \qquad (7)$$

and $$\frac{Fp^*}{F_p} = \frac{(Q_o - Q)^2}{Q_o (Q_o - 2Q)}$$

$$= 1 + \frac{Q^2}{Q_o (Q_o - 2Q)} \qquad (8)$$

If Q has a value permitted by Eq. 11,

$$F_p^* > F_p$$

In my opinion the expression "loss factor" is unfortunate, since it increases with decreasing loss.

I should like to point out that if the circuit is designed according to the paper the Q of the circuit cannot be greater than $Q_o/2$; but if the above outlined procedure is followed Q can have any value up to Q_o.

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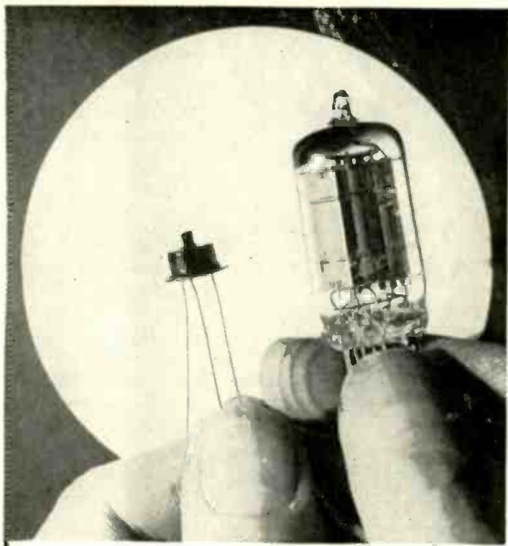

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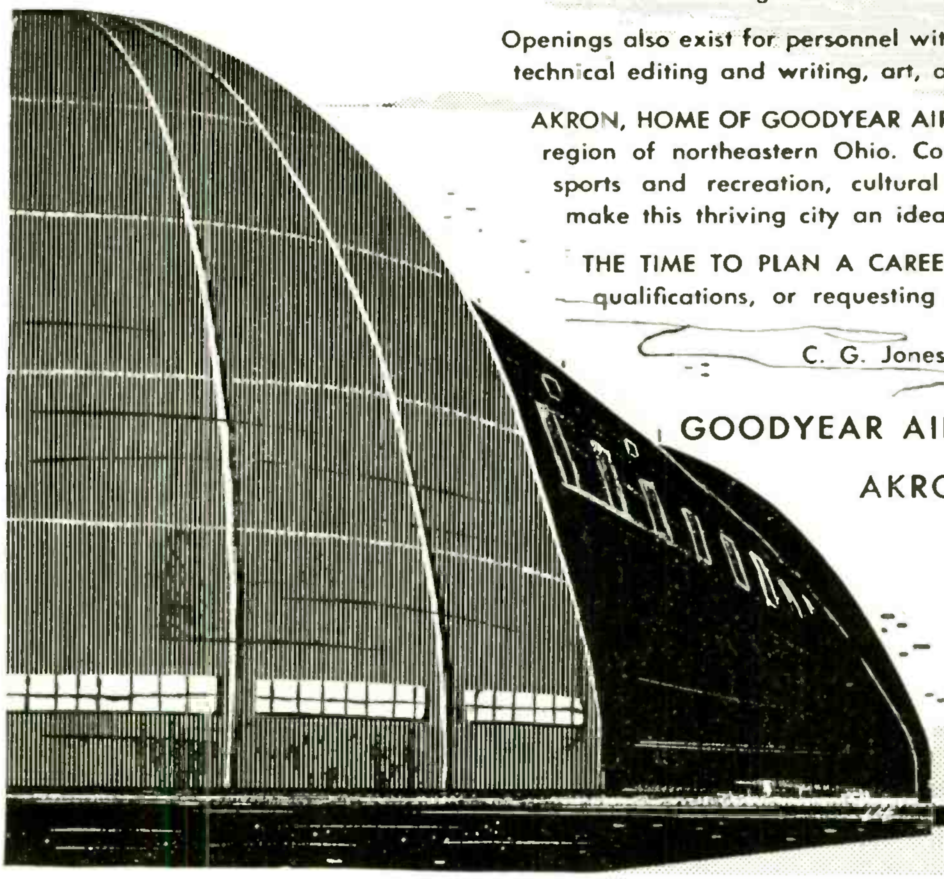

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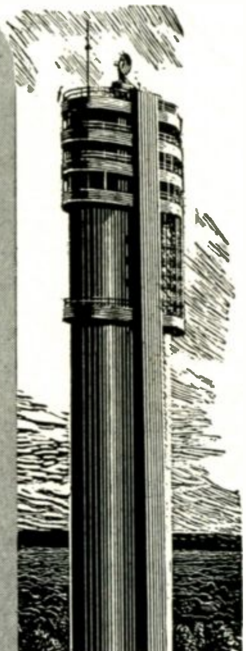

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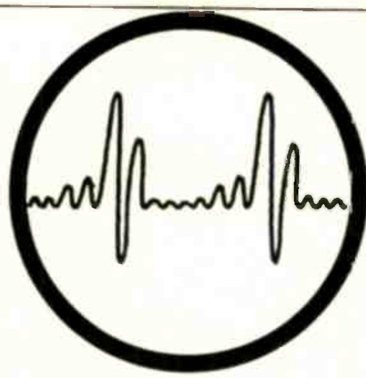

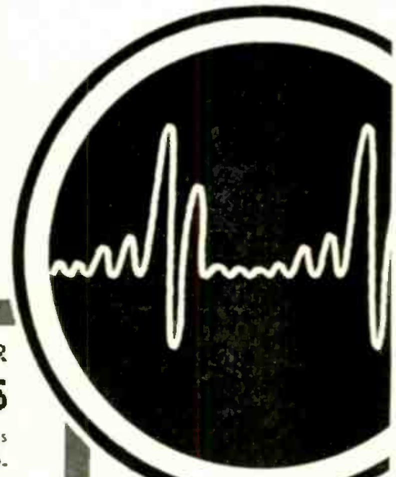

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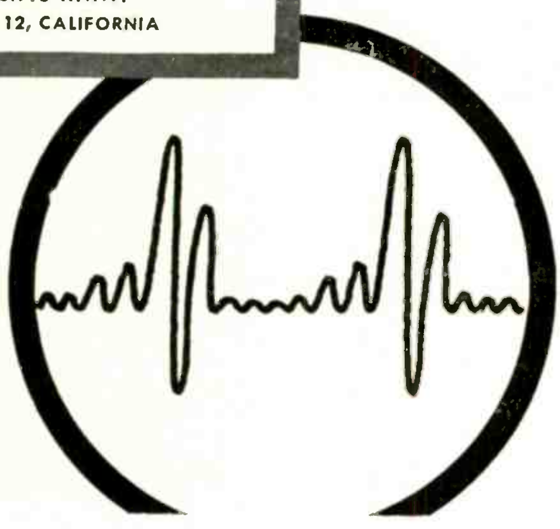

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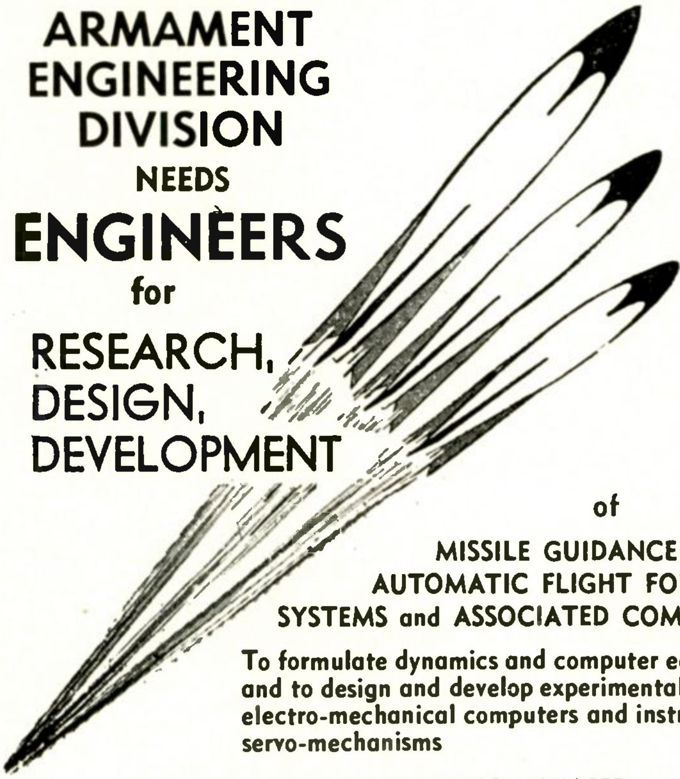

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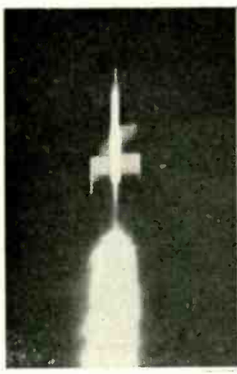

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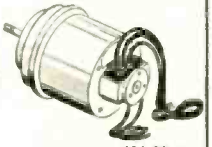

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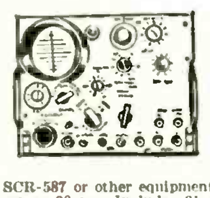

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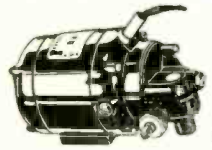

10.1 Gear Ratio: Motor operatos: 24 VDC, 2 Amps, 1/50th H.P., 5000 RPM.
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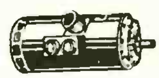
2¼ H.P. MOTOR—Mfg. LEECE-NEVILLE Co; Type 1454-MO; 24VDC; 4000 RPM; 100 amp.......$35.00

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

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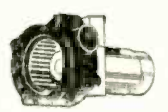

BLOWER: Mfg. John Oster; Type C2A-1B; 27 VDC; 63 amps; 1/100 H.P.; 7000 RPM; Series Wound ....$9.95 ea.

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL. 17CFM, complete with capacitor. New..............$9.95 ea.

TEST EQUIPMENT

TS 13/AP	$650.00
TS 35/UP	495.00
TS 45/APM	195.00
TS 51/APG	95.00
TS 59	69.50
TS 61/AP	69.50
TS 76/APM	79.50
TS 80/U	14.95
I-96-A	195.00
TS 251	650.00
LZ Signal Generator	149.00

C & H SALES CO

2176 East Colorado Street • Pasadena 8, California • RYan 1-7393


AMPLIFIER UNIT Magnetic
Mfr. Pioneer Instrument Type 12071-1-A; 110 volts, 400 cycles; 26 volts, 400 cycles; 4 tube (12AH7-GT); take-off for four autosyns . . .
$29.95 ea.
REMOTE INDICATOR
Mfr. PIONEER, Type A100-1E; 360° directional dial; 26 volts; 400 cycle; 3" dia. dial; contains AY 34 Autosyn.
$4.95
PIONEER TORQUE UNITS
Type 12602-1-A. Includes CK 5 motor coupled to output shaft thru 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY-43). Ratio of output shaft to follow-up autosyn is 30:1. Includes base mounting type cover for motor and gear train . . .
$34.95 ea.
TREMENDOUS SAVINGS IN
ELECTRONIC
WAR TERMINATION INVENTORIES
SAVE UP TO 85% • IMMEDIATE DELIVERY • EQUIPMENT FULLY GUARANTEED
MOTOR
Mfg. Barber-Colman Co.; shaded pole; 1500 RPM; shaft 1/8" x 5/8"; overall size 1½" x 2¼" x 2⅝"; includes mounting bracket . . .
$1.50 ea.
SYNCHRO TRANSMITTERS
Mfr. Kearfott; Type R-212-1A-A; ROTOR — 1 phase, 26 volts. STATOR — 3 phase, 11.8 volts, 400 cycle. Overall size: 1-1/16" dia. x 1-11/16" long shaft 3/16" long; Includes mounting bracket . . .
$19.95 ea.
TIME DELAY RELAY
Delay action is accomplished by a Telechron motor with a mechanism calibrated in 15 sec. steps, and adjustable from 15 sec. to 5 min. Timer contacts are S.P.D.T. and rated at 12 amps. Instantaneous Recycling. 115 VAC coil operation . . .
$7.95 ea.
TELECHRON SYNCHRONOUS MOTOR
Type 3C; 110 Volt; 60 Cycle; 60 RPM; with mounting bracket . . .
$3.95 ea.
SCHWEIN REMOTE CONTROL DUAL GYRO
Type 45600 Free & Rate Gyro. Contains two 28 VDC constant speed gyros . . . vertical and horizontal. Both gyros exceed 30,000 RPM. Size: 8" x 4½" x 4½". Complete with metal cover . . .
$22.50 ea.
HIGH PRESSURE TURBO-COMPRESSORS
12 cfm at 35 oz.; ¾ HP, AC/DC; 115 volts; 25 to 60 cycles. No. BL12SP . . . Powered by Black and Decker AC/DC, ball-bearing, cont. duty, int. fan cooled, high speed, single phase motors . . .
$49.50 ea.
SYNCHRON TIMER
Model 600; 4 RPM; 110 Volt AC; 60 Cycle . . .
$2.20 ea.
AUTOSYN MOTORS
Mfr. Bendix Type 851; 32 volts AC; 60 cycle; single phase; Size: 3¼" l. x 2⅝" dia. 1/8" shaft . . .
$19.95 pr.
WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F. O. B. PASADENA, CALIFORNIA.
C&H
SALES CO.
2176-E East Colorado St.
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RYan 1-7393
MINIATURIZED SELSYN
Mfr. Henschel Corp.; 115 volts; 60 cycle; .22 amp. Type "N" Indicator Motor with dampener. Brass encased. Approx. size: 2¼" dia. x 3½" length . . .
$19.95 pr.
PRECISION PLANETARY DIFFERENTIAL
1:1 reverse ratio, ring gear 3" dia., 120 teeth. Overall length 5¼". shaft dia. 11/32", 1/8" key on one end. Shaft length on keyed end ¾", 5/8" on other end. Gear on ring 1-11/32", 52 teeth. Shaft ends have ¼-28 threads. Construction principally brass . . .
$4.95 ea.
VARIABLE SPEED DRIVE
Mfr. Western Elec. Type 3717 Ball Integrator Model. Forward and Reverse; Input Shaft, 23/32" long x 5/16" dia. Output shaft, 23/32" long x 3/16" dia. Speed Control Shaft, 23/32" long x 11/64" dia. Torque adjustment. Approx. size: 5" x 5" x 2½". Brass construction.
$17.50

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

10 CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices $27.50

10 CM ANTENNA ASSEMBLY: 3000-3300 Mc. Parabolic Dish, 29 inch Diam. Fed from dipole Rotation: 360 Deg. Azimuth at speeds of 20 and 10 RPM. Tilt: 20 deg. above and below horizontal. Motor-Driven by 2-28V motors, 4.5 A Total Drain. Azimuth info. is fed to selsyn mechanism, and elevation data is obtained from Azimuth potentiometer. Net weight 65 lbs. $78.50

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" output connectors .... $22.50 EACH

DIRECTIONAL COUPLER. Broadband type "N" Coupling, 20 db. with std flanges, Navy #CABV47A-AN-2 .... $32.50

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 $22.50

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $27.50

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 2700-2900 MC $4.00

WAVEGUIDE to ⅞" Rigid Coax "Doorknob" Adapter Choke Flange Silver Plated Broad Band $32.50

AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50

HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284 .... $2.75

I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—less tubes $24.00

BEACON 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

3 CM.—RG 52/U Waveguide

FLEX. WAVEGUIDE SECTION, 1 ft. long. Width UG-40/UG-39 flanges. Attenuation is less than 0.1 db. at 9375 mc. and VSWR is less than 1.02. Rubber covered $7.50

3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute Elevation Scan: over 2 deg. Tilt: over 24 deg. $85.00

Cross-Guide Directional Coupler, UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal $22.50

VSWR Measuring Section: Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks, mounted ½ Wave apart $7.50

RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated .... per length $5.00

Rotating-joints supplied either with or without deck mounting. With UG40 flanges .... each, $17.50

Bulkhead Feed-thru Assembly $15.00

Pressure Gauge Section with 15 lb. gauge $10.00

Directional Coupler, UG-40/U Take off 20db $17.50

TR-ATR Duplexer section for above $8.50

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 Bandwidth: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator $175.00

ADAPTER, waveguide to type "N", UG 81/U, p/o TS 12, TS-13, Etc. $14.50

ADAPTER, UG-163/U round cover to special bbl. Flange for TS-45, etc. .... $2.50 ea.

3CM Motor-Driven Echo Box

Cavity Q is 30,000. Tuning range 80 mc Motor operates from 24 VDC. Type "N" INPUT $32.50

1¼" x ⅝" WAVEGUIDE

VSWR SECTION. 6"L, with 2-type "N" pickups mounted ½ wave apart $7.50

GG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD ... $7.50

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 $22.50

Bi-Directional Coupler. UG-52. Takeoff. 25 db. coupling $17.50

Waveguide-to-Type "N" Adapter. Broadband ... $17.50

CATHODE RAY TUBES

3FP7* ... $1.50 5FP7* ... $1.50
3EP1* ... $2.50 *Mfrs. Quantity

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345-9405	50		$8.75
2J22	3267-3333	265		7.50
2J26	2992-3019	275	.002	7.49
2J27	2965-2992	275	.002	19.95
2J29	2914-2939	275	.002	44.95
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
4J38	3550-3600	750	.001	169.45
4J42†	670-730	30	.003	169.50
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	7.50
QK259	2700-2900	800	.001	249.50
QK60†*	2840-3005	.100	CW	85.00
QK61†*	2975-3170	.100	CW	85.00
QK62†*	3135-3350	.100	CW	85.00

*—Packaged with magnet.
†—Tunable over indicated range.

KLYSTRONS

723A	$12.50	2K25/723A/B	$27.50
723A/B	19.50	417-A	17.50

MOD. MCG BATTLE AMPLIFIER

Entire unit consists of 2 150-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 from 115 v, 60 cy. 1 phase $350

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 Req'd. Brand New. Complete with schematic and all tubes $375.00

VARISTORS

D-167208	$1.35	D-171812	$1.63
D-171858	$1.42	D-172155	$1.50
D-168687	$1.35	D-167176	$1.25

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

—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—

TSX-4SE	TS-12	TS-159
TS-35A	TS-56	TS-968
TS-47	TS-34	TS-238

Sickles Model III Range Calibrator $365.00

TS 98A/AP Voltage Divided .... $ 75.00

TS 90 Dummy Load, 50 Ohms Impedance will handle 500 watts at peak of 5000 volts. Divider ratio 50:1 .... $145.00

TS 235/UP Dummy Antenna 500-1500 MC Impedance: 50 Ohms 1000 watts average power $225.00

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

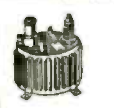
PULSE TRANSFORMERS

Westinghouse 4P37: Primary: 50 ohms imp. 750 v. Sec. 15 kv, 1000 ohms imp. Bifiar filament trans. built-in, delivers 12.6 v at 2.5 amp. (pri. 115 v, 400 cy.) $37.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: .001 400 CYCLE FIL. TRANS. "BUILT-IN" $42.50

WECO: 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 Bifiar: 1.5 amps. (as shown) ... $62.50

GE #K2748-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. Bifiar 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. Bifiar: 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. Bifiar: 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 $5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg $5.00

68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA $4.50

TR1049 Ratio 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms $6.75

K-904695-501: Ratio 1:1. Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95

Ray UX 7896—Pulse Output Pri. 5v sec. 41v $7.50

Ray UX 8442—Pulse inversion—40v + 40v $5.50

PHILCO 352-7250, 352-7251, 352-7287

RAYTHEON: UX8693, UX5986, UX-7307 .... $5 ea.

W.E.: D-166310, D-166638, KS9800, D-163247.

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

D-166173: Input: 50 ohms Z. Output: 900 ohms 3 Wdgs. Freq. range 10 kc-2mc. P/O AN/APQ-13 .... $12.50

K-2450: Pulse-inversion auto-transformer: primary 13 kv, 4 usec. Output: 14 kv @ 100 kw peak $34.50

PULSE NETWORKS

15A—1-400-50; 15 KV. "A" CKT, 1 microsec. 400 PPS. 50 ohms imp $37.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3 KV "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

H-616 10KV, 2.2 usec., 375 PPS, 50 ohms imp. $27.50

H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp. $27.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A, 32—40H @ .08A, 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

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses: 1-715B, 4-829-B, 3-72's, 1-73. New .... Less Cover—$135

ASD Modulator Units, mfd. by Sperry. Hard tube pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes $85.00

Airborne RF head, model AIA, delivers 50 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes $185.00

MICROWAVE ANTENNAS

AT49/APR—Broadband Conical. 300-3300 MC. Type N Feed $8.95

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New $100.00

Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50

AS14A/AP. 10 CM pick up dipole assy, complete w/length of coax and "N" connectors $4.50

AS46A/APG-4 Yagi Antenna, 5 element array ... $22.50

30" Parabolic Reflector Spun Aluminum dish $4.85

APS-34 Pillbox Antenna, waveguide input: 24,000-27,000 MC $22.50

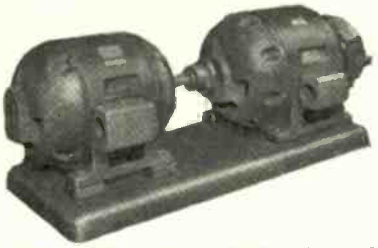
SCR 584, Dishes Perforated, Metal Construction $185.00

TPS-3, 10 Ft. Dish, "Chicken Wire" Parabola, Extremely lightweight, portable $125.00

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O.D. RATED CONCERNS SEND P. O.

131 Liberty St., New York 7, N. Y. Dept E-7 Chas. Rosen Phone: Digby 9-4124

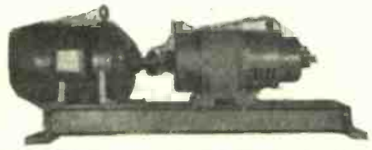
SUPERIOR VALUES FROM
AMERICA'S LARGEST ELECTRICAL CONVERSION HOUSE



General Electric Frequency Changer. Motor: 30 HP. Triclad, 550/3/60, 3600 RPM. Direct connected to Frequency Converter. Model 5MM445BJ1, with secondary of 30 KW, 440 volts, 3 phase, 240 cycles. Price $1550.00

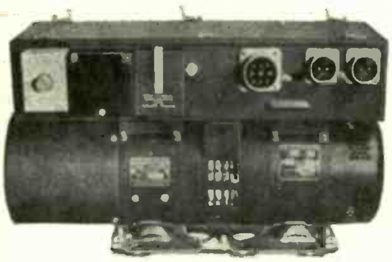
General Electric Frequency Changer. Motor: 20 HP, Triclad, 220-3-60, 3600 RPM. Direct connected to Frequency Converter. Model 5MM1365-AA1, with secondary of 10 KW, 220 volts, 3 phase, 420 cycles $1095.00

General Electric High Frequency MG. Motor: 20 HP, Triclad, 220/440-3-60, 3495 RPM. Direct connected to Alternator, Model 5A327A1, 10 KVA, 80 volts, single phase, 900 cycles, with direct-connected exciter. Complete with factory-built instrument panel having volt, amp. and frequency meters. $845.00

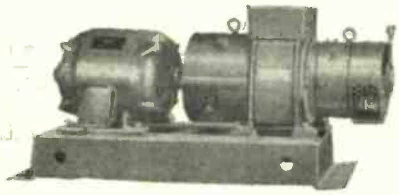


Leland MG Set. Consists of 5 HP Motor operative at 220-3-60 direct connected to self exec. alternator with output of 3 KVA, 120/208 V., 3 ph. 400 cyc. PRICE $750.00

Leland MG Set. Consists of 4 HP Motor operative at 220-3-60 Direct Connected to Self Exc. Alternator with output of 2KVA, 115 V., 1 Phase 400 Cyc. Price $488.00



Wincharger PU-7/AP: Input 28 VDC. 160 Amps. Output: 115 VAC. Single ph. 2500 V.A. 400 C.P.S. Frequency and voltage regulation $97.00



Bogue Laboratory 400 Cycle Supply. Motor 7.5 HP, 220/440-3-60 direct-coupled to self-excited alternator output. 5 KVA. 120/208 V. 3ϕ, 400 Cy. Voltage regulated. Harmonic content less than 1%. NEW $1475.00

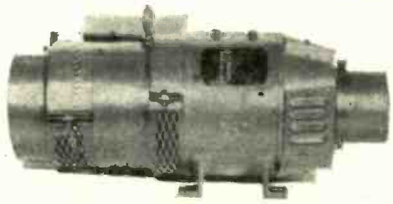
Onan 400 Cycle MG Set. Motor: 5 HP, 220/3/60. Generator: 2 KW, 115 volts, single phase, 400 CPS, self excited with secondary output of 26 volts DC, 200 watts. V-belt drive. Price $635.00

Louis-Allis 3 Unit MG Set. Consists of 5 HP motor operative at 220/440-3-60 directly coupled to alternator with output of 115 volts, 1 ph., 400 cyc. and with exciter unit all mounted on steel base. Price $565.00

Phone HA6-2480

Esco Frequency Changer. Type BFRS54, Pri 220/3/60, 3600 rpm, Sec 5 KVA, 3 KW, 250 Volts, 1 ph, 180 cycles $225.00

Great Lakes 400 Cycle Units—These are compact, 2-bearing machines completely rebuilt and guaranteed, with output of 2 KVA, 120 volts, single phase, 420~. With motor operative at 220/440 volts. 3ϕ. 60~. Price: $320.00

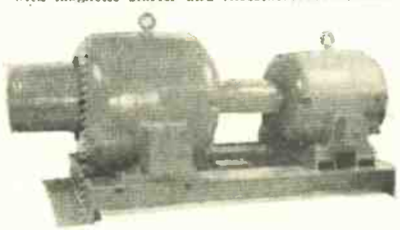


Continental 800 Cycle MG. Type CC21636, Motor: 1.5 HP, 120 VDC, 3440 RPM, directly connected Alternator with output of 120/1/800, 6.6 Amps, also 14 VDC, 4 amps $114.50

Type CC21637 Same unit but with 230 VDC motor. $119.75

Type CC21607 Same unit with 220/440/3/60 motor. $155.00

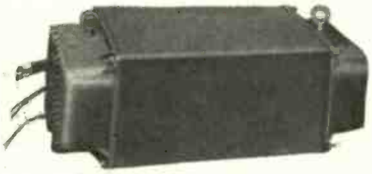
Bogue High Frequency MG. Type CGU211285. Motor: 120/80 VDC, 4000 RPM, 4 HP. Alternator: 115/1/400, 1.6 KVA, .9 P.F. DC Generator: 29.5 volts, 16 amps. Frequency regulated. Complete with magnetic starter and rheostat $325.00



Kato Motor Generator Set. Motor: 75 HP, 220/440 V, 3 Ph., 60 Cyc., 1750 RPM. Direct connected to Alternator: 120/208 V, 3 Ph., 400 Cyc., 50 KVA, 40 KW. Model 57EPOS. Total harmonic content 2%. Voltage regulation 1% $4,750.00

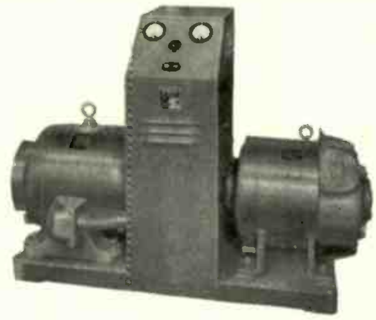
Kato 40-Pole MG Set. Motor: Synchronous, 50 HP, 220/440 V, 3 Ph., 60 Cyc., 1200 RPM. Directly connected to Alternator: 115 V, 1 Ph., 400 Cyc., no load to full load. Total harmonic content 1.5%. Voltage regulation less than 1% by magnetic amplifier $5,950.00

Kato 7.5 KVA MG Set—Motor: 12.5 HP, 220/440 volts, 3ϕ, 60~. Output: 7.5 KVA, 230 volts, single phase, 350~, with direct connected exciter. BRAND NEW. Price: $1,395.00

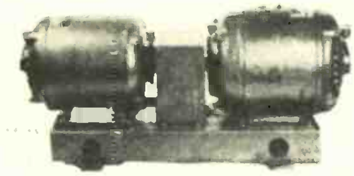


G. E. Saturable Reactors

CAT.	KVA	VAC	CIRCUIT VDC	PRICE
68G987	2.5	460	80	$ 25.00
69G217	6.0	460	125	42.00

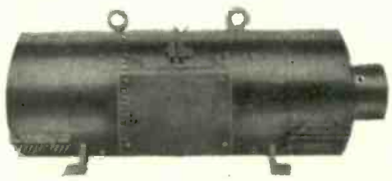


Bardco Motor Generator Set. Model MG-5-AD Motor: 7.5 HP, operative at 220 volts, 3 phase, 60 cycles, 1750 RPM, Frame 284. Direct coupled to Generator: 5 KW, 125 volts DC, 40 amperes, compound wound, drip proof panel includes: Reduced voltage motor-starter, pushbutton, field rheostat, voltmeter, ammeter, also spare parts. New .. $590.00

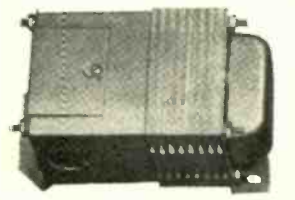


Century Low Voltage Set. Motor: .75 HP, 115/230 V, single phase, 60 Cyc., 1750 RPM. Generator: 27 VDC, 9.3 amps., comp. wound, complete with rheostat. $120.00. With 115 VDC motor ... $85.00

Electric Specialty L.V. MG Set—This unit consists of a motor rated at 1.5 HP, operative at 220/440 volts, 3 phase, 60 cycles, with output of 13/26 volts DC, 38/19 amps., 1750 RPM, shunt wound, continuous duty. Price: $116.50



Continental MG Set. Type CC-21523, Mtr: 230 VDC, 5 HP, 1800 RPM. Gen: 115/1/60, 2.5 KW, .8 P.F., with voltage and frequency regulation, radio filtered $114.50



General Electric Transformers. 60 cycles Cat. #64G678 Autotransformer, .5 KVA, 230/115 volts $14.75

Cat. #61G20, .5 KVA, pri. 460, Sec 115 .... $12.75

Cat. #61G21, .75 KVA, pri. 460, Sec 115 .... $22.00

Cat. #78G214. 1.0 KVA, pri 437/460/483 volts, Sec 115/330 volts $22.50

Cat. #75G970, 1.6 KVA, pri 437/460/483 volts, Sec 115/330 volts $25.50

Cat. #75G885, 2.5 KVA, pri 440, Sec 110 ... $31.50

G.E. Multi-Tap Transformer—Cat. 7406272, 4 KVA. Pri: 230 volts. Sec: 115 volts. 7 taps in 5 volt steps. Auto type. Price: $55.00

Raytheon Transformers — Type CRP-30382. .75 KVA. Pri: 220/440 volts. Sec: 115 volts. 4000 V. RMS. Brand new. Price: $23.50

Jefferson Transformers—Cat. 235-411-003. 1500 VA. Pri: 400/400 volts. Sec: 110/220 volts. Price: $27.45

G.E. Current Transformer—Type JY-285, 150:5 amps., 30:1 ratio, 25/125 cycles, 5000 volt insulation. Price: $13.50

WILLIAM I HORLICK COMPANY

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC, IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Est. in 1922

266 SUMMER ST.
BOSTON 10 MASS.

CRYSTALS

Guaranteed to oscillate!
Your choice of frequencies!
Largest selection in the world!

NOTE! EVERY CRYSTAL TESTED FOR ACTIVITY BEFORE SHIPMENT! All numbers listed are FUNDAMENTAL FREQUENCIES with fractions omitted.

FT-243

Lots of 10 or more. Each 69c
Lots of 5 or more. Each 79c
Individually. Each 99c

1015	2145	2495	2650	2825	2975	3130	3455	6106	6450	7200	7640	7910	8091
1110	2155	2505	2655	2830	2980	3135	3465	6125	6473	7206	7650	7920	8100
1129	2165	2510	2660	2835	2985	3140	3500	6140	6475	7225	7660	7930	8106.6
1150	2175	2515	2665	2840	2990	3145	3510	6142	6500	7240	7666.7	7940	8108
1195	2180	2520	2675	2845	2995	3150	3525	6150	6506	7273	7670	7950	8110
1525	2195	2525	2680	2850	3005	3155	3550	6173	6525	7275	7680	7960	8116
1900	2300	2530	2685	2855	3010	3160	3580	6175	6540	7300	7690	7970	8125
1915	2305	2535	2690	2860	3015	3165	3585	6185	6550	7306	7700	7980	8130
1930	2320	2545	2695	2865	3020	3170	3640	6200	6573	7325	7710	7990	8133
1940	2350	2550	2700	2870	3025	3175	3655	6206	6575	7340	7720	8000	8140
1950	2355	2557	2705	2875	3030	3180	3680	6225	6600	7350	7730	8006	8141
1965	2360	2560	2710	2880	3035	3185	3700	6235	6606	7375	7740	8008	8150
1977	2365	2565	2715	2885	3040	3190	3760	6240	6625	7400	7750	8010	8158.3
1980	2370	2570	2720	2890	3045	3195	3800	6250	6640	7406	7760	8016	8160
1985	2375	2575	2725	2895	3050	3200	3825	6273	6650	7425	7770	8020	8163.4
2010	2390	2580	2730	2900	3055	3202	3885	6275	7000	7440	7780	8025	8166
2015	2415	2585	2735	2905	3060	3205	3940	6300	7006	7500	7783.3	8030	8170
2017	2430	2590	2740	2910	3065	3210	3955	6306	7025	7510	7790	8033	8173
2020	2435	2595	2745	2915	3070	3220	3980	6315	7040	7520	7800	8040	8180
2025	2440	2600	2750	2920	3075	3225	3990	6325	7050	7530	7810	8041	8183
2035	2442	2603	2755	2925	3080	3230	3995	6335	7073	7540	7820	8050	8190
2040	2450	2605	2760	2930	3085	3235	6000	6340	7075	7550	7830	8058	8191
2060	2455	2610	2765	2935	3090	3240	6006	6350	7100	7560	7840	8060	8200
2065	2460	2615	2770	2940	3095	3290	6025	6362	7106	7570	7850	8066	8206
2090	2465	2620	2775	2945	3100	3300	6040	6373	7125	7580	7860	8070	8208
2105	2470	2625	2780	2950	3105	3310	6042	6375	7140	7590	7870	8073	8210
2125	2475	2630	2785	2955	3110	3320	6050	6405	7150	7600	7800	8075	8216
2130	2480	2635	2790	2960	3115	3340	6073	6406	7160	7610	7890	8080	8220
2135	2485	2640	2795	2965	3120	3410	6075	6425	7173	7620	7891.7	8083	8225
2140	2490	2645	2815	2970	3125	3420	6100	6440	7175	7630	7900	8090	

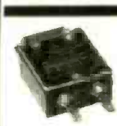
FT-243

Lots of 10 or more. Each 34c
Lots of 5 or more. Each 39c
Individually. Each 49c

4035	4300	4635	4930	5295	5645	5782.5	5906.7	6275	6706.6	6906.6	7625	7975	8475
4045	4330	4680	4950	5300	5660	5800	5907.5	6300	6725	6925	7673.3	8240	8500
4080	4340	4695	4980	5305	5675	5806.7	5925	6306	6740	6940	7675	8250	8525
4095	4395	4710	4995	5327.5	5687.5	5820	5940	6325	6750	6950	7706.6	8273	8550
4110	4397.5	4735	5030	5335	5700	5825	5950	6340	6773.3	6973.3	7725	8275	8575
4135	4445	4780	5035	5385	5706.7	5840	5955	6350	6775	6975	7773.3	8300	8600
4165	4450	4785	5090	5397.5	5725	5850	5973.3	6373.3	6800	7450	7775	8306	8625
4175	4490	4815	5127.5	5435	5730	5852.5	5975	6375	6806.6	7473.3	7806.6	8325	8650
4190	4495	4820	5165	5437.5	5740	5860	5995	6400	6825	7475	7825	8340	8675
4215	4535	4840	5180	5485	5750	5873.5	6206.6	6406.6	6840	7506.6	7873.3	8350	8690
4220	4540	4845	5205	5500	5760	5875	6225	6425	6850	7525	7875	8375	
4255	4580	4852.5	5235	5545	5773.3	5880	6240	6673.3	6873.3	7573.3	7906.6	8400	
4280	4610	4880	5245	5582.5	5775	5892.5	6250	6675	6875	7575	7925	8425	
4295	4620	4900	5285	5587.5	5780	5900	6273.5	6700	6900	7606.6	7973.3	8450	

DC-34 & DC-35 CRYSTALS
Your Choice. Ea. only 99¢

			2220	2390	2586	2776	3023	3317	3610	3770	3935	4085	4255
			2235	2395	2587	2807	3027.5	3365	3630	3775	3940	4090	4275
			2240	2415	2605	2816	3055	3385	3650	3790	3950	4095	4280
			2255	2422	2625	2831	3077.5	3390	3655	3792.5	3960	4097.5	4305
			2258	2435		2851	3095	3395	3665	3807.5	3965	4115	4310
1690	1890	2090	2275	2446	2643	2853	3117	3412.5	3680	3825	3985	4130	4325
1705	1910	2105	2280	2466	2665	2894	3149	3422.5	3695	3830	3995	4135	4335
1720	1930	2106	2295	2467		2995	3155	3462	3700	3850	4012.5	4150	4345
1738	1950	2131	2300	2478	2685	2899	3161	3480		3855	4015	4155	4350
1746	1970		2315	2481	2710	2925	3190	3485		3870	4020	4175	4370
1770	1990	2155	2326	2500	2711	2926	3201	3500		3885	4030	4177.5	4380
1790	2010		2335	2510	2725	2960	3270	3520		3890	4035	4192.5	4397.5
1810	2030	2175	2340	2515	2732	2971	3279	3540		3895	4050	4210	4415
1830	2050	2195	2355	2527	2745	2980	3280	3550	3750	3905	4055	4215	4435
1850	2075	2202	2360	2540	2764	3000	3297	3575	3760	3920	4065	4235	4440
1870	2082	2215	2375	2559	2775	3010	3311	3580	3765	3925	4080	4240	



FT-171

Lots of 10 or more. Each 79c
Lots of 5 or more. Each 89c
Individually. Each 99c

			2123	2280	2415	2582	3010	3422.5	3660	3812.5	3980	4245	5225
			2125	2282.5	2435	2630	3010.5	3500	3667.5	3825	3995	4255	5492.5
			2131	2290	2442.5	2665	3175	3510	3682.5	3870	4012.5	4280	6000
			2145	2300	2467	2725	3202.5	3520	3695	3880	4037.5	4310	6210
			2150	2305	2470	2780	3205.5	3550	3700	3945	4050	4345	7165
			2155	2320	2500	2835	3215	3562	3712.5	3950	4080	4350	7950
1151.8	1940	2045	2191	2340	2532.5	2911	3237.5	3569	3760	3955	4097.5	4360	8000
1562.5	2010	2065	2220	2360	2545	2940	3250	3570	3790	3966.5	4110	4400	9200
1738	2030	2082	2258	2390	2550	2967	3322.5	3580	3807.5	3970	4112	4735	9590
1746	2040	2105	2260	2405	2557	2990	3400	3637.5	3810	3975	4177.5	5200	

DISCOUNTS FOR QUANTITY PURCHASES

WE INVITE INQUIRIES FROM FOREIGN BUYERS, AIRLINES, MILITARY AND EXPORT PURCHASERS, MANUFACTURERS, JOBBERS, WHOLESALE AND VOLUME DEALERS.

NOTE! All items subject to prior sale and change of price without notice. MINIMUM ORDER: $2.50. All orders MUST be accompanied by check, cash or M.O WITH PAYMENT IN FULL. No C.O.D. CALIFORNIA BUYERS add sales tax. INCLUDE APPROXIMATELY 5c PER CRYSTAL FOR POSTAGE. **DEALERS & JOBBERS: WRITE FOR SPECIAL QUANTITY DISCOUNTS.** All buyers invited to write for FREE crystal catalogue giving complete list of frequencies.

COMPLETE SETS

Individually tested and *Guaranteed* to operate!

SCR-508	Channels 0–79. FT-241 HOLDERS. Fundamental crystal frequency range: 370.370 to 516.667 KC. Set of 80 crystals	$35.00
SCR-509 & SCR-510	Channels 0–79. FT-243 HOLDERS. Fundamental crystal frequency range: 5706.7 to 8340 KC. Set of 80 crystals	$32.00
SCR-608	Channels 270-389. FT-241 HOLDERS. Fundamental crystal frequency range: 375.000 to 540.277 KC. Set of 120 crystals	$48.00
TRC-1	Channels 70–999. In 2 types of holders: TRANSMITTER Crystals in FT-241 HOLDER. Fundamental crystal frequency range: 729.167 to 1040.625 KC. RECEIVER Crystals in FT-243 HOLDER. Fundamental crystal frequency range 7500 to 8750 KC. MATCHED PAIR (1 transmitter crystal and 1 receiver crystal)	$1.50
	SET OF 300 TRANSMITTER CRYSTALS	$300.00
SCR-609 & SCR-610	Channels 270–389. FT-243 HOLDERS. Fundamental crystal frequency range: 5675–8650 KC. Set of 120 crystals	$48.00

FUNDAMENTAL OUTPUT FREQUENCIES

4035	4280	4495	4710	4930	5205	5397.5	5587.5	5780	5950
4080	4330	4540	4780	4980	5245	5437.5	5645	5820	5995
4165	4397.5	4580	4840	5030	5285	5500	5687.5	5860	
4240	4445	4635	4880	5127.5	5327.5	5545	5730	5907.5	

SCR-536 Matched pairs of Transmitter-Receiver crystals in FT-243 HOLDERS. Receiver crystal is 455 KC. higher than the frequency of Transmitter crystal.

YOUR CHOICE OF ANY MATCHED PAIR. PER PAIR $1.00

NOTE: For individual crystals, see frequencies and prices in the chart on the left.

MISCELLANEOUS & SHIP BAND FREQUENCIES

81.95	KC. Octal tube type (Used in SCR-584 & SPM-1)	$3.99
200	KC FT-241	1.99
200	KC Type DC-15 in octal tube base type holder	1.99
327.8	KC No. 241 D-168342 (used in TS-102/AP)	9.95
500	KC. FT-241	1.99
1000	KC. FT-241	2.49
1000	KC. Type DC-9, in octal tube base type holder	3.45
2000	KC. FT-243	1.99
2142	KC DC-34	2.99
2174	KC DC-34	2.99
2182	KC FT-243	2.99
2500	KC FT-243	1.99
2632	KC FT-243	2.99
2637	KC FT-243	2.99
263 F	KC. DC-34	2.99

2638	KC FT-243	$2.99
2670	KC. FT-243	2.99
2647	KC. FT-443	2.99
2870	KC DC-34	2.99
2738	KC type 1-C	2.99
2738	KC. FT-243	2.99
2788	KC. MC-7	2.99
3000	KC. FT-243	1.99
3098	KC. FT-243	2.99
3093	KC. FT-243	2.99
3098	KC. FT-243	2.99
3103	KC. FT-243	2.99
3198	KC. FT-243	2.99
3193	KC. FT-243	2.99
3198	KC FT-243	2.99
3203	KC FT-243	2.99
5000	KC. FT-243	1.99
10,000	KC. Type SR-5 Bliley, in CR-1 holder	1.99

CR-1A

Lots of 10 or more 69c
Lots of 5 or more 79c
Individually. Each 79c

			5980	6670	7120	7460	7930	8032	8116	8172.2	8272.5	8340	8423
			6181	6700	7130	7470	7960	8050	8126	8176	8284	8351	8428
			6350	6740	7160	7550	7980	8060	8128	8193.2	8290	8357	8430
			6380	6750	7180	7570	8007	8080	8132.3	8194.2	8397.1	8373	8438.7
			6450	6890	7230	7590	8010	8090	8137	8200	8308	8374	8475
5020	5300	5590	6510	7010	7350	7670	8013	8092	8140	8205	8317	8380	8502.8
5041.6	5520	5677.7	6530	7020	7360	7730	8018	8103.7	8142.8	8216.2	8320	8392	8528.5
5180	5550	5700	6550	7040	7400	7790	8020	8110	8146.1	8220	8328	8400	8554.2
5208.3	5583.3	5722.2	6650	7080	7440	7810	8025	8115	8152	8260	8335	8404	8580
													8590

AR7-W
1500 to 3400 KC
Ea. $2.99

FT-164
201 to 4300 KC.
Ea. $3.99

FT-241 or CR-4
300 freqs. from 729.167 to 1040.625 KC. in steps of every 1.041 KC.
Ea. 99c

COLLINS TYPE 1-C
1335 to 4467.5 KC.
Ea. $1.99

RCA MI-8412 A or B
2618 to 5805 KC.
Ea. $1.99

RCA MODEL AVA-10J
169 to 6510 KC.
Ea. $1.99

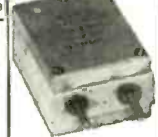
BLILEY TYPE MC-7 or BSD
163.94 to 8730 KC.
Ea. $1.99

AVA-53
2035 to 6910 KC.
Ea. $2.45

MX9-E
Freqs. & Prices on request.

AA9-A PIEZO ELECTRIC
1388 to 8730 KC.
Ea. $1.99

AR-4W or FT-249
1398 to 4765 KC.
Ea. $1.99



BSD 180G
056.875 to 1300 KC.
Ea. $1.99

TEST EQUIPMENT

Measurement Corp Test Set		1E-19A	TS-7/ASQ
TS-428 (XM-2) PCM		TS-14/AP	TS-102A/AP
TS-35A/AP	TS-481U	W.E. 17B	W.E. 19C (SPC)

U. S. CRYSTALS, INC.,

Dept. E.
805 S. UNION AVE.,
LOS ANGELES 17, CALIF.

NEW ITEMS:

INVERTERS & GENERATORS:

5D21NJ3A—27 VDC input; output 110 Volt 400 cycle. 1 Phase 485 VA....$39.50

PE-109D—Input 13.5 VDC 29 A; output 115 V 400 cycle. 1 Phase 1.53 Amps....$59.50

PU-7/AP—Input 28 VDC 160A; output 115 V 21.6 A 400 cycle 2500 VA....$89.50

PE-118—Input 28 VDC 100 A; output 115 V 400 cycle, 1 Phase 1500 VA....Used: $14.95

PE-218—Input 28 VDC 100 A; output 115 Volt 400 cycle, 1 Phase 1500 VA....Used: $24.95
NEW: $49.95

PE-115 or PE-206—Input 28 VDC 36 A; output 80 Volts 800 cycle 7.2 Amps....Like New: $12.95

TYPE 800-1-D—Input 28 Volts 62 A; output 115 V 7 Amps, 1 Phase 800 cycle....Used: $39.95
NEW: $75.00

MOTOR AMPLIDYNE—Input 115 Volt 60 cycle 1 Phase; Output 250 Volts, 6 Amps. GE # 5AM450815
Price: $39.50

MOTOR GENERATOR POWER SUPPLY—Model BK, Set type CCL 211014—Input 115 VDC, ¾ HP Motor—Output Generator: 27 VDC 250 Watts.
Price: $59.50

GASOLINE ENGINE GENERATOR — PU-6/TPS-1 Generator Output 120 Volt 400 cycle 1 Phase 1400 Watt, & 27 VDC 400 Watt. Direct drive by single cyl. air-cooled 2 cycle gas engine. Price....$175.00

COAXIAL CABLE & CONNECTORS:

CD-1071 CORD—With PL-259 Plugs each end. Removeable Vinylite Covering over Plugs. 50 ohm coax. 2 Ft. long. Price: 59¢ Each — Or Lots of 10 @ **50¢ Ea.**

PL-259—Plug ea. end & 32"—RG-54/U—58 ohm.50¢

UG-21/U—Plug ea. end & 32"—RG-11/U75 ohm.50¢

UG-22/U—with 4" Coaxial Cable....50¢

RG-8/U (SPECIAL) 51.5 ohm. Same size as RG-8/U. Prices: 1 to 100 ft. @ 8¢ per ft.—100 to 500 ft. @ 7½¢ per ft.—500 to 1000 ft. @ 7¢ per ft.—1000 ft. Rolls (or more) @ 6½¢ per ft.

RG-34/U—71 ohm, 145 ft. length....$15.00

SOUND POWERED PHONES:

HEAD AND CHEST SET—NAVY TYPE— No batteries required. Ideal for TV Antenna installations, and many other uses. 20 Ft. Cord. Used—Tested....Each: $5.95

NEW ITEM **HANDSET TS-10**
Sound Powered—Used—Tested.... **$6.95**

BLOWERS:

115 VOLT 60 CYCLE BLOWER—Approx. 100 CFM Dis. 2¼" intake - 2" outlet. Quiet running. Motor size: 2½" x 3¼". NEW—Not Gov't. surplus. Order No. 1C939....$8.95

DUAL BLOWER — Same as RN-520 above, except has blower assembly in each side of motor. Order No. IC880....$13.95

COMPACT TYPE — 108 CFM motor built Inside squirrel case, 4-½" Intake: 3-⅝" x 3" Dis. Complete size: 4-¼" W. x 9-⅝" H. x 8-½" D. Order No. 2C067....$14.50

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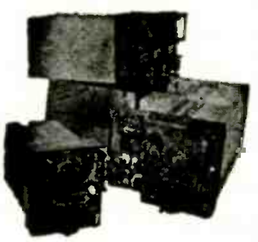

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1N34	.64	5R4GY	1.45	446A	1.00	954	.25
1N43	1.35	C6J	6.50	450TH	44.00	955	.35
1N81	1.35	6AS6	1.75	506AX	1.10	956	.35
1P23	2.50	6C21	18.00	507AX	1.00	957	.35
1P36	3.95	10Y	.45	702A	1.75	CK1005	.45
1P40	1.50	FG17	4.00	703A	2.50	CK1006	1.95
2C39	12.50	28D7	.95	704A	.85	1608	.95
2C39A	15.00	FG32	8.95	705A	1.50	2050	1.20
2C40	7.75	RK60/1641	1.95	707A	4.95	2051 RCA	.85
2C42	7.50	QK60	60.50	715A	2.95	5591 WE	5.75
2C43	14.50	QK61	60.50	715C	15.85	5635	9.75
2C46	7.50	FG98	17.50	717A	.85	5636	5.75
2C52	3.50	FG105	25.00	723A	9.95	5642	1.00
2D21	.75	F123A	6.95	801A	.35	5651	1.95
2J33	20.00			807	1.45	5654	1.65
2J34	17.75			813	8.50	5670	3.25
2J39	12.50			814	2.50	5676	1.15
2J54	47.50			815	4.25	5725	4.10
2J62	17.50			816	1.40	5726	1.50
2K22	17.50			829	6.65	5749	1.90
2K23	15.50			829B	9.95	6080	3.50
2K28	25.00			832	7.25	6097	1.50
2K33A	65.00			832A	7.50	7193	.45
2K54	65.00						
2K55	65.00						
2X2/879	.45						

8012A	1.95	DIODES****	
8013A	3.50	1N21	1.35
8025	4.50	1N21B	1.55
9001	.85	1N23A	2.25
9002	.80	1N23B	2.50
9003	1.25	1N26	7.75
9004	.25	1N34	.64
9005	1.95	1N43	1.50
9006	.25	1N81	1.35
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2AP1	6.95	1A7GT	.60
3AP1	4.95	1C5GT	.45
3AP1A	6.95	1E7G	.85
3BP1	3.50	1L4	.45
3DP1	2.75	1Q5GT	.60
3GP1	2.75	1S5	.60
3JP1	9.75	1T4	.55
5BP1	3.50	3B7	.33
5BP1A	8.00	3D6	.33
5HP1	4.25	3Q4	.60
5HP4	4.25	3S4	.60
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10 Channel FM Receiver and Transmitter. Frequency Range 20-27.9mc. Receiver is manually tuned, transmitter is crystal controlled. Consists of 2 BC-603 Receivers, BC-604 Transmitter, FT-237 mount, Box 80 xtals BC-606 Control, A-62 Phantom Ant., Headsets, mike, and antenna. Input 12v DC. SCR-608 also avail. ....POR

SCR-291A

1.5-30mc automatic direction finder. This equipment used to take bearings on transmitters within its freq. range. Complete equipments available comprising the following: BC-1147A Rec., PN 31, Power Panel, BC-1159, automatic bearing goniometer. RC-223 antennae system consisting of 5 masts with legs, MC-412, MC-413 phase inverters calibrating transmitter, cables, 115v 60 cyc gasoline generator. Complete equipment overhauled and guaranteed. ....POR

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This is a remote PPI indicator "7 in." screen for use with any Radar for remote viewing. Contains all indicating circuits and is driven by the main Radar. Input 115v 60 cyc. POR

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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

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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. Input 28v D.C.
Mfg. Western Electric ....POR

AN/TPS-3—AN/TPQ-3

Mortar shell tracking and portable early warning radar system. Operating frequency 600 mc. Uses a 7" P.P.I. and a 5" A scope. Search ranges 20, 60, 120 miles. Transmitter power output 200 Kw. Altitude coverage on aircraft 30,000 ft. Range accuracy 2 miles. Azimuth accuracy 2. Has complete anti jamming facilities. Complete installations available ....POR

SCR-206

Portable direction finder. Frequency 200kc-18mc. complete sets available consisting of BC-470 receiver, LP-22 loop, sense antennae, power supply, operates from 6v DC. Mounted in a transporting trunk.

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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

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This equipment is inclosed in a 6 ft high rack cabinet with doors. Single voice channel operation for point to point communication. The rec.-trans. is tuneable. Wave guide is used in the trans.-rec. circuits. Mfg. SPERRY Input 110v 60cyc.

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OB2	.84
OB3/VR-90	.84
OC3/VR-105	.92
OD3/VR-150	.79
OZ4	.59
1B22	1.19
1B23	4.96
1B24	5.99
1B26	2.99
1B27	8.71
1B29	2.35
1B32/532A	1.32
1N21	1.60
1N23	1.94
1N27	7.99
1N38	1.05
1N60	.69
1N70	2.40
1P-28	7.91
1P-29	1.95
1P-30	2.79
2AP1	5.49
2B22	1.99
2C21/1642	.79
2C26	.19
2C33	1.99
2C34	.39
2C36	29.41
2C39	19.99
2C39A	17.99
2C40	5.75
2C43	15.77
2C44	.96
2C46	17.49
2C51	3.99
2D21	1.99
2E22	2.29
2E24	1.69
2E26	3.29
2J21	4.55
2J21A	4.69
2J22	4.69
2J26	5.99
2J27	7.99
2J30	59.50

Tube	Price	Tube	Price	Tube	Price
2J31	24.50	3C27	3.29	4J37	189.00
2J32	18.99	3C28	4.75	5AP1	3.49
2J33	24.50	3C31/C1B	3.49	5BP1	2.69
2J34	19.65	3C33	9.75	5BP4	2.99
2J36	74.50	3C45	11.69	5CP1	3.69
2J38	29.50	3D23	3.99	5C21/C6J	6.99
2J39	49.50	3DP1	3.99	5C22	42.50
2J42	74.50	3E29	9.49	5D21	8.49
2J49	64.50	3EP1	3.99	5FP7	1.92
2J50	48.50	3FP7	1.45	5HP1	4.49
2J61	22.00	3GP1	2.49	5HP4	6.49
2J62	16.00	3HP1	1.99	5JP1	8.75
2K22	17.50	3J21	149.50	5JP1A	22.49
2K23	19.50	3J30	119.50	5HP5	7.99
2K25	18.99	3J31	89.50	5J29	12.15
2K28	24.95	3K30	189.50	5J30	29.55
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869B	44.69
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304TH	5.30
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2K45	99.00	4B28/CE225	3.85	6C21	16.41
2K54	49.50	4-125A	24.95	7C22	89.50
2K55	49.50	4C27	8.95	7C25	87.50
2X2A	1.39	4C28	32.91	7C30	77.50
3AP1	4.99	4C35	16.95	7BP7	2.99
3BP1	2.99	4D22	18.50	7FP7	2.99
3B22	2.19	4E27/257B	12.75	9LP7	3.99
3B23	3.99	4J31	99.00	10Y	.29
3B24	3.89	4J32	199.50	15E	1.09
3B25	2.99	4J34	74.00	15R	.34
3B27	8.99	4J35	99.00	18C	.19
3B28	3.99	4J36	120.00	24R	1.69
3C22	79.95			35TG	4.44
3C23	6.65			CSB	2.94
3C24	.89			C6J	6.99

Tube	Price
FG-32	6.21
FG-67/5559	14.99
HF200	9.99
HF300	15.99
HY114B	.43
RK-34	.39
RK35	.89
RK-39	.89
RK-59	1.99
RK-60	2.49
RK-72	.94
RK-73	.92
RX21A	7.99
VR-78	.98
VT-52	.49
VT-67	.29
VT-98	12.95
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217A	2.49
217C	4.99
221A	1.89
231D	1.29
242C	4.99
249B	4.49
250R	4.49
250TH	18.75
250TL	18.99
258B	4.49
264C	3.19
271A	4.99
274B	1.49
276A	4.99
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286A	6.49
287A	5.15
304TL	4.95
304TH	5.30
305A	4.39
307A/RK75	1.99
310A	2.99
316A	.69

Tube	Price	Tube	Price
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354C	14.99	720AY/CY/DY/EY	29.75
371B	.39	721A	1.75
388A	.86	721B	5.75
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394A	2.95	723A/B	13.89
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446B	2.99	726A	7.49
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527	15.99		
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GL-562	72.40	808	1.99
KU-610	14.99	809	3.49
615	.29	810	9.69
700/A/B/C/D	9.25	811	2.85
701A	4.22	813	9.91
702A	1.69	814	3.49
703-A	2.49	815	2.49
704-A	.82	816	1.39
705-A	.76	826	.59
706-B	19.90	828	9.65
707A	4.99	829B	9.75
707B	8.65	830B	1.69
708A	1.59	832	5.75
709A	1.92	832A	7.59
713A	.82	833A	36.75
714AY	10.69	836	2.99
715A	2.59	837	.94
715B	3.99	838	2.71
715C	15.59	841	.22
717A	.89	843	.39
		845	12.99
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Tube	Price
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860	2.49
861	14.99
864	.19
866	.39
866A	.99
869B	44.69
872A	1.99
874	.96
876	1.29
884	.99
891R	189.50
892R	189.50
9-3	.19
902	5.75
902P1	7.49
918	2.18
927	2.18
931A	4.24
954	.22
955	.34
956	.34
957	.35
958	.59
1500-T/750TH	86.50
CK-1005	.59
1603	.99
1611	1.70
1613	1.70
1616	.69
1619	.29
1624	1.24
1625	.29
1626	.19
1629	.21
1630	.69
1632	.42
1639	.89
1642	.89
1806/P1	3.66
2050	1.21
2051	.89
1A3	.69
1A7	.64
1B3/GT	.89
1G6/GT	.59
1LC5	.59
1LD5	.79
1LN5	.69
1L4	.49
1L6	1.09
1H5	.59
1N5	.69
1R5	.65

Tube	Price	Tube	Price	Tube	Price
1S4	.62	6BA7	.89	6SK7	.58
1S5	.62	6B5	1.09	6SL7	.58
1T4	.48	6B3	.59	6SN7	.83
1X2A	.89	6BG6G	1.62	6SR7	.53
1V2	.79	6BH6	.89	6SQ7	.51
2A3	.99	6BN6	1.19	6U4	.39
2X2/879	.24	6BJ6	.59	6Y6	.92
2X2A	1.61	6CS6	1.04	6W4	.61
3A4	.64	6C4	.49	6X4	.49
3B7/1291	.35	6C6	.54	6X5	.52
3D6/1299	.34	6C8G	.59	6T8	.86
3S4	.62	6F6	3.19	7A5	.59
3Q4	.62	6F5	.49	7A6	.59
3Q5	.79	6D4	2.70	7A7	.69
3V4	.66	6J4	4.91	7B6	.69
5Y3	.46	6J5	.45	7B7	.69
5U4	.69	6J6	.72	7C4	.28
5R4GY	1.24	6J7-M	.69	7C5	.96

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2K33A	49.50
2K54A	49.50
F-128A	34.95
GL-434A	9.95

Tube	Price	Tube	Price	Tube	Price
5T4	1.19	6J7G	.59	7C6	.69
5V4	.92	6K4A	4.69	7F7	.79
5Z4	.96	6K6	.59	7F8	.83
5W4	.99	6K7	.44	7H7	.59
6AC7	.87	6L5	.54	7N7	.79
6AB7	.76	6L6M	1.39	7G7	.69
6AF4	1.31	6L6G	.92	7Q7	.69
6AG5	.59	6L7G	.41	7Y4	.49
6AG7	.96	6L7M	.86	7Z4	.49
6AH6	.89	6SC7	.72	12A6	.53
6AJ5	.99	6SF5	.69	12AU7	.79
6AK5	.99	6SF7	.79	12A 7	.88
6AK6	.39	6SS7	.78	12AV7	.99
6AN5	3.39	6N7GT	.46	12AX7	.71
6AQ6	.66	6N7	.76	12AY7	1.44
6AR6	2.69	6S4	.66	12BA7	.79
6AS5	.79	6SA7	.48	12BH7	.86
6AS7G	3.49	6SG7	.59	12SC7	.71
6B4G	1.12	6SH7	.58	12SQ7	.54

Tube	Price
12SR7	.56
12SF5	.44
12SG7	.69
12SH7	.62
12SJ7	.46
12SK7	.51
12SN7	.74
12SL7	.66
14A7	.63
14B6	.64
14B8	.66
14N7	.76
14R7	.69
14W7	.69
25L6	.69
25Z6	.56
28D7	1.49
35L6	.76
35Z5	.51
35Y4	.49
50A5	.72
50B5	.69
50C5	.79
50L6	.79
77	.59
78	.59
81	.89
83-V	.99
84/6Z4	.59
117Z3	.69
5516	7.55
5559	21.70
5560	24.49
5633	10.95
5634	11.45
5651	2.69
5654	1.69
5670	3.59
5694	3.25
5718	5.99
5751	2.89
5814	1.79
5964	2.19
7193	.14
8002R	34.95
8012	1.94
8013A	3.99
8020	.94
8025	2.91
9001	1.08
9002	.69
9003	1.21
9004	.24
9006	.24
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SPECIAL PURPOSE TUBES

OA5	$3.25	3DP1	2.00	RK-19	1.50	283A	3.00	702B	2.00	838	2.50
1B24	6.00	3EP1	3.00	RK-21	1.25	286A	5.50	703A	2.00	846	125.00
1B27	8.75	3GP1	1.75	RK-23	3.00	304TH	5.00	707A	4.00	849	15.00
1B42	7.75	4-65A	17.00	28D7W	3.00	304TL	3.75	707B	7.75	850	20.00
2AP1	5.00	4B26	4.50	Twin 30	10.00	305A	3.50	708A	1.50	860	1.50
2C33/RX-233A	2.00	4B27	5.00	FP-54/5740	44.00	307A	1.75	709A	1.50	861	10.00
2C40	4.75	4C22/HF-100	7.50	HK-54	3.50	310A	3.00	715A	2.00	866A	1.00
2D21	1.00	4C27/CV-92	7.50	RK-60/1641	1.75	311A	5.00	715B	3.00	869B	30.00
2E22	1.50	4C35	16.50	RK-62	1.75	313C	2.50	715C	12.50	872A	1.50
2J21A	4.75	4E27	12.00	RK-65/5D23	20.00	316A	1.00	719A	10.00	878	1.00
2J22	4.75	4J34	70.00	RK-73	1.00	323B	5.75	721A	1.25	884	1.00
2J26	4.75	4J35	80.00	FG-95/5560	14.75	328A	3.25	723A/B	14.00	885	1.35
2J27	8.00	4J42	75.00	C-100D	2.00	329A	5.50	724A	1.00	891R	100.00
2J29	25.00	5BP1	2.75	F-128A	35.00	348A	6.00	724B	1.25	892R	150.00
2J30	50.00	5BP4	2.75	HK-154	4.00	349A	6.50	725A	4.00	902-P1	4.25
2J32	19.00	5CP1	3.75	VT-158	20.00	350A	2.50	726A	10.00	913	9.00
2J33	23.00	5C30/C5B	2.00	FG-190	5.00	354A	10.00	726B	30.00	922	1.00
2J34	17.50	5D21	8.00	HF-200	12.50	355A	10.00	726C	30.00	923	1.00
2J36	75.00	5FP7	1.00	C-202	10.00	393A	5.50	803	2.75	931A	3.75
2J37	10.00	5FP14	6.00	203Z	5.00	394A	2.00	805	2.50	959	1.35
2J38	8.00	5JP1	9.00	204A	10.00	417A	6.50	807	1.00	CK-1006	1.35
2J40	25.00	5JP4	9.00	205B	1.00	GL-434A	8.00	808	1.50	1500T	100.00
2J55	55.00	5J26	75.00	F-207	50.00	446A	1.00	810	9.25	1624	1.00
2J56	80.00	5J30	18.50	217A	2.50	446B	2.00	811	2.00	1904	12.00
2J61	23.00	5J32	50.00	WL-218	20.00	WL-460	10.00	811A	3.00	2050	1.00
2J62	10.50	5R4GY	1.00	235R	75.00	464A	3.50	812	2.50	ZB-3200	85.00
2J-B51	1.00	C6A	6.00	250R	6.00	WL-468	15.00	813	8.25	5551/652	60.00
2K33A	47.50	C6L/5528	5.00	250TH	14.00	CK-510AX	1.50	815	2.00	5610	1.50
2K54	35.00	6BM6	50.00	251A	45.00	527	12.50	822	15.00	5725	3.75
2K55	35.00	6C21	15.00	252A	15.00	WL-530	8.00	826	1.00	CK-5829	2.25
3AP1	4.50	6G4/X-102B	3.00	253A	5.00	WL-531	4.50	828	8.75	5963	1.25
3BP1	3.00	6J4	4.50	257A	3.00	559	1.00	829B	9.00	8002R	25.00
3B24	3.00	7BP7	2.00	267B	6.00	575A	15.00	830B	1.75	8005	4.00
3B24W	6.75	9GP7	3.75	271A	5.00	WL-579B	12.50	832	5.00	8012	1.50
3B25	2.50	9LP7	2.50	274B	1.50	631-P1	3.00	832A	6.00	8012A	2.50
3B26	2.50	12GP7	15.00	276A	4.50	701A	3.00	833A	30.00	8013	1.50
3B28	3.50	FG-17/5557	3.50	282A	6.00	702A	1.25	837	1.00	8020	1.00
3C23	5.00									8025	2.75
3C24/24G	1.00									PD8365	50.00
3C45	8.00										
3D22	7.75										

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BC375	I-83	

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General Radio Type 620A Hetrodyne Frequency Meter Panel Mounting 33KC.-33MC. . . . . Exc. 425.00
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INDEX TO THE SEARCHLIGHT ADVERTISERS

JULY, 1954

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SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

ADVERTISERS INDEX

NEW YORK'S RADIO TUBE EXCHANGE

TERRIFIC SLASHES IN PRICE UP TO 70% FROM PREVIOUS LOW PRICES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
OA2	$1.00	1N23C	7.50	2J40	29.00	3B28	8.00	4J34	103.00	7BP7	5.00	242C	10.00	MX408U	.50	715C	22.50	810	10.50	884	1.50	Various 5000	
OA3	1.10	1N25	4.50	2J42	135.00	EL3C	5.50	4J35	150.00	7DP4	9.00	244A	9.50	417A	15.00	717A	1.50	811A	3.75	885	1.50	and 6000 series	
OB2	.99	1N26	6.75	2J49	60.00	3C22	99.00	4J36	150.00	12AP4	50.00	249C	4.25	434A	15.00	718AY/		812A	3.95	914A	75.00	of new	
OB3	1.10	1N27	3.50	2J50	55.00	3C24	1.50	4J37	150.00	12DP7	24.00	250TH	19.95	446A	1.95	EY	30.00	813	13.75	931A	5.00	production	
OC3	.96	1N34A	.79	2J55	150.00	3C31	2.95	4J38	150.00	LM15	225.00	205TL	12.00	446B	3.95	719A	22.50	814	3.75	954	.35		
OD3	.89	1N43	2.25	2J56	110.00	3DP1	7.50	4J39	150.00	15E	1.75	274B	2.75	450TL	45.00	720AY/		815	6.25	955	.50	8012	2.00
C1B	2.95	1P25	75.00	2J61	35.00	3DP1A	10.00	4J40	150.00	15R	.75	304TH	10.00	450TH	52.50	GY	150.00	816	1.45	956	.75	8012A	2.50
1B21	1.50	2B4	1.25	2J62	35.00	3DP1A-		4J41	150.00	NE16	.59	304TL	10.00	464A	7.50	721A	3.50	829	11.00	957	.25	8013	3.00
1B22	1.50	2B22	1.75	2K22	15.00	52	10.00	4J42	190.00	20-4	.75	307A	3.50	471A	1.25	722A	3.50	829A	12.00	958A	.60	8013A	3.50
1B23	6.95	2C34	.15	2K23	15.00	3EP1	5.00	4J51	190.00	KY21A	8.25	310A	4.50	527	18.00	723A/B	18.00	829B	15.00	959	2.25	8019	1.75
1B24	12.00	2C40	9.00	2K25	27.50	3E29	15.50	4J52	225.00	RX21	8.00	310B	4.95	WL530	23.00	724A	1.95	830B	2.00	E114A	.25	8020	1.80
1B26	1.75	2C42	12.00	2K26	68.00	3FP7	5.00	4J53	225.00	HK24G	1.50	311A	6.50	WL531	22.50	724B	2.25	832A	9.95	1280	.95	8025	3.75
1B27	12.50	2C43	14.50	2K28	35.00	3HP7	5.00	C5B	250.00	25T	2.95	312A	3.50	WL532	1.75	725A	9.00	833A	45.00	1500T	135.00	PD8365	96.00
1B32	2.95	2C44	.60	2K29	35.00	3GP1	5.00	5BP1	3.95	45 Special	.35	323A	15.00	WL533	15.00	726A	18.00	834	7.50	HK1554	75.00	9001	1.25
1B38	35.00	2C46	7.50	2K33A	75.00	4B26	5.40	5BP2A	12.00	RK39	2.75	327A	3.75	HK654	35.00	726B	45.00	836	3.95	1603	5.00	9002	.90
1B50	23.00	2E22	2.25	2K39	140.00	4C27	22.50	5BP4	3.95	HF50	1.75	323A	6.75	700A/D	10.00	726C	45.00	837	2.75	1612	1.50	9003	1.25
1B51	7.50	2J21A	12.00	2K41	135.00	4C28	35.00	5CP1	7.50	VT52	.35	350A	10.00	701A	4.50	723AY/		838	5.95	1613	1.25	9004	.35
1B56	35.00	2J22	9.00	2K45	80.00	4E27	16.00	5CP7	6.95	HK54	4.50	350B	5.95	703A	3.95	GY	15.00	849	35.00	1616	1.25	9005	2.75
1B60	35.00	2J26	15.00	2K50	275.00	4J25	150.00	5CP7A	14.00	RK72	1.00	352A	3.00	704A	1.95	730A	22.50	860	3.50	1619	.45	9006	.25
1N21	1.25	2J27	15.00	2K54	125.00	4J26	150.00	5D21	18.00	RK73	1.00	HK354C	15.00	705A	21.75	750TL	99.00	861	25.00	1622	1.50		
1N21A	1.75	2J31	24.00	2K55	125.00	4J27	150.00	5FP7	1.95	FG95	19.95	357A	15.00	706AY/		801A	.90	866A	1.50	1624	1.75		
1N21B	2.75	2J32	29.00	2K56	72.00	4J28	150.00	5JP1	27.50	100TH	7.95	368AS	4.95	FY	5.00	802	3.95	869B	67.50	1625	.35	Thousands	
1N21C	19.50	2J33	32.00	3AP1A	10.00	4J29	150.00	5JP2	19.50	FG105	20.00	371B	1.50	707A	9.75	803	5.95	869BX	50.00	1626	.25	of other	
1N22	1.00	2J34	36.00	3BP1	7.20	4J30	150.00	5JP4	27.50	122A	1.75	385A	4.50	707B	15.00	805	4.95	872A	3.50	1851	1.80	tubes	
1N23	1.95	2J36	90.00	3B24	4.50	5J31	150.00	5J23	45.00	203A	7.50	388A	1.80	714AY	18.00	807	1.50	878	1.50	2000T	150.00		
1N23A	2.75	2J38	8.95	3B25	5.50	4J32	150.00	C6A	11.00	211	.95	393A	7.50	715A	4.50	808	1.95	879	.50	2050	1.80		
1N23B	2.75	2J39	8.95	3B26	5.00	4J33	150.00	C6J	7.50	217C	12.00	394A	3.95	715B	9.00	809	2.95	880	250.00	2051	1.00		

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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
I-96A Signal Generator
TS45 X Band Signal Generator
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000 MC
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
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TF890/1 X Band Spectrum Analyzer
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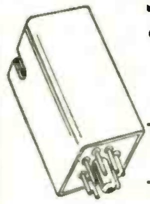

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900V/35MA, 2X2.5V/2A, Xelent 1800V Dbler TWO 2X2 FIL WNDGS.................$2.25
850VCT/148MA, 5V/3A, 6.3V/5A, 6.3V/3A DOUBLE Half Shell...........$4.98: 2 for $9.00
778VCT/200MA, 5V/3A, 6.3VCT/5A THORDARSON......$4.98; 2 for $9; 6 for $24
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS 4/scope.....$3.69; 2 for $6.00
700VCT/70MA, 5VCT/3A, 6.3VCT/2.5A...$3.95
600VCT/50MA, 6V/3A, 6V/1.5A, 5V/1A HALF SHELL......$2.49; 2 for $4.50; 10 for $20.00
550VCT/250MA, 5V/2A, 6.3VCT/2.5A, 12.6V/3.5A CSD RCA.................$4.50; 2 for $8.00
500VCT/60MA, 6.3V/4A, HMSLD.........$2.98
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC & 115 & 230 VAC @.........$1.49
2X330VCT/10MA, EACH WNDG.........$3.49

230 TO 115V AUTOFORMERS

For 220-240V/50-60cy Input. To 110-120V or Step-up with Cord Plug & Receptacle.
Model TPA100 100 Watts Cased..........$4.00
Model TPA300 300 Watts Cased..........$7.25
Model TPA500 500 Watts Cased..........$8.25
Model TPA1000 1000 Watts Cased........$16.95

FILTER CHOKES

10Hy/75ma.......................1.25
10Hy/125ma/UTC/Csd H'sld/1 KVins...............1.98
50Hy/125ma/Csd/H'Sld......2.89
20Hy/300ma or 15Hy/400ma/12KVins Kenyon.......... 8.95
13.5Hy/1 Amp/17KVins/Raytheon..........35.00
Dual 2 Hy/300ma USN...........95c; 2 for 1.49
6 Hy 175ma 250 Ohm...........$1.49; 2 for 2.49
10 Hy 100ma Freed.............................1.39
5-30 Hy 500ma Swinging CSD..6.98 @ 2 for $13

Filament Trans. 115V/60 Cy. input

2.5VCT/10A 5KVINS..............................3.59
2.5VCT/10A 12.5 KVINS......$5.50; 3 for 14.00
5VCT/13A 5 KVINS UTC S-59...............3.95
7.5VCT/12A CSD 15 KVINS...10.95; 2 for 17.50
25.2V/2A or 12.6V/4A or 2X 12.6V/2A Cased 2¾W 3¼H 2⅜D $3.59 @ 3 for $10; 12 for $36
42.5V/2A Sel. Rect. Xfmr......$2.95; 2 for $5.50
PRI 110 & 220V SEC 16.6V/1.25A, 12.6VCT/3.5A $4.98; 2 for $8.00

TRANSFORMER SPECIAL!!
6.3 Volt 3¾ Amp.

CONTINUOUS DTY
115VAC Input
SIZE 2 5/16H/2L/1½" W
HVY DTY CHANNEL MTG 8INCH WIRE LEADS MFGRS, JOBBERS, DLRS ORDER NOW THIS $1.98 VALUE
Special $1; 12 for $10; 100 for $75

CIRCUIT BREAKERS

Heinmann Magn Bkrs, Amps: .220, 3, 7, 9, 12, 20, 30, 35, 40, 80, 180.EA: 1.98: 12/$20.: 50/$75.
Sq. D & CH Toggle Sw Bkrs, Amps: 5, 10, 15, 20, 25.....98c; 10 for $8.98; 50 for $39
Circuit Breaker Fuses Amps: 3, 5, 7, 10, 15, 20...........EA 27c; 5/$1.00; Asst 100/$15.00
Crkt Bkr Fuse w/Mtg Clips..............3/$1.00

Mica Condensers

Fig.	MFD	WVDC	PRICE
A	.03	600	69c: 5 for 2.39
A	.02	600	69c; 5 for 2.25
A	.015	2500	1.75: 2 for 3.00
B	.01	600	56c: 3 for 1.20
B	.01	1200	69c; 3 for 1.49
A	.005	2500	1.19; 3 for 2.95
B	.004	600	49c; 3 for 1.10
B	.002	1200	58c; 3 for 1.25
A	.002	2500	98c: 3 for 2.25
A	.001	1200	55c: 3 for 1.20
C	.0007	3000	89c: 3 for 2.39
A	.0004	2500	39c: 6 for 1.95
A	.0001	600	25c: 5 for 1.00
C	.0001	3000	89c; 3 for 2.00
C	.0001	5000	1.49; 4 for 5.00

Write for Condenser Catalog

TOGGLE SWITCHES

SPDT 15A 125V Center Off AN3022-1B.......69c; 5/$2.50
SPST 5A/125V used I.N 4/$1.00
SPDT 15A/125V Center Off MOM.....79c: 3/$2.00: 20/$10
SPDT 15A/125V AN3022-3B EA59c; 3/$1.25: 30/$10.00
DPST 20A/125V EA 69c; 5/$2.50: 25/$10.00
DPST 3A/125V AH & H 3 for $1.00; 20/$5
DPST 5A/125V Bklt CSD...........49c; 3/$1.20
3PDT 22A/125V C'Hammer.......$1.49: 2/$1.98
4PDT 10A/125V.....$1.98; 3 for $5.00: 20/$30.

CONDENSER SPECIALS

2 MFD 1000 VDC 330 VAC "CD" MFGR **25¢ EA** LOTS OF 10
Smaller Quantities Each........ 49c; 3 for $1.25

TOGGLE SWITCHES

SPDT 15A/125V AN3022-1B.....69c; 5 for $2.50
SPST 6A/115V Bat Handle (Used)....4 for $1.00
SPDT 15A/125V Center Off Mom 79c: 3 for $2.00
SPDT 15A/125V AN3022-3B....59c: 3 for $1.25
DPST 20A/125V AN3027-2B....69c: 5 for $2.50
DPST 3A/125V AH & H Laminated..3 for $1.00
DPST 5A/125V Bklt Cased.....49c: 3 for $1.20
3PDT 22A/125V CH-8744K6...1.49; 2 for $1.90
4PDT 10A/125V AH & H $1.98; 3 for $5.00
WRITE FOR QUANTITY PRICES

CRYSTAL DIODES
1N21 @ 30¢ ea. 100 at 25¢ ea.

KEMTRON—W.E.—SYLVANIA
1N23B.......$2.: 5 for $9.: 50 for $70
1N21A.............$1.55; 5 for $7.00
1N21B.............$2.10; 5 for $9.50
1N41.............$8.95; 2 for $16.00
1N42.............$16.95: 2 for $28.00
1N34.......63c; 5 for $3.: 100 for $58
1N34A......88c; 6 for $5.: 100 for $75
1N39....$4.49: 6 for $25.: 100 for $375

SYNCHRO'S

2J1H1 GE Selsyns.....................Each $8.98
2J1F3 GE Brand New 115V/400 cy. ea.......9.75
C78248 Sync. Trans. 115/60 cy..$25.00: 2 for $45
C78249 Sync Diff. 115V/60 cy 9.00: 2 for 15.00
Sync. Repeater 115/60 cy Type 11-4..2 for 99.00
Bendix Autosyns AY1 & AY5.........2 for 6.95
Bendix AY20 New Orig Crtns.............1298

"TAB" THAT'S A BUY

"TAB" SPECIALS

RF CHOKE 20MH/500MA........69c; 10/$4.00
RF CHOKE 20MH/200MA........39c; 10/$2.00
VEEDER ROOT Counter 3 Digit.....79c: 10/$5.
VEEDER ROOT 4 Digit..........89c; 10 for $6.
PRECISION RESISTOR 400K Ohm 1% 1W 10/$1.50: 100/$10.
BLOWER 40CFM/24VDC/centrifugal $5.00: 2/$8
CLOCK MOTOR Haydon Synchronous 6-10VAC 24 RPM w/switch.............98c; 3 for $2
872's NEW each $2.25; ten for $20.

FL-5 FILTER

Range or voice. Filters 1020 cycle audio, excellent for CW Work. 59c; 2 for $1.00

BANDPASS FILTER

Sharp Cutoff HIQ. Cased & Shielded 60, 90, 150 cycles..............Each $1.50; 3 for $3.75
UTC 854, 1024, 1250 Cyc. Ea. $1.25; 2 for $2.00

END EQUIPMENT BUYS

I-222A Sig. Gen 8-15MC 45-76MC (150-230MC Harmonic)...............$55.00
BC221 Freq Meter 125-20,000 KC.......$125.00
LM Freq Meters 125-20,000KC..........$45.00
T85/APT5 Xmittr 300-1600MC less tubes..$25.00
CPS/APS15 Less Tubes.................$25.00
BC654 Transceiver 3800-5800KC........$75.00
G.E. Oscilloscope ST-2A & Accs.......$275.00
G.E. Sweep Generator ST-4A & Accs....$275.00
G.E. Marker Gen. ST-5A & Xtal/Accs...$300.00
G.E. YYZ-1 Decade Sealing Unit. Rate 5x106 (5MC) Counts Per Sec Max.....$252.00

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INPUT 6VDC. Output 200V/100ma. or 12/24V Output 500V/50ma "P" Magnt. As Illustrated.. 6.95
INPUT 28VDC/1.4A Output 250V/60ma...$2.95; 2/$5.00
DA3A 28V/10.5A output 300VDC/260ma 150VDC/10ma. 14.5vdc/5amp.......................$4.98
PE94 Plate Supp., Uses DA3A (SCR522)...$5.95
INVERTER GE 5D2_NJ3A Input 28VDC output 115Volt/400cy/485VA. New.........$49.95

HI-MEG HI-VOLT RESISTORS

.75 MEG "MVP" 10W 10KV... .79 10 for 5.00
2MEG "MVG" 4W 5KV....... .89 10 for 7.50
2 MEG 5W 10KV........... .99 10 for 8.50
2.5 MEG "MVA" 20W 25KV..1.50 10 for 12.00
2.5 MEG "MVT" 5W 7.5KV... .93 10 for 7.00
7 MEG "MVP" 10W 10KV....1.35 10 for 12.00
10 MEG "MVP" 10W 10KV...1.69 10 for 15.00
12 MEG 10W 10KV.........1.69 10 for 15.00
20 MEG "MVO" 35W 50KV...2.25 10 for 20.00
50 MEG "MVE" 25W 40KV...2.75 10 for 25.00
100 MEG "MVP" 10W 10KV..2.25 10 for 20.00
WRITE FOR QTY PRICE

TUBES

"TAB" TESTED & GUARANTEED
PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

DA2	$0.98
DA3/VR75	1.04
OB2	1.37
DB3/VR90	.96
DC3/VR105	.92
OD3/VR150	.92
1B3/8016	.80
1B22	1.82
1B23	8.87
1B24	8.98
1B26	2.24
1B27	11.98
1B32/532A	2.48
1B35	9.15
1B37	14.87
1B38	29.45
1B41	49.95
1B42	17.48
1B46	1.98
1B63	45.00
1L4	.48
1L6	1.35
1LD5	.98
1LN5	.78
1P5	.78
1U4	.52
1U5	.54
1V2	.70
1X2A	.98
2C36	27.00
2C39A	26.98
2C40	4.98
2C43	17.48
2C44	1.15
2C51	3.88
2D21	1.18
2E43	1.49
2J31	27.00
2J32	29.48
2J33	27.00
2J34	24.98
2J37	12.70
2J38	69.98
2J39	6.98
2J42	148.98
2J48	24.45
2J49	84.00
2J50	99.98
2J51	238.98
2J56	149.00
2J62	49.45
2K22	23.48
2K23	11.48
2K25	28.49
2K25/723AB	23.88
2K28	27.48
2K33	219.48
2K39	134.99
2K41	126.00
2K42	145.00
2K45	129.48
2K48	99.48
2P23	298.00
2X2	.42
3B22	2.48
3B23/RK22	4.95
3B24	4.70
3B26	3.70
3B28	7.90
3C22	85.00
3C23	8.67
3C31/C1B	3.45
3C33	9.51
3C45	9.98
3D6/1299	.69
3D21A	8.15
3D22	13.97
3D23	4.90
3E29	14.49
4C35	21.49
4D21	18.99
4E27	22.49
4J22	129.51

4J31	99.51
4J52	199.99
EL5BHD	15.99
5C21/C6J	9.89
5C22	38.95
5D21	14.98
5J29	11.92
5R4GY	1.20
5R4GYW	1.75
5T4	1.48
5U4G	.55
5V4G	.95
5Z3	.99
5Z4	1.49
6A3	.90
6A7	.85
6A8GT	.90
6AC7	.80
6AG5	.71
6AG7	1.14
6AH6	1.21
6AJ5	1.40
6AK5	.87
6AK5W	2.79
6AK6	.92
6AL5	.48
6AL7GT	.98
6AN5	3.27
6AQ5	.52
6AQ5W	2.79
6AQ6	.81
6AQ7GT	1.29
6AR6	3.27
6AS5	.79
6AS6	2.22
6AS7G	3.48
6AT6	.54
6AU5GT	1.10
6AU6	.56
6AV5GT	.98
6AV6	.49
6B4G	1.18
6B8G	.60
6BA6	.54
6BA7	1.09
6BC5	.63
6BC7	1.23
6BD6	.83
6BE6	.54
6BF5	.98
6BG6G	1.58
6BH6	.63
6BJ6	.69
6BK7	1.58
6BL7GT	1.19
6BN7	2.69
6BQ6GT	1.20
6BQ7	1.65
6C4	.52
6C21	24.50
6CB6	.59
6CD6G	1.69
6D4	2.70
6D6	.84
6F4	6.20
6F6	.79
C6J/5C21	9.89
6J4	6.66
6J5	.54
6J6	.58
6K6GT	.54
6K7	.58
6K8	1.08
6L6	1.48
6L6G	1.08
6L6GA	1.08
6L6GAY	1.98
6SA7GT	.66
6SC7	.90
6SF5	.78
6SF7	.73
6SG7	.64
6SH7	.61

6SJ7	.58
6SK7GT	.56
6SL7GT	.64
6SN7GT	.68
6SQ7GT	.62
6SR7	.62
6SS7	.88
6T8	.96
6U4	.74
6U8	.99
6V6	1.39
6V6GT	.59
6W4GT	.52
6X4	.49
6X5GT	.54
6Y6G	.88
7A8	.68
7C7	.76
7F7	.82
7F8	1.24
7H7	.72
7N7	.92
7V7	1.06
7Y4	.68
8D21	298.00
12AL5	.54
12AT6	.54
12AT7	.89
12AU6	.72
12AU7	.69
12AV6	.52
12AV7	.98
12AW6	1.18
12AX7	.98
12AY7	1.69
12BA6	.59
12BA7	.94
12BD6	.59
12BE6	.59
12BF6	.85
12BH7	1.29
12SA7GT	.68
12SC7	1.08
12SF5GT	.54
12SF7GT	.84
12SG7	.80
12SH7	.63
12SJ7GT	.54
12SK7	.66
12SL7GT	.62
12SN7GT	.68
12SQ7GT	.54
12SR7	.66
FG17	3.90
24G/3C24	1.32
25BQ6GT	.98
26L6GT	.67
25Z5	.79
25Z6GT	.58
FG-27A	8.24
35Z5GT	.54
35T	4.88
35L6	.67
35Y4	.69
45Z3	.88
48	1.98
50A5	.76
50C5	.54
50L6GT	.62
RK61/XFG1	2.65
FG67	14.68
HY69	4.98
71A	.74
78	.78
80	.58
81	1.38
83	1.12
83V	1.22
84/6Z4	.62
100TH	9.88
FG104	24.58
FG105	19.48
VXR130	4.50

CV148	9.98
FG166	48.49
FG172	29.00
211/VT4C	.86
RX215	7.98
RX233A	3.49
250TH	18.97
250TL	17.75
304TH	12.49
304TL	12.49
371B	.88
388A	1.48
GL434A	12.69
446A	1.05
446B	3.48
450TH	49.97
450TL	52.00
460/HF200	15.95
CK502AX	1.49
CK503AX	1.49
CK505AX	1.79
CK512AX	1.45
CK531DX	1.89
531	5.72
CK532DX	1.89
WL532A	3.68
CK536AX	.99
CK538DX	.98
CK539DX	2.19
CK541DX	1.99
CK543DX	.99
CK544DX	.99
CK546DX	1.99
CK571AX/5886	2.49
CK573AX/6029	3.49
WL652	65.00
WL676	34.98
703A	4.72
705A	1.88
707A	7.90
707B	14.88
715A	4.96
715B	7.94
715C	17.98
717A	.88
719A	24.48
721A	3.92
722A/287	1.94
723A/B	16.98
724A	3.95
724B	2.74
725A	9.98
726A	14.48
726B	44.88
726C	64.88
801A	.42
803	3.48
805	3.22
807	1.54
808	2.62
809	3.58
810	10.88
811	3.00
812	2.70
813	11.48
814	4.98
815	5.98
829	7.94
829B	12.48
832	7.72
832A	9.92
833A	39.45
836	5.95
837	1.42
849	29.45
860	4.48
865	1.26
866A	1.50
872A	3.29
917	2.59
925	2.14

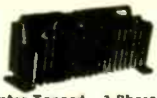
927/CE25	1.70
CK1005	.68
1613	.82
1614	1.95
1625	.32
1632	.68
1633	.98
1636	3.08
1642	.62
1644	.92
2050	1.48
2050W	2.48
5618	3.50
5635	11.57
5637	6.53
5640	11.57
5641	7.52
5643	11.57
5644	11.57
5646	11.57
5651	2.24
5654	1.72
5656	12.08
RK5657	298.48
5663	1.06
5670	3.44
CK5672	1.20
CK5678	1.28
5687	3.74
5691	7.54
5692	8.52
5693	6.24
5694	3.65
CK5702	2.90
CK5703	1.29
5713	120.00
WL5736	130.00
5749	1.72
5751	2.88
5769	2.98
5812	2.99
5814	2.08
5820	148.00
5840	7.98
5844	2.98
5881	2.70
8012	2.58
8013	3.92

Xtal Diodes

1N21A	$1.55
1N21B	2.10
1N22	1.22
1N23	1.35
1N23A	1.89
1N23B	2.00
1N25	4.98
1N26	8.75
1N27	1.55
1N34	.64
1N34A	.88
1N35	1.65
1N38A	1.29
1N41	8.95
1N42	16.95
1N45	1.45
1N46	.69
1N47	4.00
1N48	.47
1N51	.45
1N54	.78
1N54A	1.00
1N55A	1.15
1N60	.60
1N63/K63	2.49
1N64	.69

OTHER TYPES IN STOCK WRITE

SELENIUM RECTIFIERS
FULL WAVE BRIDGE*



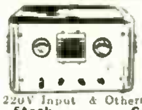
We specialize in power rectifiers to your specifications. Contact "TAB" for fast delivery on any rating, from one amp up to and above 1000 amps. convection or fan cooled. Single or 3 phase to your spec's. Magamp rectifiers also.

Max Amps	18/14* Volts	36/28* Volts	72/56* Volts	130/100* Volts	144/118* Volts	266/217* Volts	Center Tapped AC/DC 16/6.5	Center Tapped AC/DC 30/12	3 Phase Bridge 120/150
1	$1.40	$2.40	$4.60	$8.50	$12.75	$22.85	Q	Q	Q
2	2.10	3.00	6.00	10.50	15.75	28.85	Q	Q	5.90
2½	3.00	4.20	8.00	13.00	Q	Q	Q	Q	Q
4	3.75	7.50	14.50	25.25	26.75	38.85	Q	2.95	Q
6	4.50	9.00	17.50	33.00	34.75	54.85	2.95	3.25	19.90
10	6.60	12.75	25.00	42.50	44.75	84.85	Q	4.75	36.90
12	8.20	16.25	30.00	46.00	Q	Q	3.25	5.95	41.90
20	13.25	25.50	49.00	79.50	82.75	Q	6.25	7.95	50.90
24	16.25	32.50	58.00	86.50	Q	Q	8.95	9.95	89.90
30	20.00	38.00	72.00	Q	Q	Q	Q	Q	Q
36	25.00	48.50	88.00	Q	Q	Q	12.95	14.95	134.90
50	32.00	62.50	Q	Q	Q	Q	17.95	23.95	179.90
100	60.00	120.00	Q	Q	Q	Q	29.95	39.95	359.90

Rectifier & Transformer Combination
115 Volt 60 cyc Input

up to 14VDC at 12 amps...............$19.98
up to 28VDC at 4 amps.................14.98
up to 28VDC at 12 amps................29.98
up to 28VDC at 24 amps................63.98
up to 28VDC at 50 amps...............127.00

HIGH CURRENT PWR SUPPLIES



Variable 0-28VDC. Completely Built, Ready to Go. Full Wave Selenium Rectifier. Transformer, Variac, Volt & Amp Meters, witch, Terminals & Fuse. In Heavy Duty Steel Cabinet Standard 115V 60 cy Input 220V Input & Others On Special Order... write

Stock Number	Continuous Rating	With Meters
T28V5A	0-28VDC at 5 Amp	$47.75
T28V12A	0-28VDC at 12 Amp	89.00
T28V24A	0-28VDC at 24 Amp	129.50
T28V50A	0-28VDC at 50 Amp	239.50

RECTIFIERS XFMRS

PRIMARY 115V 60 cyc
SECONDARY 0-9-12-18-24-36V
4 amp......$8.75: 2 for $15.75
12 amp.....$16.75: 2 for $29.95
24 amp.....$35.75; 2 for $69.95
30-32-34-36V/48A...........$9.50
18 Volt 2 amp..$2.25 @ 2 for $4
2X12.6V/2A or 25.2V/2A or 12.6V/4 amp RCA CSD..................$3.59; 3/$10.: 12/$36.

RECTIFIER CHOKES

4 Amp	.07 Hy	.6 Ohm	$7.95
12 Amp	.01 Hy	.1 Ohm	14.95
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Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 60cy Output 6.3V or 12.6V 2 Amp.
Model 2DCF (2 amp)...................$12.98
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#122-237 (813)...............50c: 3 for 1.00
#122-234 (5D21-715)..........1.25; 4 for 3.90
#124-213 (304TL).............1.30; 2 for 2.49
#122-227 (1625)..............30c; 4 for 1.00
#122-225 (807)...............35c; 4 for 1.20
#49-SS11L (Maginal)..........59c; 2 for 1.00
5 prong (Acorn)..............35c; 4 for 1.00
4 prong (5C22-8008)..........1.20; 4 for 4.00
Octal (low-loss mica) ring mtg.........10 for 1.00
Octal (mica) ring mtg..................12 for 1.00
Octal (bakelite) ring mtg..............15 for 1.00
Octal (bakelite) saddle mtg............15 for 1.00
Octal (mica) saddle mtg................12 for 1.00
Octal (steatite) saddle mtg............12 for 2.00
Loktal (steatite) ring mtg.............10 for 2.00
Loktal (mica) saddle mtg...............12 for 1.00
7 pin min (mica) bottom mtg.... 12c; 10 for 1.00
7 pin min (blkt) rubber shock mtg 20c; 12 for 2.00
9 pin min (mica) bottom mtg.... 20c; 12 for 2.00
9 pin min (blkt) bottom mtg.... 18c; 7 for 1.00
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.5MFD/1500V.....85c; 3 for $2.00
1MFD/500V.....33c; 4 for $1.00
1MFD/600V.....39c; 3 for $1.00
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2 MFD 600 VDC

Type P09. Steatite insulators Adjustable Mounting Clamp. Case 2" Dia x 2¾" High. Brand New Special.....49c; 10 for $3.50

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125 ohm 25W Model H...........1.30; 10 for 10.00
225 ohm 50W...................1.98; 10 for 15.00
250 ohm 25 W..................1.10; 10 for 6.00
300 ohm 225 W Model P.........2.98; 5 for 10.00
500 ohm 25 W Model H..........1.10; 10 for 7.50
800 ohm 50 W Model J..........1.98; 10 for 15.00
2500 ohm 25 W.................1.30; 10 for 7.00
5000 ohm 25 W Model H.........1.25; 10 for 9.00
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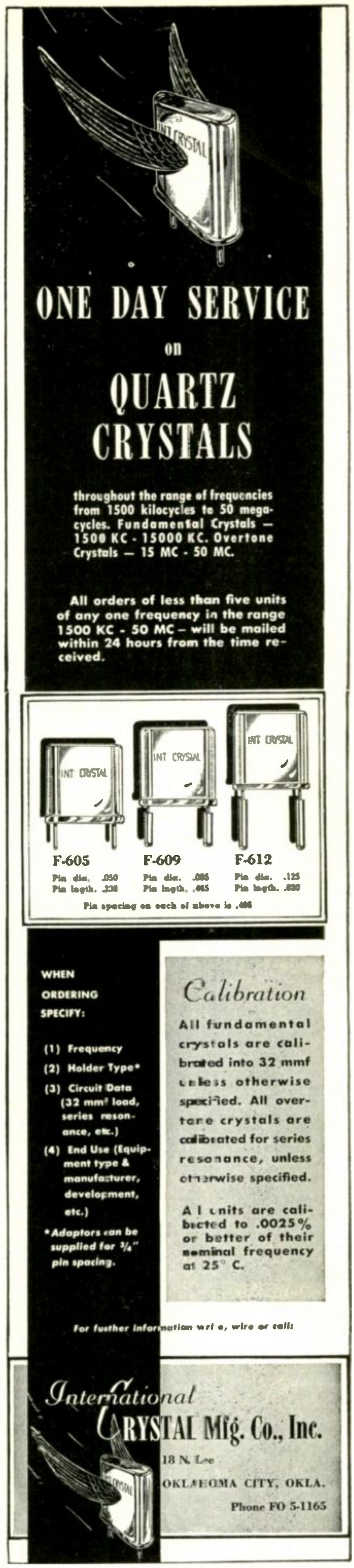

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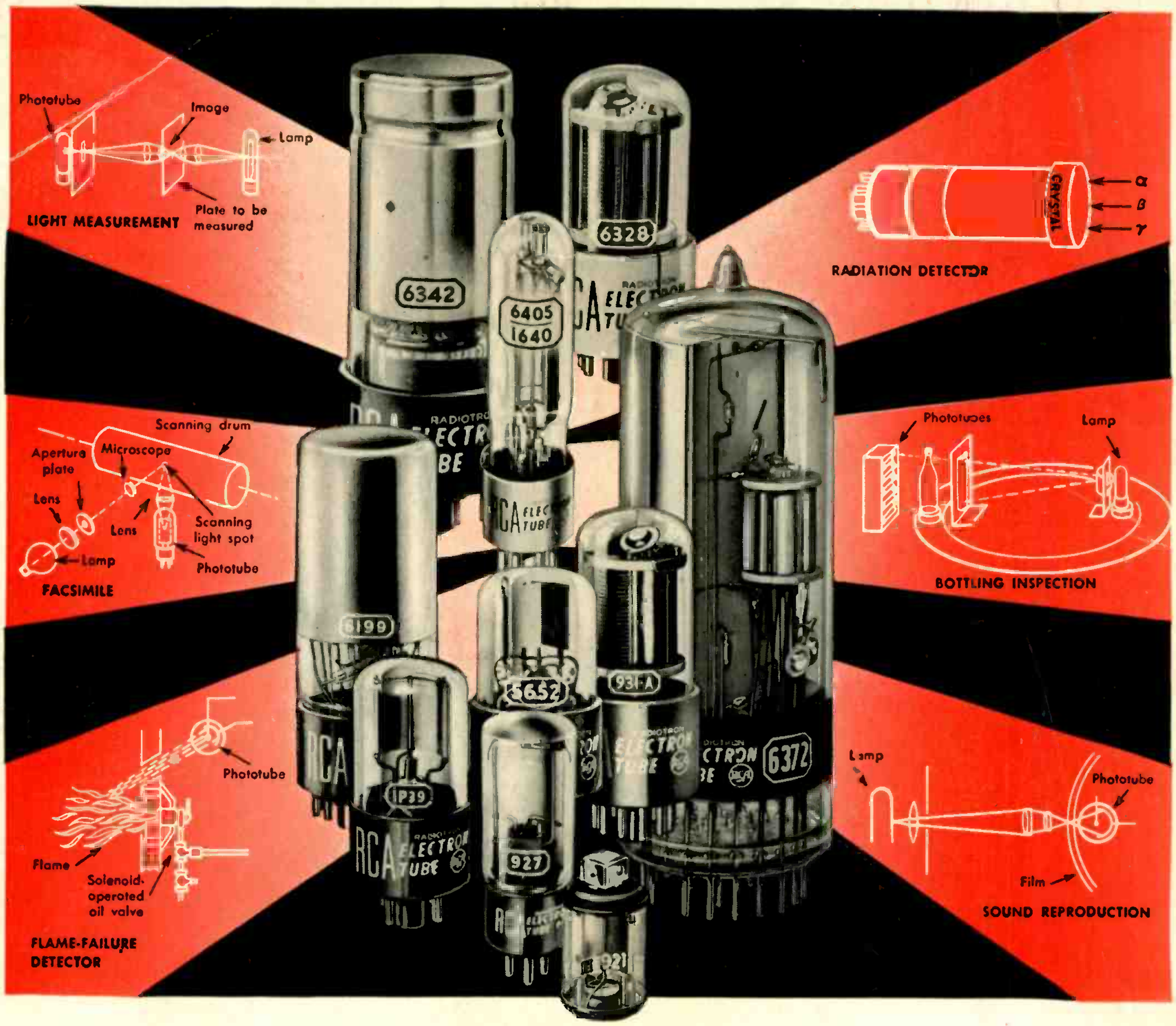

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