OCTOBER · 1954

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electronics

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Mechanical Design of Electronic Equipment

a 64-page Special Report

Colored Chassis Speed Navigational Radar Maintenance

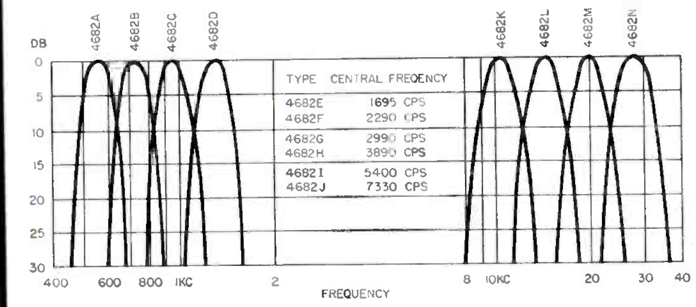
OUR MILLIONTH FILTER SHIPPED THIS YEAR...

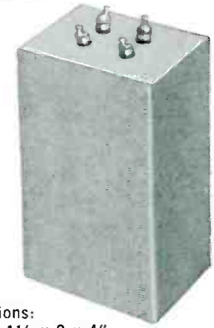
FILTERS

FOR EVERY APPLICATION

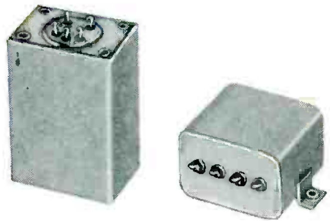
TELEMETERING FILTERS

UTC manufactures a wide variety of band pass filters for multi-channel telemetering. Illustrated are a group of filters supplied for 400 cycle to 40 KC service. Miniaturized units have been made for many applications. For example a group of 4 cubic inch units which provide 50 channels between 4 KC and 100 KC.

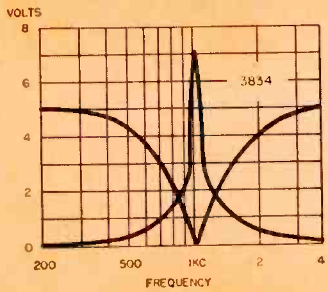


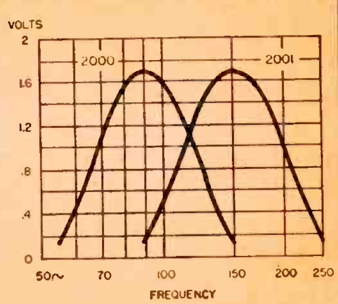


Dimensions:
(4682A) 1½ x 2 x 4″



Dimensions:
(3834) 1¼ x 1¾ x 2-3/16″.
(2000, 1) 1¼ x 1¾ x 1⅝″.





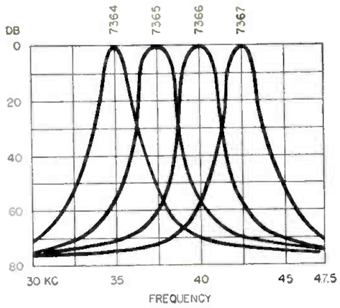
AIRCRAFT FILTERS

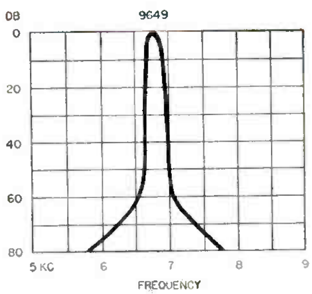
UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1020 cycles) range filter providing high attenuation between voice and range frequencies.

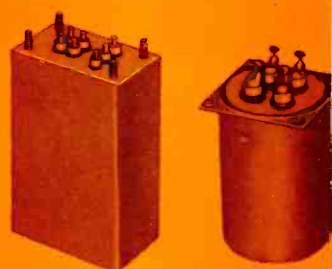
Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

CARRIER FILTERS

A wide variety of carrier filters are available for specific applications. This type of tone channel filter can be supplied in a varied range of band widths and attenuations. The curves shown are typical units.







Dimensions:
(7364 series) 1⅝ x 1⅝ x 2¼″.
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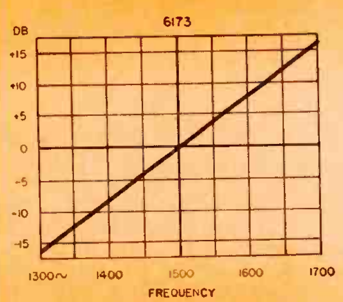
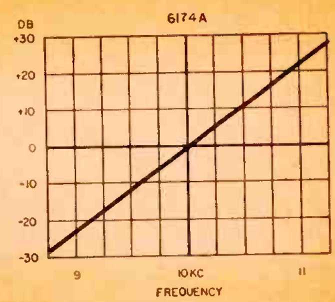
These high Q discriminators provide exceptional amplification and linearity. Typical characteristics available are illustrated by the low and higher frequency curves shown.





Dimensions:
(6173) 1-1/16 x 1⅜ x 3″.
(6174A) 1 x 1¼ x 2¼″.

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COLORED CHASSIS SPEED NAVIGATIONAL RADAR MAINTENANCE—Anodizing in nine distinctive colors permits rapid identification of the various subassemblies in the AN/APN-81 Radar Navigation Set developed at General Precision Laboratory, Inc., Pleasantville, N. Y. Photo by James Pazzi. Details on p 200 .... *COVER*

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specifications

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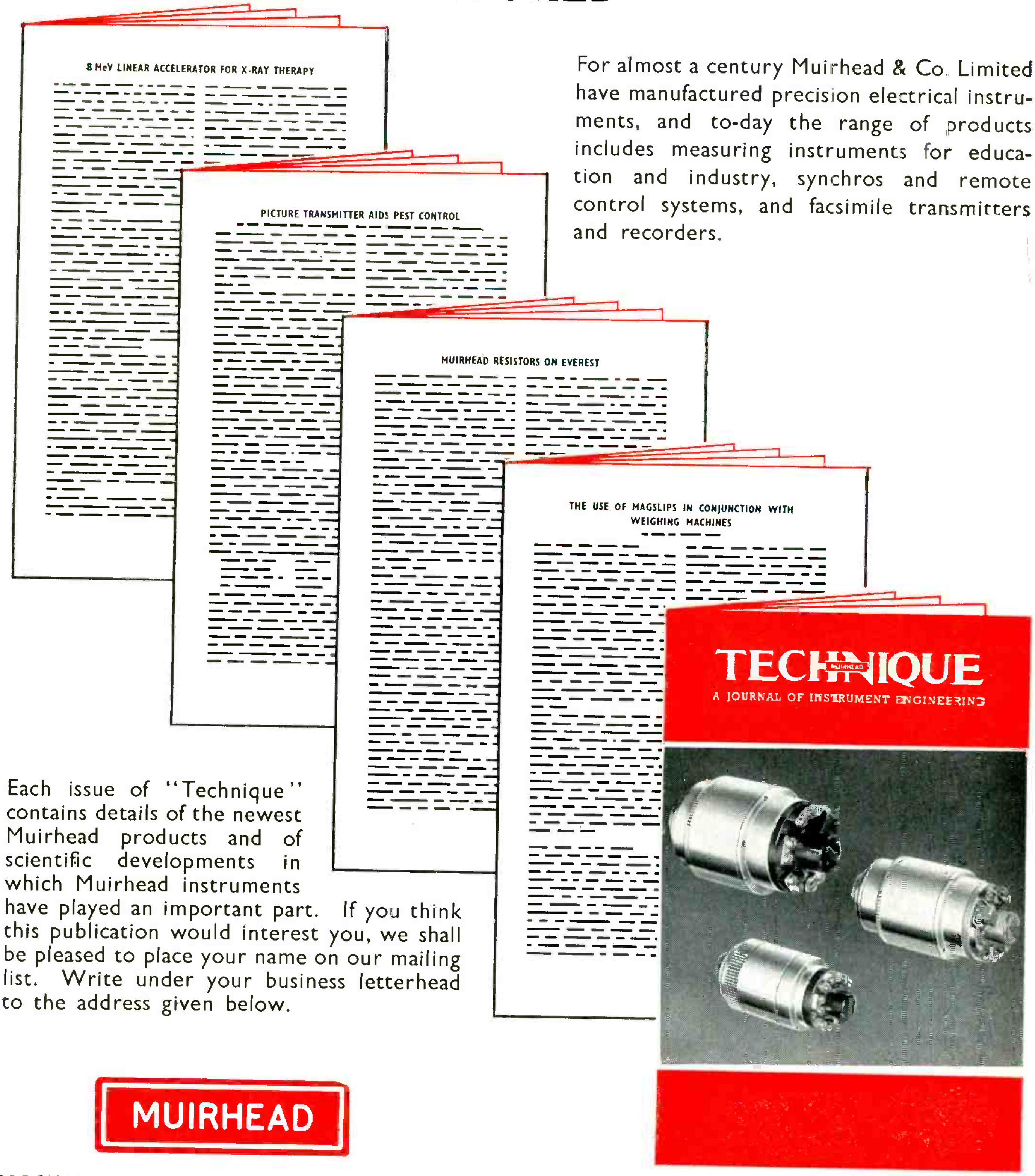

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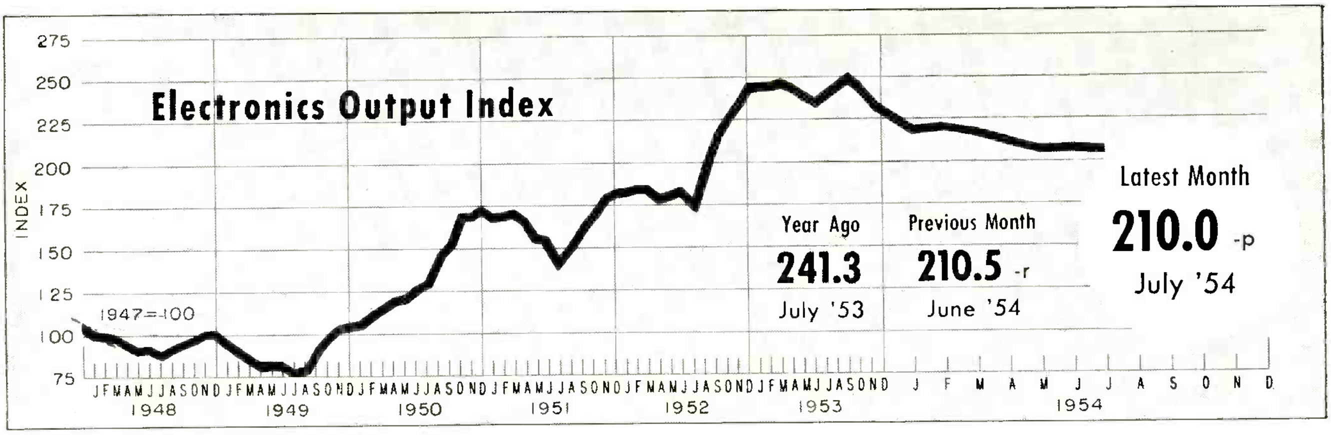


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago	Previous Month	Latest Month
	July '53	June '54	July '54
Television sets, total	316,289	544,142	306,985
With UHF	———	99,404	57,838
Color sets		347	32
Radio sets, total	674,459	837,655	438,061
With F-M	22,986	15,854	8,622
Home sets	172,197	226,350	150,002
Clock radios	87,620	132,668	57,100
Portable sets	78,434	141,904	39,447
Auto sets	336,208	336,733	191,512

RECEIVER SALES

(Source: RETMA)	July '53	June '54	July '54
Television sets, units	340,406	351,885	368,634
Radio sets (except auto)	366,666	537,494	411,197

RECEIVING TUBE SALES

(Source: RETMA)	July '53	June '54	July '54
Receiv. tubes, total units	26,462,069	31,031,315	24,208,512
Receiv. tubes, value	$18,243,030	$21,694,400	$18,082,753
Picture tubes, total units	634,200	681,937	514,346
Picture tubes, value	$15,155,870	$13,933,845	$10,102,903

SEMICONDUCTOR SALES

	June '53	May '54	June '54
Germanium diodes / Silicon diodes	1,344,636	1,001,905	960,112

INDUSTRIAL TUBE SALES

(Source: NEMA)	Year Ago	Previous Quarter	Latest Quarter
	Quarterly Figures		
	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
	Aug. '53	July '54	Aug. '54
TV Homes, total	24,895,000	30,717,000	31,036,000

BROADCAST STATIONS

(Source: FCC)	Aug. '53	July '54	Aug. '54
TV stations on air	253	409	413
TV stations CPs—not on air	270	169	165
TV stations—applications	521	16	14
A-M stations on air	2,476	2,592	2,603
A-M stations CPs—not on air	117	121	113
A-M stations—applications	177	167	163
F-M stations on air	579	559	561
F-M stations CPs—not on air	18	12	10
F-M stations—applications	7	5	6

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	July '53	June '53	July '54
Aeronautical	40,655	40,154	40,708
Marine	41,473	46,299	46,621
Police, fire, etc.	13,869	15,697	15,926
Industrial	17,951	21,598	21,867
Land transportation	6,069	6,891	6,925
Amateur	110,862	123,287	120,409
Citizens radio	3,877	7,054	8,093
Disaster	191	283	305
Experimental	463	586	592
Common carrier	1,222	1,635	1,661

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	June '53	May '54	June '54
Prod. workers, comm. equip.	417,800	342,600-r	339,300-p
Av. wkly. earnings, comm.	$66.66	$67.42 -r	$68.51 -p
Av. wkly. earnings, radio	$64.64	$66.08 -r	$67.49 -p
Av. wkly. hours, comm.	40.4	39.2 -r	39.6 -p
Av. wkly. hours, radio	39.9	39.1 -r	39.7 -p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Aug. '53	July '54	Aug. '54
Radio-tv & electronics	280.0	351.2	354.8
Radio broadcasters	274.8	377.3	381.3

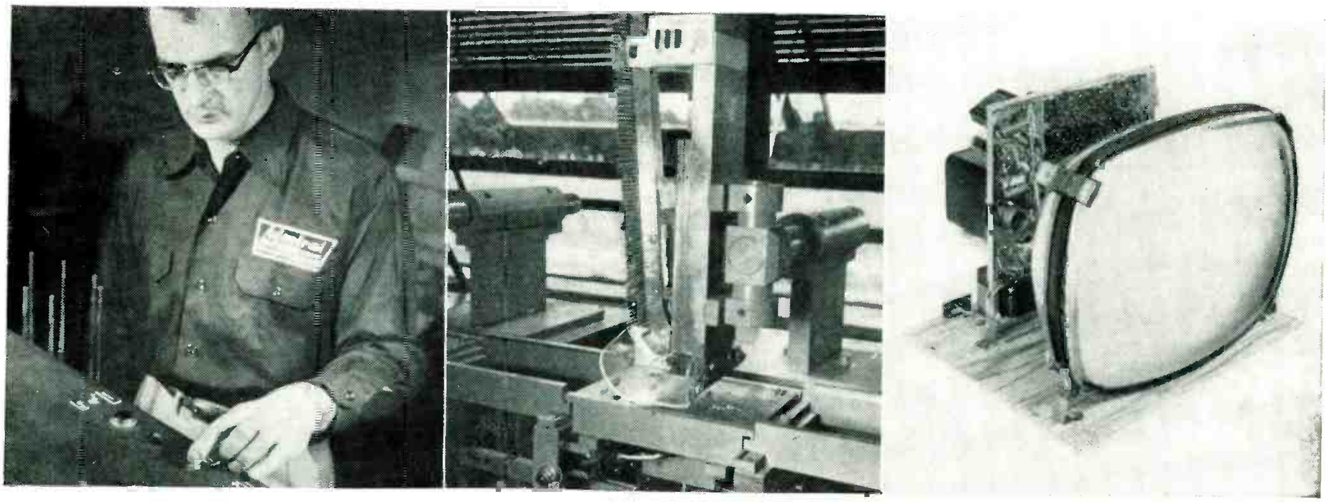
p—provisional; r—revised

FIGURES OF THE YEAR

	1953 Total	TOTALS FOR FIRST SEVEN MONTHS 1953	1954	Percent Change
Television set production	7,214,787	4,150,525	3,152,132	—24.0
Radio set production	13,368,556	7,941,001	5,324,620	—32.9
Television set sales	6,375,279	3,116,306	3,174,394	+ 1.9
Radio set sales (except auto)	7,064,485	3,383,862	2,822,090	—16.6
Receiving tube sales	437,091,555	269,622,417	189,917,572	—29.5
Cathode-ray tube sales	7,582,835	5,831,271	4,471,584	—23.3

INDUSTRY REPORT

electronics—October • 1954



PUSHBUTTON starts machine that trims and bends resistor leads, inserts them in printed circuit boards and crimps them in position. Printed circuit assembly comprises nearly 50 percent of completed vertical tv chassis wiring as . . .

Automatic Production Speeds TV Receiver Output

Machine-assembled eight-tube circuits appear in 21-inch television sets

COMPLEX machines 30 feet long, into which resistors and wire jumpers are automatically fed, deliver assembled printed circuit boards at Admiral Corp.

▶ **How**—The electronically controlled machines, designed and built by the firm's engineers, utilize printed circuit boards that are photo-etched and stamped at one of the company's plants. As the boards automatically move from machine to machine down the 30-foot line, fifty resistors and wire jumpers are machine-inserted in each board, some singly, some two and three at a time, depending on spacing. Before the resistors are inserted, the machines trim and bend the wire leads to size. After insertion, dies crimp the leads precisely against the copper circuit pattern to insure getting good contacts by dip soldering.

Whenever any part fails to feed from its chute, a red light goes on at that machine and the entire line is automatically halted until adjustments are made.

▶ **Future**—Two other machines, one approximately 100 feet long, are under construction and will be in use in early 1955. It is expected that eventually the robots will be able to insert items such as tube sockets and tubes. This means that some components will be redesigned for automatic feeding.

According to the company, production has been increased so much with the new machines that, rather than displacing personnel, it has been necessary to hire more women employees to complete final hand assembly of the printed circuit boards. Two new vertical-chassis 21-inch tv table models now on the market use the automatically produced eight-tube circuits. Tubes are mounted horizontally for removal from the rear.

Electronic Industry Booms In California

Growth mirrored in record WESCON attendance is backed by new L. A. survey

GROWING importance of the electronics industry on the west coast was pointed up at the recent Western Electronic Show and Convention and by a new survey of Los Angeles electronic manufacturers.

▶ **WESCON**—More than 23,000 engineers, technicians and members of allied industries registered for the 1954 show in Los Angeles, exceeding last year's registration by

10,000. More than 2,800 attended the technical sessions at which 115 papers were delivered. Equipment ranging from silicon transistors to computers was exhibited by over 600 manufacturers in 522 booths, about 150 more than were used in 1953.

▶ **Survey**—Backing up the growth of the WESCON were the survey facts recently published by the Los Angeles Chamber of Commerce. They show that billings of electronic firms in the Los Angeles metropolitan area have grown from $95 million in 1946 to $750 million last year. Capital investment of firms in the area has also grown rapidly.

Last year the electronic industry in Los Angeles county invested $26.5 million, $17.3 million in seven new plants and $9.1 million in 34 expansions of existing facilities. This compares to total expenditures of $4.6 million in 1952 and $4.3 million in 1951. In the first seven months of 1954, the electronic industry ranked second in the area in the number of new expanded plants, with 32 projects representing a capital investment of $12.9 million.

▶ **Companies**—According to the survey, there are 374 firms occupying 424 plants in metropolitan Los Angeles that manufacture electronic equipment. They have a combined total of 7.7 million sq ft of plant facilities and manufacture 172 different electronic products. The total number of workers employed by these firms is 60,900, representing 75 percent of electronic employees in the west and an annual payroll of $231 million.

Breakdown of some of the 374 firms in the Los Angeles area shows that 161 are research and development firms, 19 are engineering and design companies and 22 are service and testing firms.

Larger Color Picture Tube Bows

NEW RCA 21-inch color tv tube with 250 square inches of picture area is compared with its 15-inch predecessor. It will be used in a new color tv receiver that employs 28 tubes including the picture tube. Cost of the tube is $175 and sets using the new tube will retail between $800 and $900. Sampling of the picture tube to other manufacturers is scheduled to begin Nov. 1.

Initial sets using the tube will employ modified 19-inch chassis containing 39 tubes. A few thousand of these sets will be made and are expected to be on the market before the end of the year.

Radio Control System Guides Tractor-Trains

Pushbutton unit on belt cuts order-filling costs in large warehouses

OLD-TIME MILKMEN did very little driving. Only an occasional whistle was necessary to keep horse and wagon moving down the street in step with the milkman as he cut across lawns and back yards. With modern in-plant material-handling tractor-trains, however, the driver-loader must often spend half his time running back to the controls.

A new electronic control system has solved this difficulty. A warehouseman loading groceries and supplies onto a tractor-train need touch the tractor controls only occasionally. To move from dry cereals to soap powders, for example, he merely pushes one of three buttons. Three different tone signals whistle the tractor to start, turn right or turn left. When his finger is removed, the tractor brakes to a smooth halt.

Radio-controlled tractor built by Barrett-Cravens of Northbrook, Ill. hauls trailers in 5-acre warehouse of Super-valu Stores, Inc., in Hopkins, Minn.

▶ **Who Can Use It?**—So far, only about two dozen radio-controlled tractors have been put into service, eight of them in one warehouse. Time studies now in progress indicate that there may be as much as 20 percent savings in an order-filler's time.

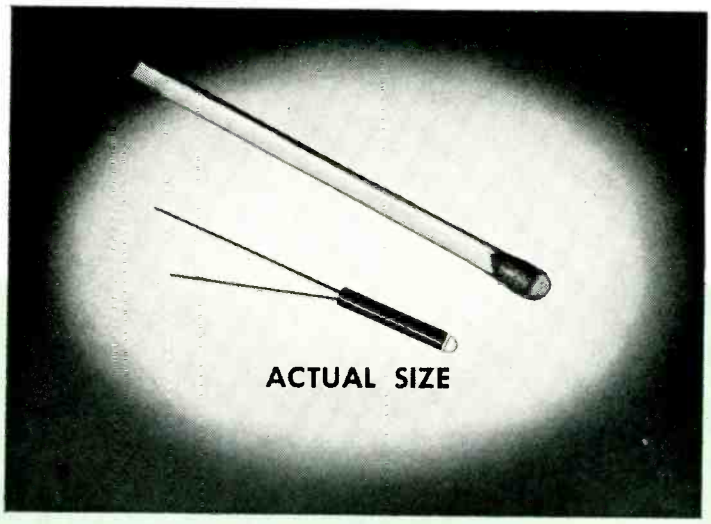
Cost of the radio system and

(Continued on page 8)

HIGHLY SENSITIVE...COMPACT IN SIZE!

SYLVANIA PHOTODIODE

1N77A



The Sylvania 1N77A is a highly sensitive compact junction photodiode.

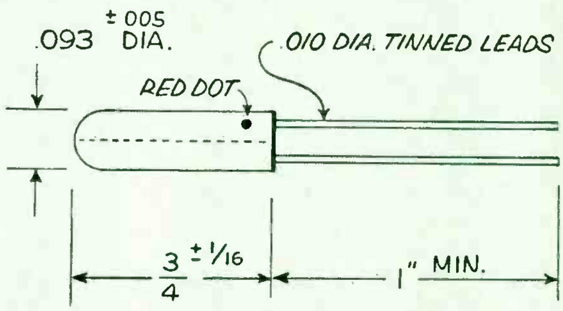
Its useful sensitivity covers the visible spectrum and extends into the infrared region where it peaks at approximately 15,000 Angstrom Units.

Consider these advantages:

1. **Hermetically sealed in glass.**
2. **Extreme stability in operation.**
3. **Uniformly high sensitivity (8.5 volts min. to 17.0 volts max. across a 100 k-ohm load).**
4. **Low dark current (200 μa @ —50 volts.**

The high sensitivity and compact packaging of the 1N77A should provide the answer to many light-sensing application problems. *Still more reasons why it pays to specify Sylvania.*

DETAILED DRAWING



FOR FULL DETAILS about the complete line of Sylvania diodes write to Dept. 4E-1610 at Sylvania.

SYLVANIA

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electric tractor together is $4,000 but the radio gear itself sells for about $1,400. The manufacturers believe such control equipment can be applied satisfactorily to fork trucks, bridge cranes and other devices subject to remote operation.

▶ **Radio System**—Although design details have not yet been revealed, it is known that the radio control operates under FCC low-power rules without necessity for a license. The mobile receiver uses the rubber-tired tractor and trailers as antenna.

Color Set Makers Size Up Color Broadcasting

Networks and network routes are set for color programs but local stations lag

IT has been almost axiomatic in new black-and-white tv markets that when programs were poor or sparse so were tv set sales. Good shows sold sets. Manufacturers who will have color receivers on the market this fall are therefore taking a hard look at the color program plans of networks and stations for this year.

▶ **Programs**—NBC has the most ambitious lineup of color programs among the networks. It has scheduled 49½ hours of color programming for the fall season. By the first of the year it will have facilities for color origination available for 60 hours of color programs a month.

CBS has 77 separate color shows now scheduled through April 6 of next year for about 40 hours of color programs.

Du Mont's WABD goes on the air in September with one color program a week. This will be stepped up later to three weekly programs. This firm's Pittsburgh and Washington, D. C. stations expect to be equipped for color this year. All of its initial programs will be taken from color film.

▶ **Network**—AT&T will have its routes ready for network color programs. Already 31,000 of the 59,000 channel miles of tv facilities now in service have been re-engineered and re-equipped to carry color programs. Color tv can now be transmitted to 65 cities across the nation.

At present 145 stations in these cities are receiving network tv service and about 95 of them are getting color in addition to black-and-white. AT&T estimates that by November most of its principal routes will be equipped with color and that by the end of the year it will be able to transmit color programs to about 95 of the 202 cities now linked for black-and-white tv.

▶ **Local**—Although there may be a total of 100 hours of network color programs available this year to help sell color sets, sizeable gaps in a prospective color set owner's viewing schedule remain. As with black-and-white tv, these gaps will be taken up by color programs of local stations.

So far, outside of the networks, only about 10 stations have equipment for originating live color programs. Only about 10 color film scanners have been delivered for color film use. The four scanner manufacturers, DuMont, GE, Philco and RCA, are stepping up their production schedules, however. It is expected that as color sets trickle into local markets, more local stations will order color cameras and film equipment or convert present equipment.

TELEPHONE, tv receiver and vidicon camera combine as . . .

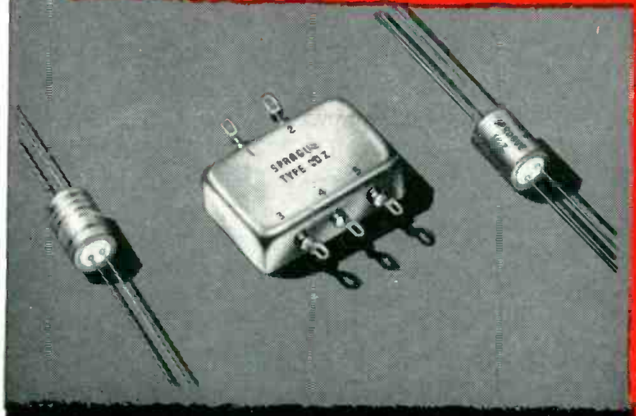
Intercom TV Makes Its Debut

TELEVISION-TELEPHONE intercom system became a commercial reality when Kay Lab recently demonstrated its new unit. It is designed around a 17-inch tv receiver, a vidicon industrial tv camera, a telephone handset and the necessary switching equipment. Approximate cost of a two-station installation is $5,000, with additional stations costing proportionately less per unit.

▶ **Operation**—When the telephone is lifted from its hook, the caller's image appears on one-half of both his and the called party's screen. The answering party's image appears on the remaining half of each screen. Either user can make the entire screen available if desired, for uses such as viewing signatures, blueprints and documents. When the telephone is not

(Continued on page 10)

Sprague PULSE TRANSFORMERS for digital computers



Type 10Z pulse transformer at left is color-coded to customer specifications. Unit at right is standard.

As a new line of reliable components for digital computers, Sprague has introduced and is in production on pulse transformers of a new type. This transformer line is principally directed to high speed, low power computer circuits, with some designs also finding application in blocking oscillator circuits, memory ring driving circuits, etc.

Two major types are offered: a miniature transformer, Type 10Z, for 0.05 to 0.5 microsecond pulse circuits, and a larger transformer, Type 20Z, for handling pulses up to 20 microseconds in length. Intermediate sizes and plug-in units are also available for special customer requirements.

Basic data on the high reliability miniature transformer is tabulated at right. Complete details are in Engineering Bulletin M 502. A copy will be sent you on letterhead request to the Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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

BASIC CHARACTERISTICS OF TYPE 10Z PULSE TRANSFORMERS

Pulse Duration	.05 to 0.5 microseconds.
Applications	flipflop circuits • buffer circuits pulse amplifier circuits • gating circuits • other circuits with pulse lengths up to about 0.5 microseconds.
Physical Description	Hermetically sealed. Housed in corrosion-resistant can with glass-to-metal solder-seal terminals at each end. Can length is ¾″ and diameter is ½″. Transformers can be mounted and supported by lead wires in most applications.
Ratios Offered	Ratio 1:1 — Cat. No. 10Z3 Ratio 2:1 — Cat. No. 10Z5 Ratio 3:1 — Cat. No. 10Z4 Ratio 4:1 — Cat. No. 10Z2 Ratio 5:1 — Cat. No. 10Z1 Special Ratios Available
Maximum Repetition Rate	For a pulse length of 0.1 microsecond, pulse repetition rates up to 2 megacycles per second can be employed.
Pulse Amplitude	Normally used in circuits whose pulse amplitude varies up to 60 volts.
D-C Rating	Maximum working voltage, 300VDC. Flash tested between windings at 600VDC. May be life tested at 450 VDC between windings, 85°C, for 250 hours.
Temperature	May be operated between −55°C and +85°C. Higher temperature units available on request.
Insulation Resistance	20,000 megohms minimum between windings, measured at 25°C and 180 Volts DC.

WORLD'S LARGEST CAPACITOR MANUFACTURER

SPRAGUE

Export For The Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

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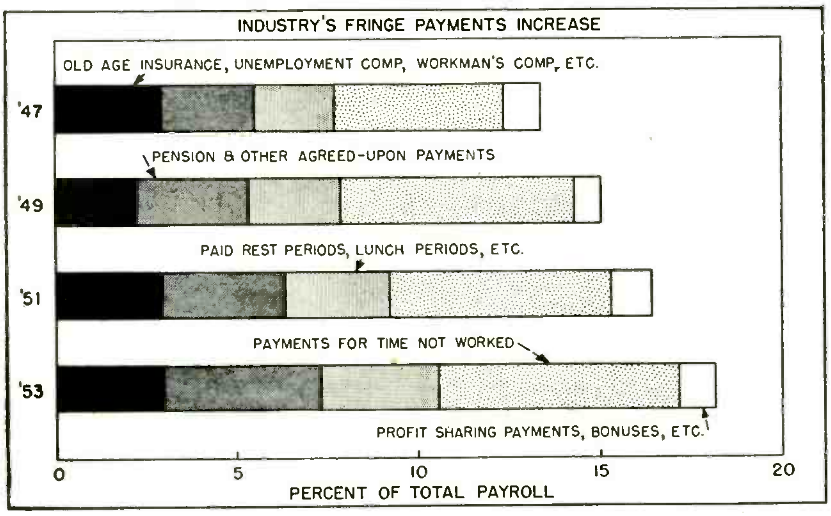
in use, the monitor can be used for regular closed-circuit tv, subscription tv or as a standard tv set.

▶ **Use**—The tv intercom is designed primarily for applications in industry, for interplant conferences and other uses where savings in time and expense can be made. The system is seen as being especially applicable as a surveillance aid. A unit installed at electrically controlled gate stations could eliminate the expense of full-time guards. The cost of maintaining a single guard position at large installations is estimated at $20,000 annually.



PAYROLLS for electrical and electronic manufacturers increase as . . .

Fringe Benefit Costs Grow Heavier

Electronic firms are among the top five manufacturing groups in fringe payments

ELECTRONIC pay envelopes reflect only part of labor costs for manufacturers in the field because of increasing payments made in the form of fringe benefits. Today these benefits, measured against total payrolls in the industry, represent 18 percent of wage costs, 35 cents per payroll hour or about $700 extra per year for each employee.

▶ **Trend**—There has been a steady rise in fringe benefits in the electrical machinery industry classification, which includes electronic firms, since 1947, as is shown in the chart. In 1947, according to a survey by the U. S. Chamber of Commerce, fringe payments in the field represented about 13 percent of total payroll, 18 cents per payroll hour and $390 per year per employee. In 1951 benefits had jumped to 16.4 percent measured against total industry payroll, 28 cents per payroll hour and $616 per year per employee.

Main increase in benefits between 1951 and 1953 was in the employers' share for pensions and other agreed-upon payments such as accident and medical care insurance premiums, hospitalization, death benefits, life insurance premiums, separation pay allowances and tuition refunds. Other increases were in paid rest periods, lunch periods and payments for time not worked. Bonuses and profit-sharing payments showed a slight drop for the industry in the period.

▶ **Where**—Amounts paid in fringe benefits vary with a manufacturer's location in the U. S. Producers in the North East, from Pennsylvania to Maine, paid 18.4 percent of payroll in fringe benefits for the highest percentage in the country. Manufacturers in East North Central States paid 16 percent of payroll and those in the West spent 15.2 percent in fringe benefits.

Size of the company affected benefit payments randomly. According to the survey, those companies in the field with between 500 and 999 employees paid 18.1 percent of total payroll in fringes. Companies with under 500 workers and others with between 1,000 and 2,449 workers paid 17 percent. Firms with 2,500 to 4,999 employees paid 16.2 percent and those with 5,000 and over paid 16.9 percent of payroll in fringe benefits.

▶ **Comparison**—Total fringe payments made by other manufacturing industries show wide variation. Electronic and electrical manufacturers ranked sixth among 12 industries in benefits paid. Petroleum companies led all industries surveyed with fringe payments equal to 28 percent of total payroll. Transportation equipment manufacturers were lowest with 14.8 percent. The fact that there is variation in the amounts paid by each industry group may not mean, however, that one industry is ahead or behind another because, in many cases, the employer and the workers may prefer to have income reflected entirely or chiefly in the pay envelope.

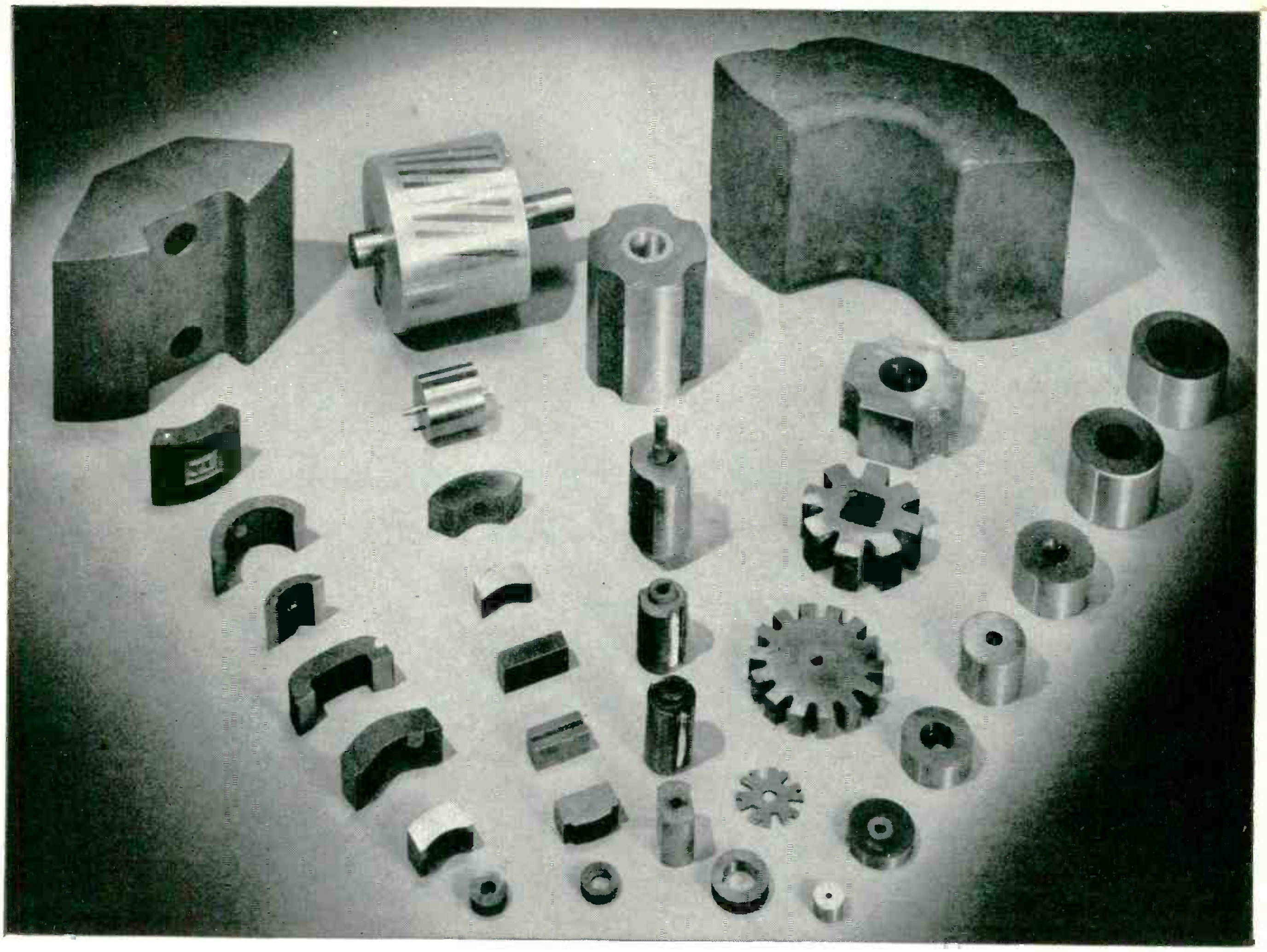
U.S. Navy Encourages Automatic Production

Bureau of Aeronautics adopts new policy giving preference to mechanized electronics

DIVISIONS of Navy's Bureau of Aeronautics concerned with the design and procurement of electronic equipment have been directed to encourage electronic contractors, through development and production contracts, to utilize mechanized production techniques.

According to the new policy, BUAER intends, whenever practicable, to select new designs for electronic equipment that have the increased mobilization potential of mechanized production. The automatic production of equipments

(Continued on page 12)



Magnets for rotors or stators ...any design or size you may require

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Contains handy data on various types of Alnico Magnets, partial lists of stock items, and information on other permanent magnet materials. Also includes valuable technical data on Arnold tape-wound cores, powder cores, and types "C" and "E" split cores in various tape gauges and core sizes.

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The use of Alnico permanent magnets in rotor and stator assemblies of motors, generators, magnetoes and tachometers has revolutionized the designs of these devices. Whatever your need may be —from a tiny rotor for a timing device to a large slab for power generators—Arnold can take care of your requirements, either for experimental samples or production quantities.

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with high mobilization requirements will be particularly encouraged where it will substantially reduce the lead time required for mobilization production schedules.

▶ **Aim**—Purpose behind BUAER'S new policy is to develop sufficient capacity in the electronics industry to produce the large volume of military-quality equipments that will be required in the event of a global war. The Bureau feels that progress in the field of mechanized production has now advanced sufficiently to warrant its use in field equipment for the fleet.

▶ **Status**—So far the only product in current production for BUAER that uses mechanized techniques is the sonobuoy under a contract with Willys Motors. This contract, however, is drawing to a close and it is reported that the company is contemplating moving out of this field. The machines in its pilot plant are owned by BUAER and no decision on their disposition has yet been made.

▶ **Advances**—National Bureau of Standards is continuing to develop components for use in Tinkertoy production. A self-adhesive tape capacitor, manufactured in much the same manner as the NBS tape resistor, has been developed. It can be applied to one side of a wafer.

Defense Needs Spur Lighting Panel Sales

PLASTIC LIGHTING PANELS that permit military pilots to read their instruments without losing their dark adaptation or night vision sustain about a $10 million industry filling largely defense needs.

▶ **Market**—A new B-52 bomber requires 175 panels—covering for the most part electronic equipment. Another 30 to 40 panels are installed on government-furnished equipment mounted in the plane. Plastic lighting panels are expensive since they must be made to exacting tolerances. Twenty-nine firms are reportedly in the business, although a half-dozen of these claim to do the lion's share of the business. The industry is concentrated near New York, Chicago and Los Angeles.

▶ **What Is It**—Basically a plastic lighting panel is a $\frac{3}{16}$-in. sheet of clear methacrylate plastic in which is embedded a tiny light bulb equipped with a red filter. The panel is then painted an opaque black with the lettering and indicators done in translucent white. The panel is thus black and white by day and red by night. Such a panel is transilluminated.

Red light is chosen to illuminate the panels since a pilot may look at a dim red light and preserve his night vision. Military specifications require that the light source may be dimmed over a 7 to 1 ratio.

Industry Proposal Spurs UHF-TV

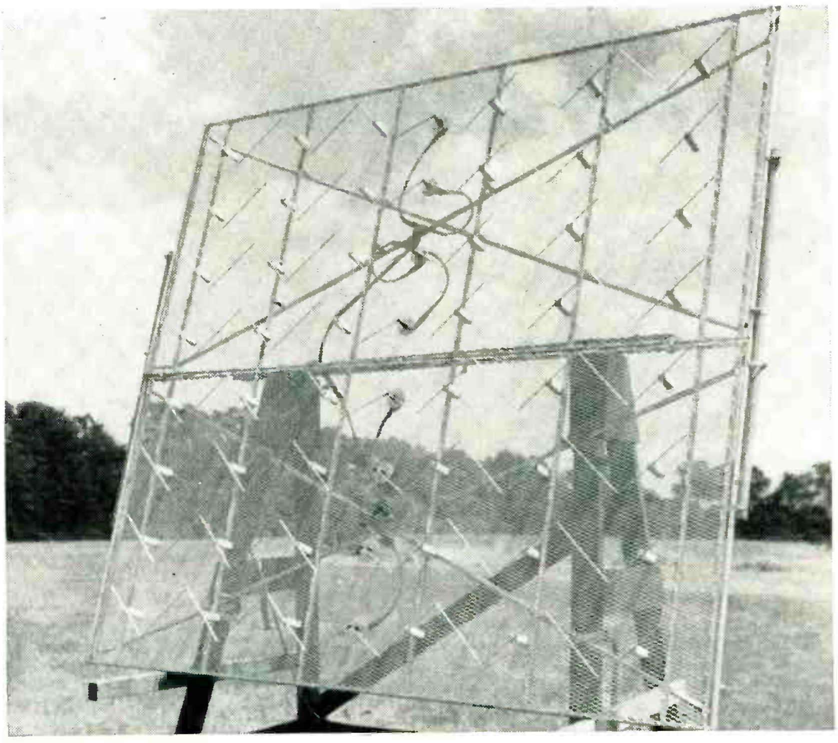
RETMA committee would add low-power stations to aid tv coverage

CONTROVERSY on how to help uhf television may taper off fast if industry plans for modifying Commission rules get the green light in Washington. A special committee of Radio-Electronics and Television Manufacturers Association suggests two new classes of television stations. Such stations are expected to improve television coverage for both vhf and uhf.

▶ **Definitions**—One type of station, defined by the committee as a satellite, would operate unattended on the same television channel as the primary or controlling station upon which it depends for all its program and identification material. Such a station has been commonly called a booster—a term now deleted by the committee.

The other type, a Special Serv-

(Continued on page 14)



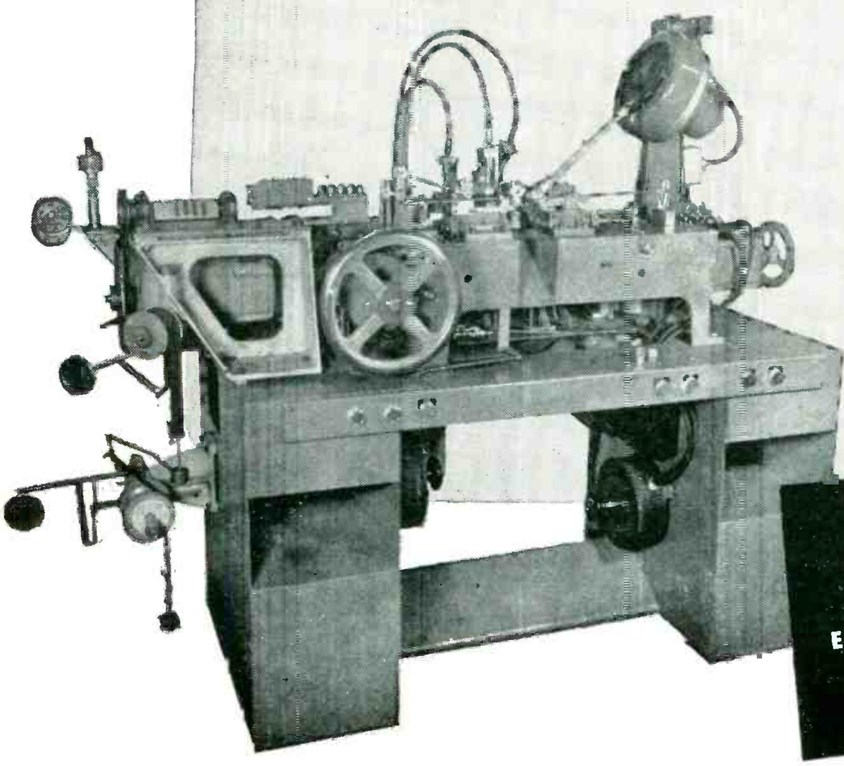
Receiving antenna made up of eight zigzag rods receives weak television signal 37 miles from the WJTV transmitter in Jackson, Miss. Signal is amplified and rebroadcast from low-power RCA transmitter attached to similar high-gain antenna to fill holes in coverage area of this uhf television station

Here's how to get production quantities of precision components for TRANSISTORS • DIODES • RADIO TUBES • HERMETIC SEALS • LAMPS

Now it is possible for progressive manufacturers to produce their own precision electronic components. For example, the Automatic Lead Wire Welding Machine, shown below, was recently designed and built by Kahle to produce 12,000 3-piece leads per hour for miniature receiving tubes. Although this machine, Model 2148, is designed to make standard welds, it is but one step from a machine to produce leads for electronics' latest wonder . . . the transistor. In addition, Kahle has produced a fully automatic Filament Making and Tabbing Machine, Model 2036, that produces from 1,200 to 3,000 filaments per hour depending upon wire diameter.

These machines reflect Kahle's ability to design and build special-purpose machinery to meet any given specifications. Regardless of your current production problems, learn . . . without obligation . . . how Kahle's more than 40 years of practical experience can benefit you.

For specific information, write Kahle . . . now.



Kahle
ENGINEERING COMPANY
1310 SEVENTH STREET
NORTH BERGEN, N. J.

ices station (usually referred to as a satellite, in current parlance) would operate on a normally allocated television channel, but with relaxed rules and regulations permitting a favorable economic operation. Such a station might start with reduced power and antenna, depending solely or in part upon other stations or sources for programs.

▶ **Equipment Market**—Experts are guessing that a satellite package—including 100-ft tower, antenna, 10-kw transmitter and housing—might come not lower than $10,000 and probably not more than $15,000. In a couple of years there might be a hundred of them. Some uhf stations might need two, three or four to fill pattern holes.

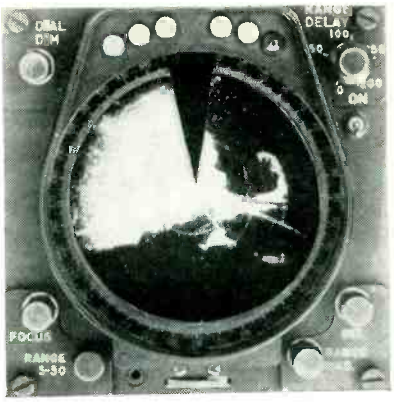
Besides guessing that they will be useful and maybe plentiful, the manufacturers are silent on how many relaxed-rule stations the country can absorb. It depends, they say, on how far the rules relax. For example, a 100-watt job complete might run in the vicinity of $50,000. By contrast, a full-rules 1-kw station costs about $200,000 and operating costs are commensurate. Relaxed rules might make television economically feasible for communities under 100,000 population.

Low-power stations operating with experimental licenses on the same or different frequencies from the mother station have been in existence for some time. Reports of satisfactory service indicate that the new proposal is sound.

Airline Orders Boost Radar Sales

Storm warning gear for big transports looms as multi-million-dollar business

SALE of airborne storm-detecting radar to commercial airlines may become a major part of the non-military radar business. Both domestic and overwater carriers are interested in the equipment, which warns pilots of impending storms while providing a map of terrain features below. Big advantages are increased safety and added payload since extra gas need not be carried for flying long, circuitous paths around storm centers. The pilot can see the storm's center and select the shortest route around it.



Radar displays may become road maps for civilian pilots

▶ **Overseas**—Panagra, which flies to Latin American points, has had a Bendix 9,000-mc set installed aboard one of their new DC-6B's since April. The line plans to buy five more sets for installation aboard its new DC-7's. Delivery is planned for 1955. Cost is $35,000 per plane, installed.

Other overwater carriers are looking into storm-detection radar. These include Air France, BOAC (British), KLM (Dutch) and Sabena (Belgian). In addition, many private firms with their own executive fleets are enthused.

▶ **Other Lines**—The board of United Air Lines has earmarked $4 million for storm-detection radar on their new DC-7's. This action follows four months during which an RCA 5,400-mc set was flight-tested aboard a United Air Lines plane. According to RCA, four other carriers—Braniff Airways, National Airlines, Pan-American World Airways and Trans-World Airlines—have also requested equipment for flight evaluation. Delivery is promised for this year.

The RCA unit operates in the C-band, which some experts claim is best for weather-monitoring purposes. The unit weighs 150 lb and has a 75-kw transmitter.

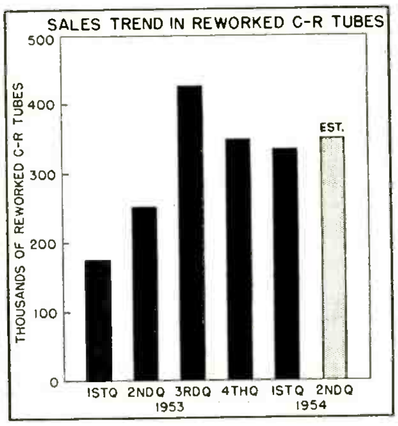
▶ **Military**—Meanwhile, the Sperry Gyroscope Co. has announced the APN-59, a lightweight radar for installation on Air Force cargo and troop-carrying planes. The Sperry radar, it is claimed, combines terrain clearance data, collision warnings and search and surveillance functions with its navigational and storm warning duties.

Rebuilt Picture Tube Sales Increase

Growing portion of total picture tube sales is being made up of reworked glass envelopes

MORE rebuilt picture tubes are being used in U. S. tv sets. Last year over 1.2 million reworked tubes were sold. The trend so far this year indicates that 1954 sales will go considerably higher.

▶ **Companies**—It is estimated that nearly 40 firms of all types are engaged in rebuilding tv picture tubes. Bulk of the business, however, is being done by about 5 companies in the field.



Many of the major new tube manufacturers have been in the rebuilding business at one time or another. Some major tube makers have glass allowance programs in effect whereby they pay service organizations for burned-out tubes. The fact that major glass envelope manufacturers no longer produce

(Continued on page 16)

Barry Engineers Report on Design Methods

Technical articles written by Barry engineers over the past several years on the protection of electronic apparatus against damage by vibration and shock, are now available. The information presented covers both the theoretical and the practical aspects of shock and vibration protection—for aircraft, naval, mobile, and industrial equipment.

Engineers who wish copies of these reports may obtain them by asking for them by number; requests should be addressed to Mr. A. S. Chivers, Barry Corporation, Watertown, Mass.

Designing for Shock Resistance
By Charles E. Crede and Miguel C. Junger. Reprinted from "Machine Design", Jan. 1951.
Bulletin R-511

Shock Testing of Airborne Equipment
By Charles E. Crede. Reprinted from "Tele-Tech", July-August 1951. Bulletin R-518

How to Evaluate Shock Tests
By Charles E. Crede. Reprinted from "Machine Design", Dec. 1951. Bulletin R-521

Toned-Down Noise Tunes Up Operation
By Charles E. Crede. Reprinted from "Steel", Feb. 25, 1952.
Bulletin R-523

Mounting Keeps Vibration in its Place
By William C. Gallmeyer. Reprinted from "Steel", May 18, 1953. Bulletin R-535

Shock or Vibration Isolators?
By J. Markowitz. Reprinted from "Product Engineering" June, 1953. Bulletin R-536

Mock-ups for Vibration and Shock Testing
By Charles E. Crede. Reprinted from "Product Engineering" July, 1953.
Bulletin R-537

Vibration Isolators speed up plant changes
By Harold Wrigley. Reprinted from "Plant Engineering" Jan. 1954. Bulletin R-541

The Role of Shock Testing Machines in Design
By Charles E. Crede. Reprinted from "Mechanical Engineering" July, 1954.
Bulletin R-544

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CATALOG 523-A. Air-damped Barrymounts for shock and vibration protection of military airborne equipment.

BULLETIN 532. Vibration isolator Type 915, for isolating vibration and noise caused by high-speed motors or motor-driven equipment.

BULLETIN 533. Medium-impact shock machine Type 150-400 VD, for qualification and acceptance shock tests up to 77g.

BULLETIN 534. Series M44 ALL-METL vibration isolators and Series TOMA mounting bases, for military airborne equipment under extreme operating conditions.

BULLETIN 535. Component shock machine Type 20 VI, for qualification and acceptance shock tests up to 210g.

"LOOK — NO LAGGING!" Increasing profits through the use of the new Leveling Barrymount for industrial machinery.

BULLETIN 536. Series M64 ALL-METL vibration isolators and Series AOMA and NOMA mounting bases, for military airborne equipment under extreme operating conditions.

BULLETIN 537. Series 262/633 vibration isolators, for isolating vibration and noise caused by medium-speed motors or motor-driven machinery.

BULLETIN 538. Series 670/297 shock and vibration isolators, for isolating shock caused by impact-type machines, and vibration and noise caused by heavy rotating or reciprocating machines.

Here are complete engineering data, application information, and pointers to profits in every field of shock and vibration isolation. Write TODAY for your free copies of the ones *you* need.

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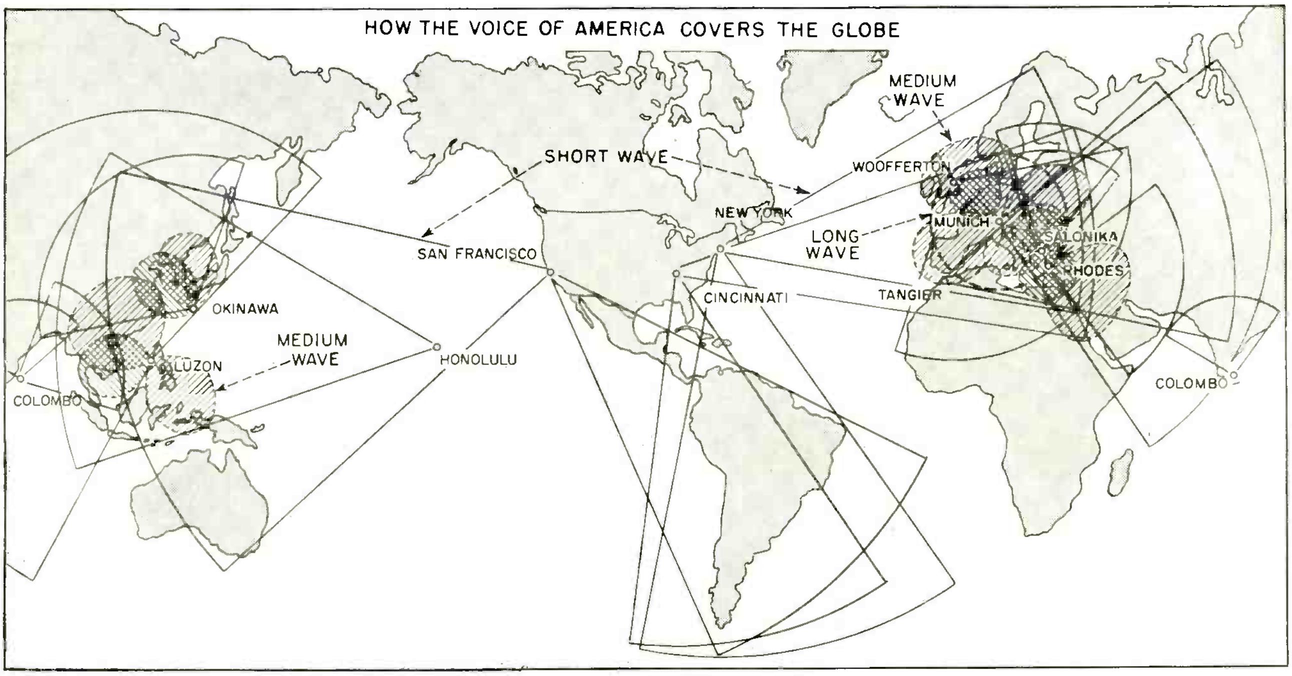
some of the smaller-sized envelopes indicates that a few manufacturers may be reusing glass envelopes for such replacement sales.

▶ **Cost**—Main reasons for the success of the reworked tube business are price and the growing replacement and second-set markets. Prices of reworked tubes vary from 60 to 90 percent of the cost of a similar new tube. This price differential has become important especially to the small-screen replacement market where the consumer is unwilling to pay the full price for a small screen. This is especially true, according to tube companies, where the tube is to be used in a second set in the home.

Rebuilt tubes also find a market in some new tv sets that are on the market. According to one rebuilder, at least four major tv set producers use reworked picture tubes in their current lines.

▶ **How**—There are many degrees of quality in rebuilt tv picture tubes. In some only the envelope itself is reused. The old tubes are taken in, washed out, refaced with phosphor and the guns are replaced. In other rebuilding operations only the gun or a defective part in the tube is replaced or repaired before the tube is put back on the market.

Currently the dominant sellers in rebuilt tube lines are in the 16 to 19-inch size bracket. But rebuilders expect that soon the 21-inch rebuilt will be the volume seller, as it is now for new picture tubes.



SHORT-WAVE RELAYS beam programs to powerful transmitters overseas, as . . .

Uncle Sam's Radio Voice Increases in Volume

Equipment buying and rental mean business for broadcasters and manufacturers

VOICE OF AMERICA is probably the world's biggest broadcasting network—if not in number of outlets, certainly in total kilowatts of signal on the air. The voice broadcasts 75 separate programs daily, amounting to 31 program hours in 38 different languages to a worldwide audience estimated at 400,000,000.

▶ **Nerve Center**—New $700,000 studios in Washington's Health, Education and Welfare building will feed 77 transmitters. Thirty of these are located in continental United States and are used as short-wave relays. Transmitting facilities within the U. S. are rented by the Voice and private firms in the international broadcasting business collect $1.9 million annually.

▶ **Outlets**—The Voice operates one-million-watt transmitters in Munich, the Philippines and Okinawa. Cost of these monster transmitters is estimated at a dollar a watt. Other high-power facilities are located in Salonika, Tangier, Ceylon, Honolulu and aboard the U. S. Coast Guard Cutter Courier anchored off the island of Rhodes in the Eastern Mediterranean. The Voice has spent $15 million on capital equipment in the last five years.

In addition to this equipment the Voice rents facilities from the BBC regularly and from local broadcasters overseas whenever additional coverage is required or when Russian jamming temporarily dislocates normal operations.

(Continued on page 18)

Variac® MOTOR SPEED CONTROLS

for Adjustable, Constant-Speed Operation of D-C Motors from A-C Lines

Introduced by General Radio Company in 1949, the VARIAC® Motor Speed Control won immediate acceptance as a new and unique system for varying speed of d-c motors operating on a-c lines.

Separate selenium rectifiers for field and armature, with a VARIAC continuously-adjustable autotransformer ahead of the armature rectifier, provide a unique combination of characteristics. This is a true adjustable armature-voltage speed control in extremely simple and compact form.

VARIAC Motor Speed Controls feature:

Very Wide Speed Range—continuously-adjustable from rated speed to zero. Full rated torque can be delivered even at zero speed continuously without overheating.

No Electron Tubes — selenium rectifiers require no warm-up—motor starts immediately when the power is turned on

Excellent Controlled-Starting Characteristics—delicate equipment can be started without jerk. Heavy machines can be started very quickly.

Very Fast Start-Stop-Reverse—ample capacities permit heavy loads to be started, stopped and reversed repeatedly without damage

Extra-Smooth Torque—satisfies the most critical requirements for low torque pulsation—excellent for such applications as precision grinding

Effectively Eliminates Need for Gears, Step Pulleys, and other types of mechanical speed changers. Any speed desired can be obtained

Low Initial Cost—Simple Installation

Long Life with minimum maintenance—no tubes to replace

Available in 9 Models for d-c motors from 1/15th hp and less to $1\frac{1}{2}$ hp

Prices shown do not include motor. Standard motors for each control are sold separately and are obtainable from General Radio. Prices and specifications on request.

We sell direct. Prices shown are NET, f.o.b. Cambridge or W. Concord, Mass.

Type 1701-AK . . $75
For shunt-wound d-c motors. Toggle switch selects speed range; either 0 to rated or 0 to twice rated. All controls on panel.

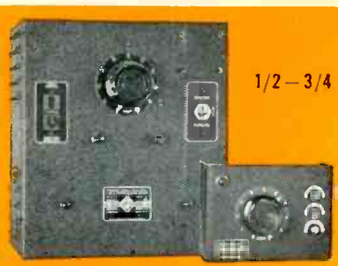
Type 1701-AM . . $75
Similar to Type 1701-AK (above) except speed range 0 to rated, only. All controls on panel.

Type 1701-AU . . $75
For high-speed shunt motor performance from universal motors. Speed range 0 to rated. All controls on panel.

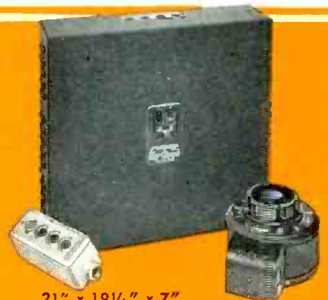
Type 1703-A . . $97.50
For d-c shunt or compound-wound motors. Dynamic braking for extra fast stopping. Speed range 0 to rated. All controls on panel.

Type 1700-B . . $170
For d-c shunt or compound-wound motors. Dynamic braking for extra fast stopping. Speed range 0 to rated. All controls on panel.

Type 1702-A . . $245
For d-c shunt or compound-wound motors. Dynamic braking. Speed range 0 to rated. All controls on panel.



Type 1702-M . . $350
Identical with Type 1702-A (above) except for push button operation at remote control station.



Type 1704-A . . $470
For d-c shunt or compound-wound motors. Speed range 0 to rated. For push button operation at remote control station.

Type 1705-A . . $495
Identical in size and appearance with Type 1704-A (above). For d-c shunt and compound motors. For push button operation at remote station. Speed range 0 to rated.

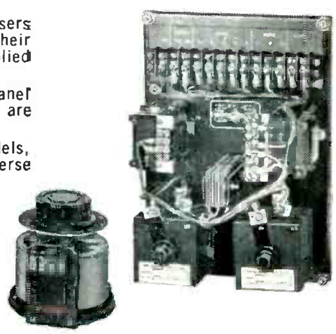
To meet the requests of many manufacturers and users who want to incorporate these versatile units into their own equipment or machines, four models are now supplied in stripped-down form.

They consist of the basic components mounted on a panel and wired to a terminal strip; all necessary leads are brought out.

All of the standard functions of the mounted models, including fusing, dynamic braking and start-stop-reverse can be incorporated easily in the external circuits in the users equipment.

Illustrated is the Type 1700-BW for 1/4-1/3 hp motors. Unit Price: $135.00. Other models available are for 1/6, 3/4 and 1 hp.

Quantity prices on the stripped-down units are available upon request.



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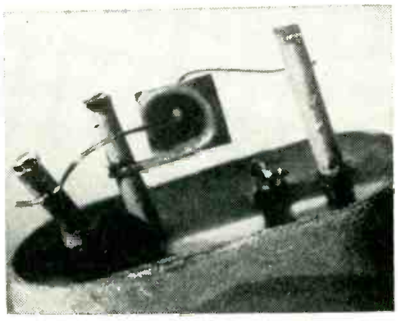
Write for the **VARIAC MOTOR SPEED BULLETIN**

Transistor Developed For UHF

New *pnip* design presents potential threat to tv tube manufacturers



Heart of intrinsic barrier transistor as seen through microscope. Input and output electrodes are connected to the indium dots on opposite sides

PRESENT-DAY TRANSISTORS cannot be used in many television receiver circuits because of frequency limitations inherent in their design. A new transistor developed by Bell Labs oscillates at 440 mc and is expected to eventually oscillate at 3,000 mc, which in effect will remove the frequency limitation from the transistor business.

▶ **Construction**—The main difference between this and conventional junction transistors is incorporation of a layer of chemically pure germanium termed an intrinsic barrier. This layer is located between the usual *pnp* layers to form a *pnip* configuration. Besides decreasing capacitances between the transistor input and output areas, the intrinsic layer permits the transistor to be operated at much higher voltages.

Traffic Control Saves $3 Million

Newly available frequency permits replacing cables with coded radio signals

CHICAGO is going all-out for an electronic solution of traffic problems that many other big cities have encountered. The direct solution is synchronization of all important intersections to speed incoming morning traffic and outgoing evening flow of vehicles. Sufficient cables to do the job would cost $7,500 an intersection. So Chicago will use coded radio signals.

▶ **Basic Problem**—During most of the day, inbound and outbound cars will receive equal consideration, with cross-traffic given its chance, too. Control signals to program this operation will be sent out from a central station.

Once the special morning and evening signals have been sent, they will generally require no further attention—except in bad weather. Roadside neon signs will show the optimum speed for which the system is set so the motorist can proceed without stops. Need for exact timing control becomes evident when it is understood that the distances between traffic signals are not identical. A steady traffic pace can be kept only if each individual light receives the code that ties it in with the rest.

▶ **Pilot Run**—For a start, the city will equip eleven heavy-traffic intersections with antennas, receivers, decoders and traffic-light controllers. Two other intersections, 8 miles from the transmitter, will be similarly equipped.

At present, Chicago has 1,200 signalized intersections. Plans call for an eventual total of 3,000. Of these, some 450 will need the special steady-pace signals. Connected by cables the control system would cost $3,375,000. Using radio, costs drop to about $480,000.

▶ **How It Works**—Top pace for rush-hour traffic is expected to be 30 mph. When fog, sleet or snow occur, the optimum speed must be reduced, but smooth flow will be possible only with exact, individual timing of lights. Information to set this timing will be sent out as a series of coded pulses. Each receiver will pick out only the pulses assigned to it. The radio signals will emanate from the tower of the Board of Trade in the Loop. Transmissions will radiate on a newly available frequency of 27.255 mc. On-the-air time will normally amount to 0.2 second out of each hour.

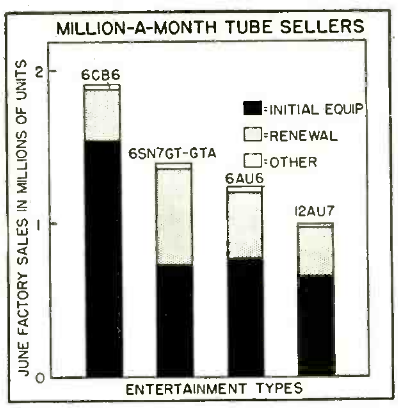
Because other cities at great distances, and medical and industrial radio equipments can use frequencies in the same band, the Chicago signals must be highly coded to avoid traffic snarls from other transmitters.

Receiving Tube Makers Push Volume Sales

Manufacturers concentrate bulk production and sales on four entertainment tube types

FACTORY sales of receiving tubes, averaging about 40 million units a month so far this year, are made up largely of entertainment tube types for the home market. In June, for example, of the 31 million tubes sold, approximately 80 percent were accounted for by sales of major entertainment receiving tube types. Of these, about 20 percent were represented by four tube types, the 6CB6, 6SN7GT & GTA, 6AU6 and 12AU7, with total sales of 5.6 million units, as shown in the chart.

▶ **Market**—The initial equipment market is the main one for the top tube sellers shown. Renewal sales are also substantial, although only



(Continued on page 20)

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the 6SN7, a relative oldtimer, has shown replacement sales exceeding 50 percent of initial equipment volume. Sales to other markets, which include government and export sales, represent only 30,000 units monthly for each of the four types.

▶ **Use**—The 6CB6 and 6AU6 are sharp-cutoff pentodes of miniature type, used in tv sets as an i-f amplifier and as an r-f amplifier in vhf tv tuners.

The 6SN7-GT, a medium-mu twin triode, is largely used as a horizontal oscillator in tv receivers.

The 12AU7, a medium-mu twin triode, is a miniature type used in tv sets, as a phase inverter or amplifier in a-c/d-c radio equipment and in many diversified applications such as multivibrators or oscillators in industrial control devices.

▶ **Future**—There are signs that new tube types may take over as sales leaders. Several manufacturers have introduced receiving types designed for application in tv sets that use series-connected heaters. If series-string tv goes over, the 6CB6 may be replaced by the 3CB6, the 6SN7GTA by the 6SN7GTB, the 6AU6 by the 3AU6 and the 12AU7 by the 6AU7.

Amateur Radio Sales Make Gains

Volume of transmitters and receivers sold increases as more hobbyists enter field

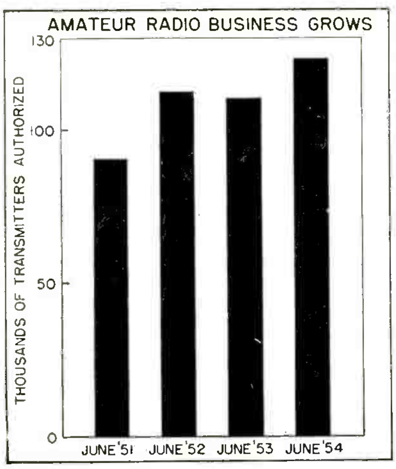
COMPANIES in the amateur radio equipment manufacturing field have experienced substantial increases in sales in the past few years. This is pointed up by the fact that in the last year alone, the number of transmitters authorized to operate in the amateur radio service increased by 12,000 for one of the largest gains on record.

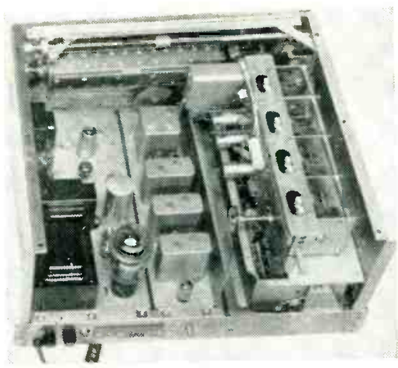
Since 1951 the number of amateur transmitters authorized has increased from some 90,000 in 1951 to 123,000 in June of this year. Receiver sales have shown a similar rising trend. Manufacturers estimate that receiver sales have far exceeded transmitter sales because of larger export volume and sales in the hi-fi field.

▶ **Why**—Some of the main reasons for growing sales of transmitters and receivers for amateur use in the last 4 years are the changes made in amateur rules by the FCC. License requirements were relaxed with the establishment of the novice class, which is the most elementary type of amateur operator license available, and the technician class which lowered code requirements. Since July 1951, when the novice class was established, over 22,000 such licenses have been issued. In the technician class more than 7,000 licenses were issued in the period; the number of extra-class licenses at the close of 1953 was 1,300, an increase of 400 over the previous year.

▶ **Equipment**—There are approximately 30 manufacturers of amateur transmitters and about the same number in the amateur receiver field. Transmitter and receiver kits account for the majority of sales in the field. However, some manufacturers note that there is a tendency now for more amateurs to buy factory-made equipment because of television interference caused by some home-made sets.

New development in the factory-made amateur equipment is the use of printed circuits in receivers. The short-wave set shown uses a tin-plated copper-on-XXXP-phenolic in the r-f section. Sectionalized mechanical construction similar to plug-in unit construction found in some military equipment is also being used.





New amateur receiver made by Hammarlund uses printed circuits in r-f section and sectionalized mechanical construction

Renegotiation Changes Help Manufacturers

Fewer government contracts are subject to review as Congress passes revised bill

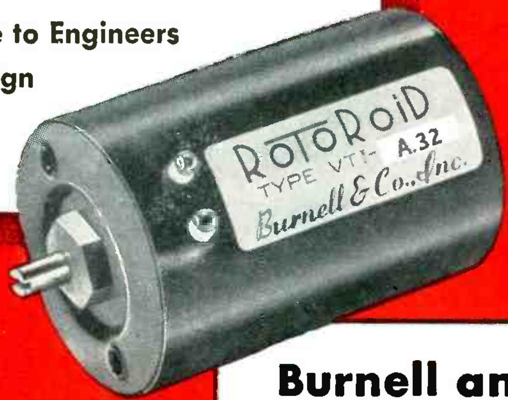
ELECTRONIC manufacturers who have had government contracts subject to renegotiation may gain some relief under the revised Renegotiation Act recently passed by Congress. Under the new bill a manufacturer with an annual income from government contracts of $500,000 or under is not subject to renegotiation. Previously, the minimum was $250,000. The new minimum applies to fiscal years ending on or after June 30, 1953.

▶ **Changes**—The revised Act also eases other provisions of the 1951 bill. It exempts from renegotiation, under certain conditions, contracts for standard commercial articles as defined in the bill. This applies when cost figures supplied by contractors show that competitive conditions prevent excessive profit. It also applies if the Renegotiation Board does not find ex-

(Continued on page 22)

An Announcement

of the Utmost Importance to Engineers Doing Research and Design Work in the Entire Audio Frequency Range.



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Applications: Virtually unlimited. Just a few of the many possible uses of ROTOROID are:

- **Tunable Audio Oscillators**
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- **Adjustable Selective Networks**
- **Variable Phase Shift Networks**
- **Variable Filters**
- **Electro-Mechanical Control Systems**

Availability: Immediately available: ROTOROIDS VTI-A and VTI-B which are equivalent in electrical characteristics to Burnell toroids TC-16 and TC-3 in cases 2¼" in diameter, 3-1/16" long. Soon to be available: two miniature types, VTI-C and VTI-D, equivalent to Burnell toroids TCO and TC-6.

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cessive profits within six months after cost figures have been filed.

▶ **Effect**—The changes in the Renegotiation Act as applied to the electronic industry may be beneficial chiefly to small manufacturers since most of the larger firms in the field have had annual income from defense contracts in excess of $500,000. Sylvania, for example, estimates that about $60 million or 22 percent of its 1953 sales are government sales subject to renegotiation.

Even under the old Act, however, most major electronic manufacturers were not required to make refunds because profits were not excessive. It is estimated that less than five percent of all Navy contracts renegotiated have been subject to substantial refunds. However, many large companies continue to make provision for possible renegotiation refunds in their financial statements.

More U.S. Watchmakers Make Electronic Items

NEED for diversification in the face of sliding markets and foreign competition has led major watchmakers in the U.S. to move into new business fields. The electronics industry has been a leading choice for many of them. About eight watch manufacturers are now connected with the industry in some degree. Two of the latest entries are U.S. Time and General Time.

Magnetic disc recorder can be converted to standard 45-rpm phonograph with plug-in cartridge and spindle adapter button

▶ **Products**—Electronic products made by watch firms range from guided missile components to magnetic recorders. U.S. Time recently introduced a magnetic disk recorder and player to retail at $59.95, aimed at the mass home market. Under development for the past year in the firm's electronic division, the recorder utilizes a new magnetic recording head structure and disks composed of iron oxide coating on a plastic base. Recording time is 3½ minutes. Tracking is achieved by placing a grooved metal disk over the center portion of the coated plastic record. A stylus on an extension of the pickup arm rides in this groove. The company also plans to enter the tape recording field.

General Time, through its Stromberg division, plans to introduce an electronic time system to supplement its present industrial timing equipment line. Their move into electronics was prompted more by the trend in an established product than as a diversification move.

OVERSEAS TELEVISION TODAY

Country	Estimated Total Sets	Hours a Week	Annual Fee	Transmitters	Scanning Lines per Frame	Price of Sets
Argentina	30,900	35	none	1	625	$1,000 (21-in.)
Belgium	10,000	30	....	2	625 & 819	$300
Brazil	110,000	130	none	4	525 & 625	$900-1,100 (21-in.)
Colombia	2,000	21	none	1	525	....
Cuba	135,000	176	none	5	525	$165 (17-in. Crosley)
Denmark	1,400	5	$7.00	1	625	$290
Dominican Rep.	5,000	40	none	1	525	$165 (17-in. Crosley)
England	3 500,000	45	$8.40	8	405	$185
France	108,000	28	$12.00	3	819	$285
French Morocco	1,000	..	....	1	819	....
German Fed. Rep.	60,000	17	$15.00	7	625	$230
Italy	50,000	32	$20.00	8	625	$275
Japan	10,000	..	....	2	525	....
Mexico	75,000	130	none	6	525	$165 (17-in. Crosley)
Netherlands	8,000	4	....	2	625	$290
Philippine Is.	....	21	....	1	525	....
Spain	600	3½	$19.00	1	625	$375
Switzerland	4,000	16	$14.00	2	625	$240
Thailand	....	..	....	1	525	....
Venezuela	30,000	84	none	3	625	$500

Source: Voice of America. Reliable figures are not available for U.S.S.R. and her satellites. Hours per week refer to total unduplicated program hours over all stations. Price of sets is based on price of cheapest set generally available

Financial Roundup

INCREASED financial activity among companies in the electronic field was evident in the past month as eight firms made profit reports and eight companies announced security transactions.

Following are the net profit reports of nine electronic manufacturers for the fiscal periods indicated:

Company	Net Profit 1954	Net Profit 1953
Acme Electric 12m	$190,785	$239,602
Admiral 6m	2,558,850	4,762,152
American Bosch Arma 6m	1,411,965	851,569
American Electronics 6m	138,325	50,704
CBS 6m	5,177,449	4,793,370
Cornell-Dubilier 9m	1,012,000	1,258,000
Daystrom 3m	405,767	324,219
Sperry 6m	11,773,813	7,997,470

▶ **Securities** — AT&T registered with SEC covering $250 million of 30-year debentures due Sept. 15, 1984 to be offered for sale at competitive bidding. Proceeds will be used for advances to subsidiaries, purchase of stock by subsidiaries and associates, plant expansion and improvement and for general corporate purposes.

Ketay Instrument registered with SEC covering 300,000 shares of common stock, 10 cents par value, to be offered for sale to the public. Net proceeds of 200,000 shares will be applied to payments in full of outstanding obligations of $1.5

(Continued on page 24)

Five thousand, when compared to the national debt, is a small number. But when one company has manufactured over 5000 different types of special capacitors, this number becomes impressive. Yet, Hammarlund has done just that, in addition to turning out a line of standard variable capacitors. The majority of these special types were designed by us to meet customers' specifications — others were built to customers' designs. Some were quite large and intricate, while others were tiny enough to do a big job in miniature devices. They all have one thing in common: They are all built to Hammarlund's rigid quality standards—built to give optimum results.

If you have a problem calling for a special capacitor, it will pay you to check Hammarlund first. For among these 5,000 special capacitors there probably is one to meet your specification. If this is the case we have the dies; tool costs are nil and delivery is prompt. If, however, none of our existing "specials" can fill the bill, our experienced engineering staff will be happy to work with you to design a capacitor that will.

For detailed information on special and standard capacitors, write to The Hammarlund Manufacturing Co., Inc., 460 West 34th Street, New York 1, N. Y. Ask for Bulletin 105.

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million and the balance will be added to corporate funds. Proceeds from remaining 100,000 shares will go to those for whom the stock is being sold.

Storer Broadcasting borrowed $12 million on 4.5-percent notes from four banks and will use the proceeds to repay a bank loan, finance the acquisition of Empire Coil and for working capital.

Electronics Corp. of America offered 200,000 shares of $1 par value common stock at $12 per share. Proceeds will be used to reduce a $15-million bank note due Oct. 1, 1955 and the balance will be added to general funds to finance growth and expansion.

IBM plans to borrow $100 million on 3¾ percent notes maturing on May 1, 2055. Funds will be used for working capital and other corporate purposes.

Kendon Electronics offered 150,000 shares of common stock (par 10 cents) at 25 cents per share. Net proceeds are to be used to pay for the development of sample picture tubes and receivers, for further development work and for general corporate purposes.

Standard Coil Products registered with SEC covering 189,655 shares of its common stock, $1 par value. Proceeds will go to the account of the selling stock holder.

Atomic Instrument offered to its common stockholders 31,657 shares of common stock, par $1, at $6 per share on the basis of one new share for each four shares held. Net proceeds are to be added to working capital and principally applied to the financing of increased business and developments.

MEETINGS

SEPT. 29–30: IRE Symposium on Industrial Electronics, Mellon Institute, Pittsburgh, Pa.

SEPT. 30–OCT. 1: Fifth Annual Meeting of the IRE Professional Group on Vehicular Communications, Rice Hotel, Houston, Texas.

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

OCT. 3–7: The Electrochemical Society 106th Meeting, Hotel Statler, Boston, Mass.

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

OCT. 5–7: AIEE Middle Eastern District Meeting, Abraham Lincoln Hotel, Reading, Pa.

OCT. 6–7: First National Annual Meeting of the IRE Professional Group on Nuclear Science, Hotel Sherman, Chicago.

OCT. 11–15: AIEE Fall General Meeting, Morrison Hotel, Chicago.

OCT. 14-15: National Conference on Industrial Hydraulics, Automatic Production, Sheraton Hotel, Chicago.

OCT. 14–16: Annual Convention, Audio Engineering Society, Hotel New Yorker, New York, N. Y.

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

OCT. 14, 21, 28, Nov. 4, 11, 18: IRE, AIEE Symposium On Automation, Philadelphia Electric Auditorium, Philadelphia, Pa.

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

OCT. 18–22: Fall Convention of Motion Picture and Television Engineers, Ambassador Hotel, Los Angeles.

OCT. 21–23: Eighth New England Conference of the American Society for Quality Control, Ten Eyck Hotel, Albany, N. Y.

OCT. 22–24: First Annual New England High Fidelity Music Show, Hotel Touraine, Boston.

OCT. 26–28: The Second National Conference on Tube Techniques, Western Union Auditorium, New York, N. Y. Sponsors, Department of Defense.

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. 8-10: Symposium On Modern Advances In Microwave Techniques, Engineering Societies Bldg., New York City.

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.

NOV. 29–DEC. 2: First International Automation Exposition, 244th Coast Artillery Armory, New York, N. Y.

DEC. 8–10: Eastern Joint Computer Conference & Exhibition, Bellevue-Stratford Hotel, Philadelphia, Sponsors, IRE, AIEE, ACM.

JAN. 17–19, 1955: Fourth Biennial Conference On High Frequency Measurements, IRE, AIEE, URSI, NBS, Washington, D. C.

MAY 2–5, 1955: Third Annual Semiconductor Symposium of the Electrochemical Society, Cincinnati, Ohio.

Industry Shorts

▶ **Sales** to the industrial field will take an estimated 18 percent of the national electronic distributor volume for 1954, according to RCA.

▶ **Production** of large etched circuits for digital computers and other electronic assemblies has been increased to 150 per week by Bendix computer division.

▶ **Electronic** inspection machines now are being used to check precision-ground exhaust valves for Ford's new overhead valve engine.

▶ **Over** 315,000 people attended the National Radio Show in England, an increase of 20,000 over last year's attendance and the highest since 1949.

▶ **Electronic** industry's ratio of research and development expenditures to sales is 5.4 percent compared to the national average of 2 percent.

▶ **National** average ratio of cost of production equipment to yearly sales is approximately 70 percent compared to 9 percent for the electronic industry.

▶ **Fifteen** million feet of three-inch wide magnetic recording tape has been ordered by the Air Force under a $220,000 contract with Audio Devices.

▶ **Tests** made on sample quantities of receiver tubes returned to Magnavox as defective showed that about 40 percent were good.

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The inherent superiority of a boron-carbon resistor is now available with added advantages of a fully insulated unit. The IRC Type MBC ½ watt, 1% resistor offers significantly better characteristics plus protection against damage during assembly. Send coupon for detailed information.

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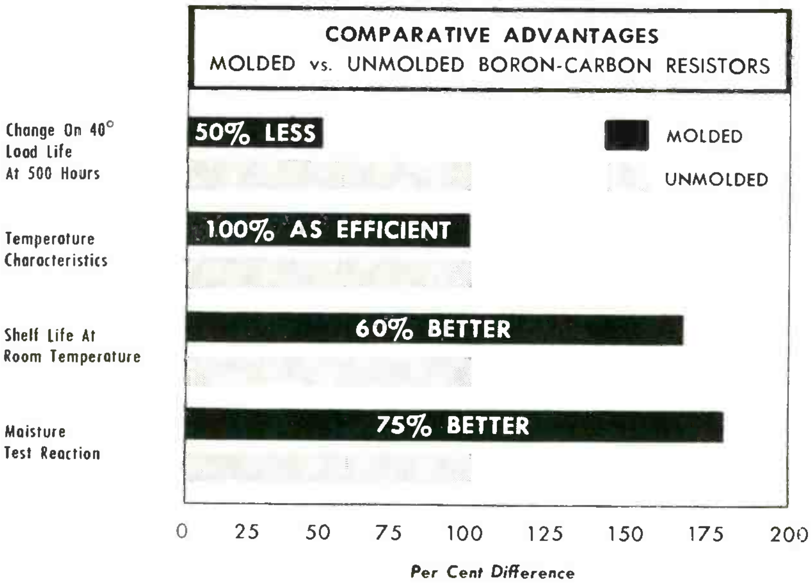

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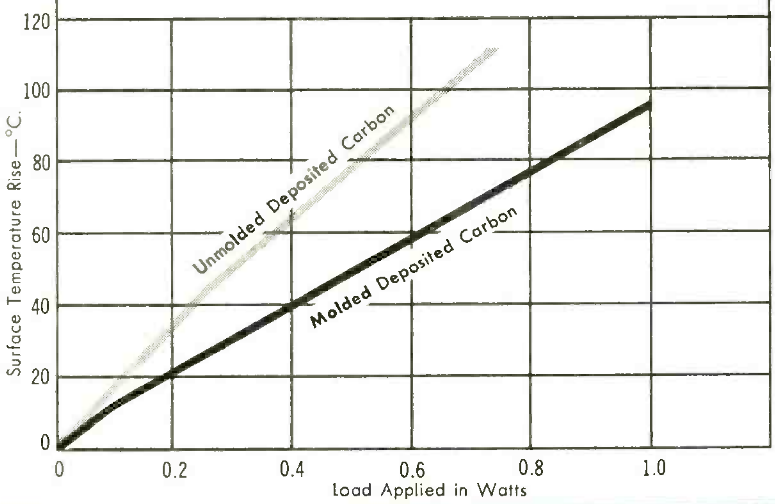

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Type WW16M—MIL-R-93A Style RB16

Type WW17M—MIL-R-93A Style RB17

Type WW18M—MIL-R-93A Style RB18

Type WW19M—MIL-R-93A Style RB19

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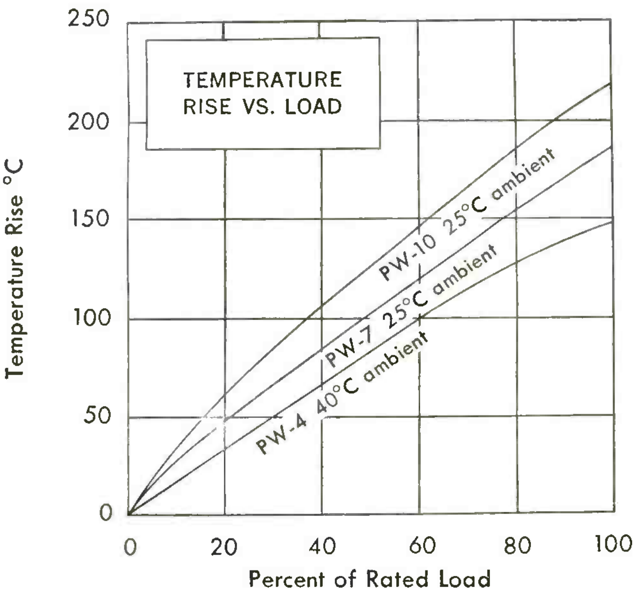
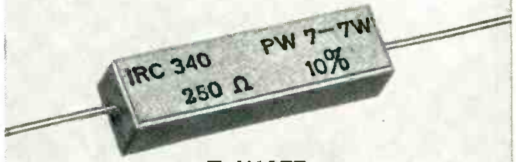


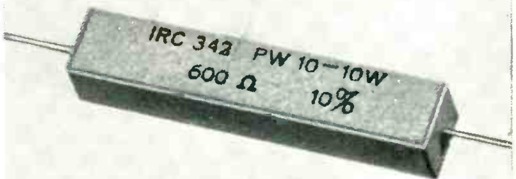
4 WATT

Type PW-4 allows safe operation with hot-spot temperatures up to 165°C. Fully insulated housing will not burn or support combustion.



7 WATT

Types PW-7 and PW-10 allow safe operation with hot-spot temperatures up to 275°C.



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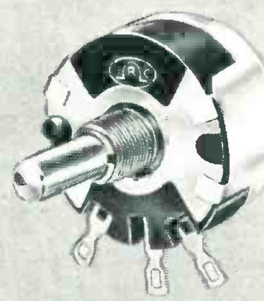
The mechanical and electrical features of Type 2W Rheostat-Potentiometer are designed for current and future electronic circuits. This modern, 2 watt unit offers maximum application adaptability plus typical IRC superior performance. Electrical operation is improved by one-piece center terminal and collector ring, and direct contact between collector ring and contactor. Advanced mechanical design anchors winding securely to strip, locks element into position, and assures accurate location of terminals.



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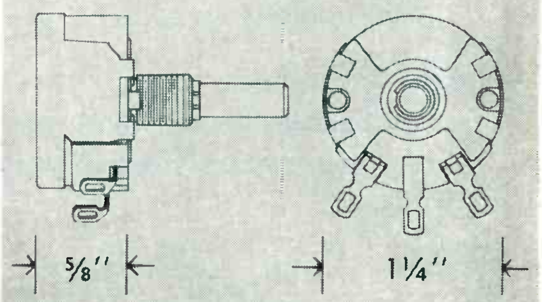

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IMPROVED DESIGN FEATURES

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- **Greater Dust Protection**
- **Increased Mechanical Rotation**
- **Increased Electrical Rotation**
- **More Resistance Values**
- **Double and Single Taps Available**

SEND COUPON FOR DATA BULLETIN

Voltmeter Multipliers • Boron & Deposited Carbon Precistors • Insulated Composition Resistors • Power Resistors • Controls and Potentiometers • Low Wattage Wire Wounds • Germanium Diodes

Wherever the Circuit Says

IRC

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

INTERNATIONAL RESISTANCE CO.

403 N. Broad Street, Philadelphia 8, Pa.

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

Send Bulletin describing Type 2W Potentiometers:

Name ____________________

Title ____________________

Company ____________________

Address ____________________

City ____________ *State* ____________

NOW

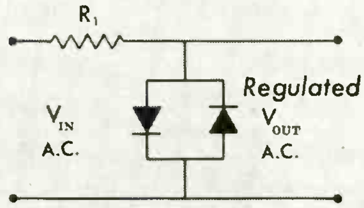
a *new* rectifier source

IRC Miniature MICROSTAK Selenium Rectifiers are available in a variety of types for many standard and special applications, in sizes as small as .060″ diameter. IRC's processing technique makes possible uniform, high grade, long-life, low capacitance cells with performance characteristics not available elsewhere.

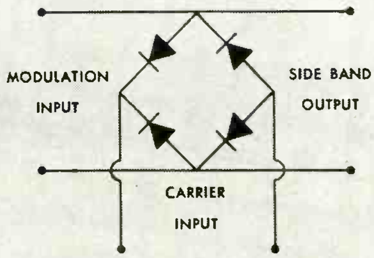
Cell thickness to ± .001. Less than 1% unbalanced voltage on bridge circuits. Hermetically sealed types available.

TYPICAL ADVANCED APPLICATIONS

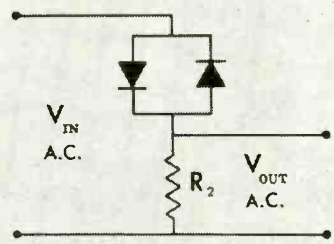
VOLTAGE REGULATION



BALANCED MODULATOR



LOGARITHMIC CONVERTERS



SEND COUPON FOR BULLETIN SHOWING CHARACTERISTICS, SPECIFICATIONS AND TYPICAL APPLICATIONS.

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

Wherever the Circuit Says

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

IRC

INTERNATIONAL RESISTANCE CO.

403 N. Broad Street, Philadelphia 8, Pa.

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

Please send Technical Bulletin SR-1 describing MICROSTAK Selenium Rectifiers.

Name ....

Title ....

Company ....

Address ....

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

Everyone Can Count on

VEEDER-ROOT

REPORTER AT LARGE . . . that's what you might call this new Veeder-Root Reset Magnetic Counter . . . adaptable to remote counting from machines or processes to central boards or instrument-clusters, wherever you want to put them. NOW . . . what can your imagination do with these few facts? For the *full facts,* write:

VEEDER-ROOT INCORPORATED

"The Name That Counts"

HARTFORD 2, CONNECTICUT

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

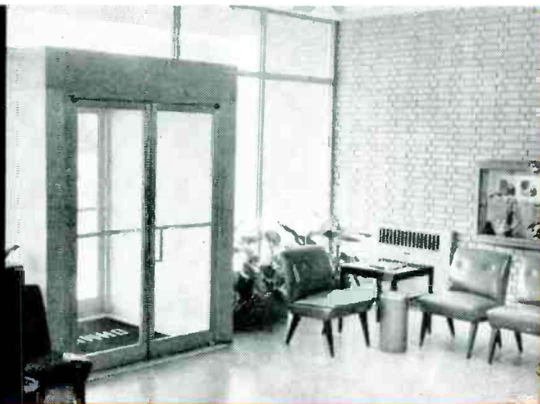
"Counts Everything on Earth"

modern new

OHMITE®

plant

Skokie, Illinois
(Suburb of Chicago)



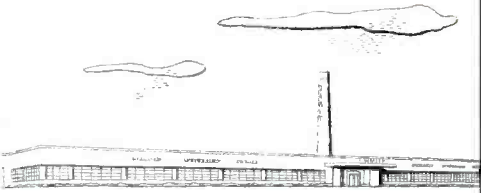
provides **advanced**
FACILITIES for
DEVELOPMENT and
PRODUCTION
of the FINEST in . . .

Rheostats

Resistors

Tap Switches

modern
new
OHMITE®
plant



Fast Shipment from Stock

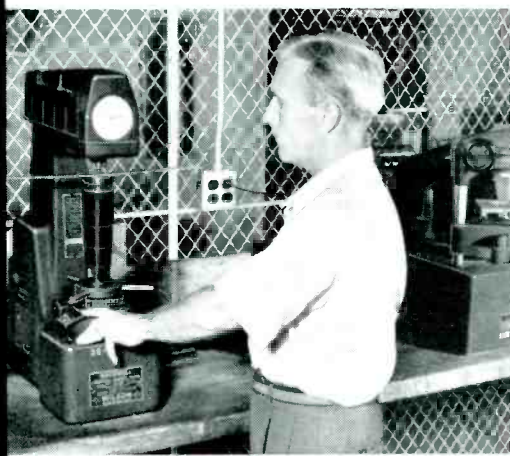
Ohmite maintains the world's largest stock of wire-wound rheostats and resistors for immediate shipment.

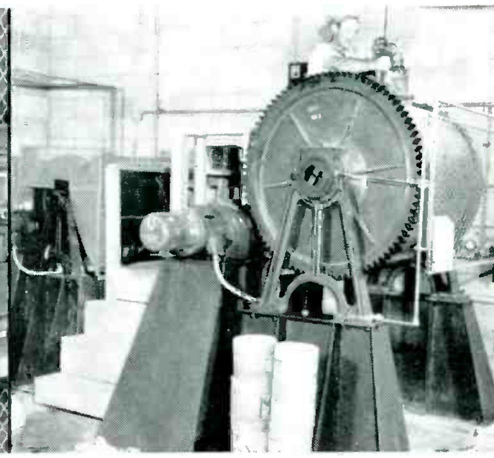
Incoming Inspection

Incoming materials are carefully checked against rigid specifications. Below, metal sample is being checked on Rockwell Hardness Tester.

Vitreous Enamel Production

To get the properties needed, Ohmite found it necessary to develop and make its own exclusive enamels. Ball mill, below, pulverizes ingredients.

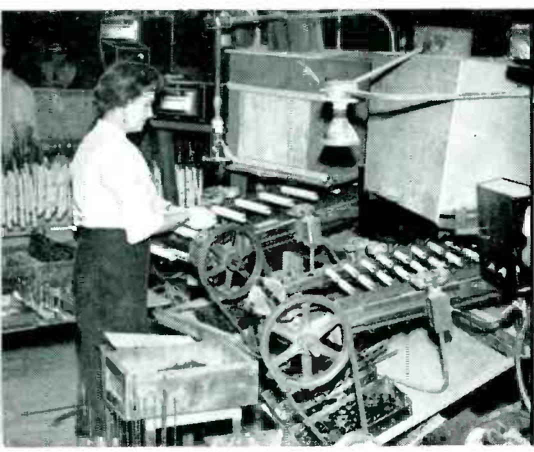


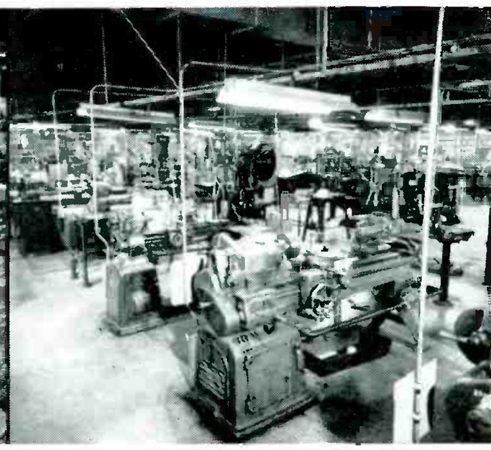


advanced PRODUCTION FACILITIES

Several months ago, Ohmite Manufacturing Company moved to its modern new plant in Skokie, Illinois—a north suburb of Chicago. This new plant has provided Ohmite with the greatly increased facilities needed to meet its continuously expanding sales volume.

The new Ohmite factory and offices—covering an area of 128,000 square feet—are completely air conditioned. The plant contains the very latest in equipment and facilities—for efficient production of quality resistance and other electrical control products.





Resistor Firing

Modern, continuous, conveyor-type furnaces rotate resistors being fired. This prevents "pile-up" of the vitreous enamel . . . assures a uniform coating.

Rheostat Firing

Gradual heating and cooling in this continuous, rotary-type furnace provides a superior coating of vitreous enamel and prevents internal cracking.

Tool and Die Shop

Ohmite designs and builds most of its own tools, dies, gauges, fixtures and special machines in the well-equipped machine shop shown above.

Precision Resistor Testing

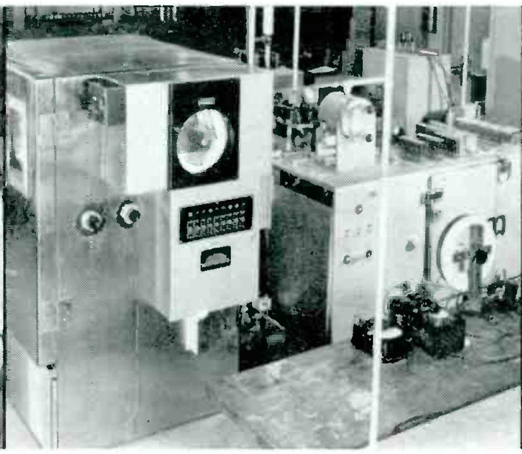
Each resistor is given a voltage breakdown test and the resistance value is measured. Ohmite resistors can be made to tolerances as low as 0.1%.

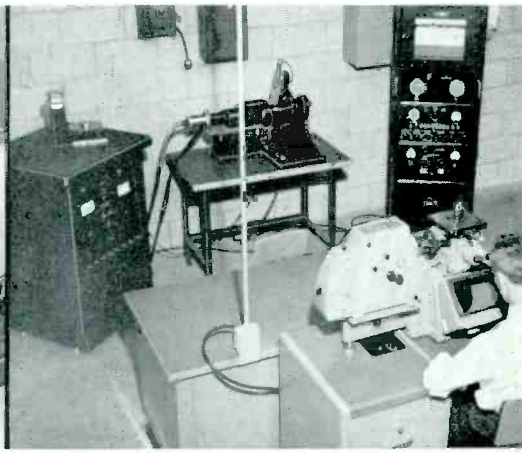
Humidity Chambers

In this equipment, using program-controlled cycles, Ohmite products are tested under a wide range of temperature and humidity conditions.

X-ray Diffractometer
and X-ray Fluorescence Spectrometer

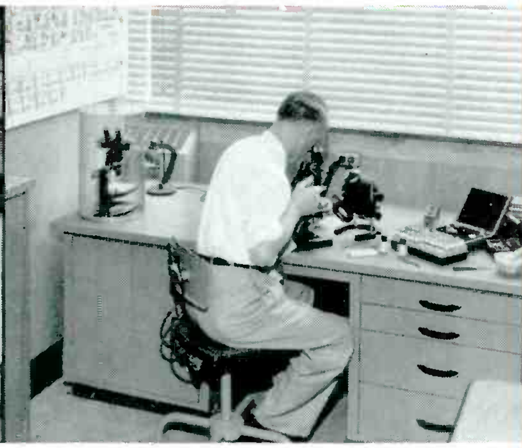
These instruments make possible the determination of crystal structure as well as elemental composition of materials and products by means of x-rays.





advanced
RESEARCH AND TESTING LABORATORIES

The new Ohmite research, development, and testing laboratories use the finest scientific instruments and equipment. Here Ohmite products are tested and retested under the most grueling conditions to detect potential sources of trouble. And these same laboratories are used for the development of new materials, new processes, and new designs—to build Ohmite products that set new standards of long life and trouble-free performance.



Metallographic Laboratory

Special equipment is available for microscopic analysis of structure using metallograph. Thermal expansion of ceramics and vitreous enamels can be determined with interferometer equipment.

OHMITE®

MANUFACTURING COMPANY

3610 Howard Street, Skokie, Illinois

(Suburb of Chicago)

Testing Resistance Values

Resistors from the production lines are checked for continuity resistance value and tolerance. Standard Ohmite tolerance is ±5% where number of turns and alloy permit.

Microscopic and Petrographic Equipment

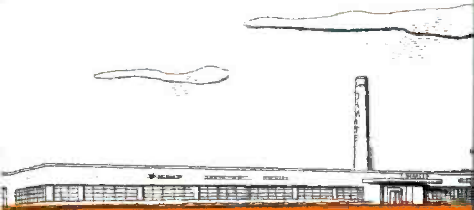
The Ohmite laboratories contain this equipment for the optical examination of materials and products.

RHEOSTATS

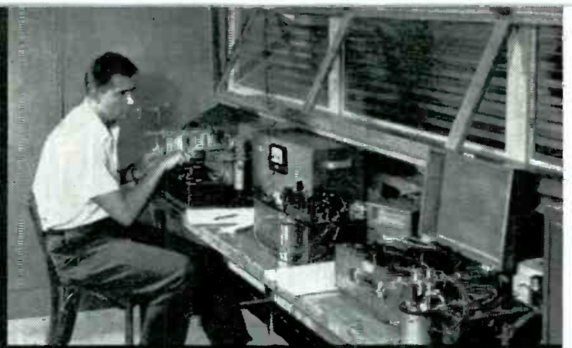
RESISTORS

TAP SWITCHES

modern
new
OHMITE
plant

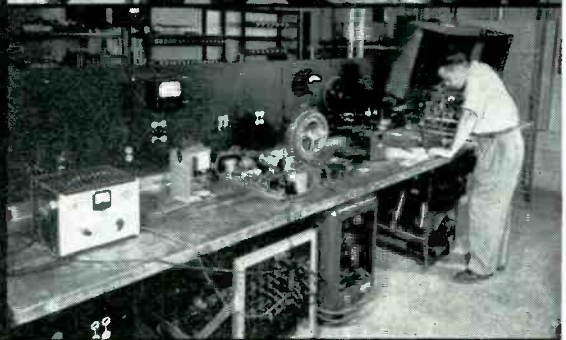


FIRST
in
resistance
products



Standardization Laboratory

The instruments shown here are used to check and standardize the many pieces of Ohmite electrical test equipment.

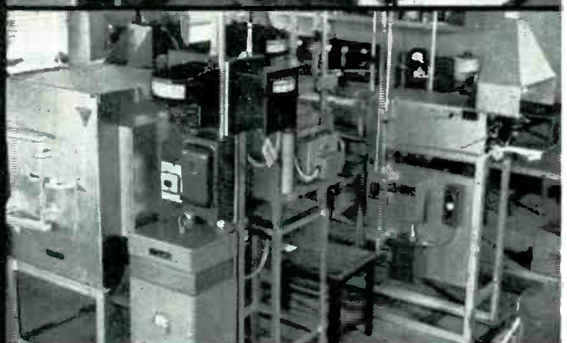


Power Panel

This power panel provides AC or DC in a wide range of currents, voltages and frequencies—permits testing Ohmite products under operating conditions.

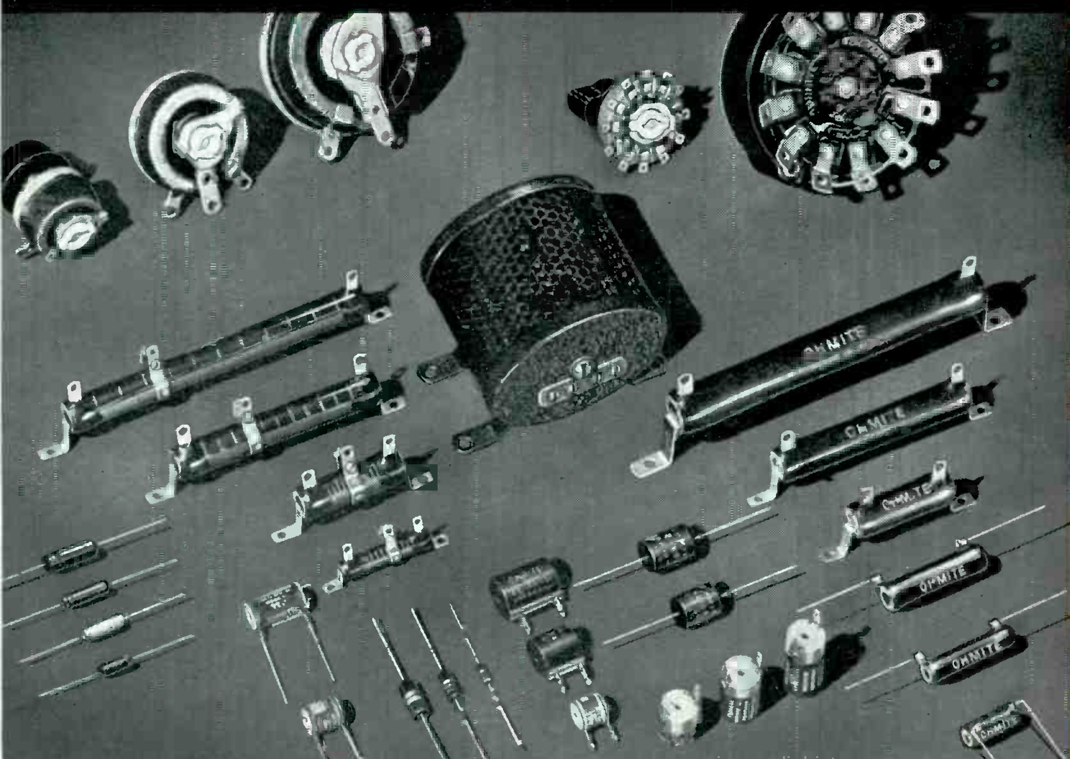
Vacuum Chambers

Vacuum chambers of this type are used to deposit an extremely thin film or coating of evaporated metal.



Special Purpose Furnaces

High temperature globar furnace; muffle furnace for enamel testing; hydrogen atmosphere sintering furnace.



OHMITE®
MANUFACTURING COMPANY
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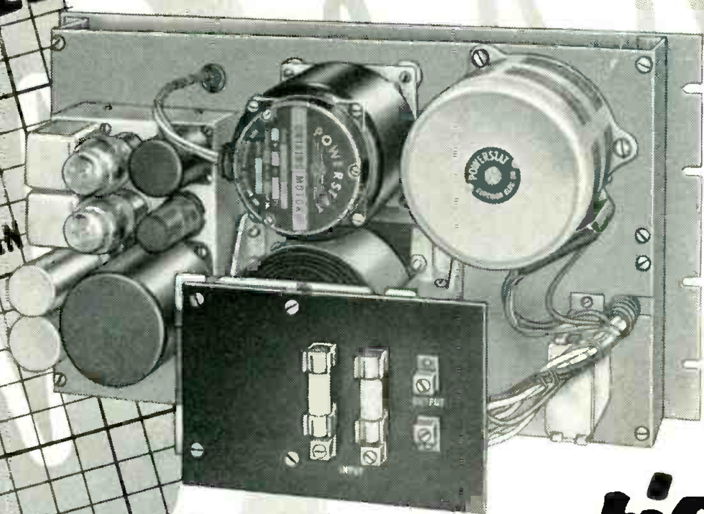
RHEOSTATS
RESISTORS
TAP SWITCHES

Write on Company Letterhead for Catalog and Engineering Manual.

Maintain Constant Output Voltage

THE WAVE THAT GOES IN

COMES OUT UNCHANGED



STABILINE
Type EM4102R

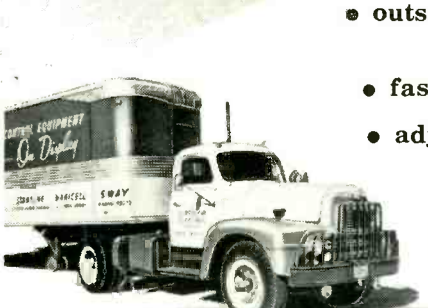
with-Zero Waveform Distortion

If you want to maintain constant output voltage with zero waveform distortion or constant voltage to large industrial loads, you will find the STABILINE Type EM the answer.

STABILINE automatic voltage regulators Type EM not only stabilize and regulate the voltage output and exactly reproduce the input waveform, but feature:

- **outstanding efficiency — comparable to the most conservatively designed fixed-ratio transformers**
- **fast correction rates for voltage changes**
- **wide input voltage ranges**
- **adjustable output voltage settings**
- **adjustable operating sensitivity**

Send coupon below for full details.



See the Superior Electric's Mobile Display when it is in your area.

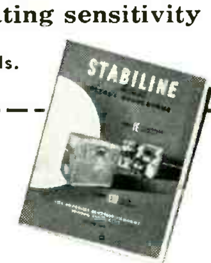
THE SUPERIOR ELECTRIC COMPANY

210 Clarke Ave., Bristol, Conn.

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC COMPANY
210 Clarke Ave., Bristol, Conn.

Please send Bulletin S351 on STABILINE automatic voltage regulators.



Name..
Position..
Company Name..
Company Address..
City.................................Zone......State..................

1st – 1939

In 1939, *-hp-* designed and manufactured the first commercial RC (resistance-capacity) oscillator. Today, this type is recognized as the most versatile, practical, dependable and convenient of all oscillators. Through the years, *-hp-* RC oscillators have become world-famous for their high stability, accuracy, wide frequency range and compact size.

OSCILL

17 OSCILLATORS FOR EVERY NEED

Instrument	Primary Uses	Frequency Range	Output	Price
-hp- 200AB	Audio tests	20 cps to 40 kc	1 watt/24.5 v	$120.00
-hp- 200CD	Audio, ultrasonic tests	5 cps to 600 kc	160 mw/20 v *	150.00
-hp- 200I	Interpolation and frequency measurements	6 cps to 6 kc	100 mw/10 v	225.00
-hp- 200T	Telemetry, carrier current tests	250 cps to 100 kc	160 mw/20 v *	350.00
-hp- 201B	High quality audio tests	20 cps to 20 kc	3 w/42.5 v	250.00
-hp- 202A	Low frequency measurements	.01 cps to 1 kc	20 mw/10 v	465.00
-hp- 202B	Low frequency measurements	½ cps to 50 kc	100 mw/10 v	365.00
-hp- 202D	Low frequency measurements	2 cps to 70 kc	100 mw/10 v	275.00
-hp- 204A	Portable, battery operated	2 cps to 20 kc	2.5 mw/5 v	175.00
-hp- 205A	High power audio tests	20 cps to 20 kc	5 watts	405.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 kc	5 watts	440.00
-hp- 205AH	High power supersonic tests	1 kc to 100 kc	5 watts	565.00
-hp- 206A	High quality, high accuracy audio tests	20 cps to 20 kc	+15 dbm	565.00
-hp- 230A	Carrier test oscillator	35 cps to 35 kc	+14 dbm/600 ohms	275.00
-hp- 233A	Carrier test oscillator	50 cps to 500 kc	3w/600 ohms	475.00
-hp- 234A	Carrier test oscillator	160 cps to 160 kc	+14 dbm/600 ohms	300.00
-hp- 650A	Wide range video tests	10 cps to 10 mc	15 mw/3 v	490.00

*Open circuit. Internal impedance 600 ohms. Data subject to change without notice. Prices f.o.b. factory.

Modern *-hp-* oscillators give you the broadest usefulness, highest quality and greatest value of any oscillators ever built.

They are the ultimate product of 15 years experience in designing and manufacturing 50,000 quality oscillators. This total of 50,000 is a record unequalled in quality oscillator manufacture.

Seventeen *-hp-* oscillators, for all types of applications, provide complete coverage of all frequencies 0.01 to 10,000,000 cps. They are uniformly characterized by their flat frequency response, ease of adjustment, low distortion, high stability, accurate calibration and trouble-free operating reliability.

Brief details of these universally-used instruments appear at left. For complete data, ask your *-hp-* sales engineer, or write factory direct.

Want more information? Use post card on last page.

...world's most complete line

ATORS

50,000th – 1954

Today, *-hp-* RC oscillators are the accepted standard in science and industry. The 50,000th *-hp-* oscillator – the golden commemorative instrument pictured here – is an *-hp-* 200CD, popular member of the world's largest oscillator family. *-hp-* 200CD covers all frequencies 5 to 600,000 cps. Output is 10 volts into 600 ohms. For the entire frequency range response is ± 1 db, and distortion less than 0.5%. Price, $150.00.

HEWLETT-PACKARD COMPANY

Service engineers serving all principal areas

3183A Page Mill Road • Palo Alto, California, U.S.A.

Export Division: 275 Page Mill Road, Palo Alto, California

Cable "HEWPACK"

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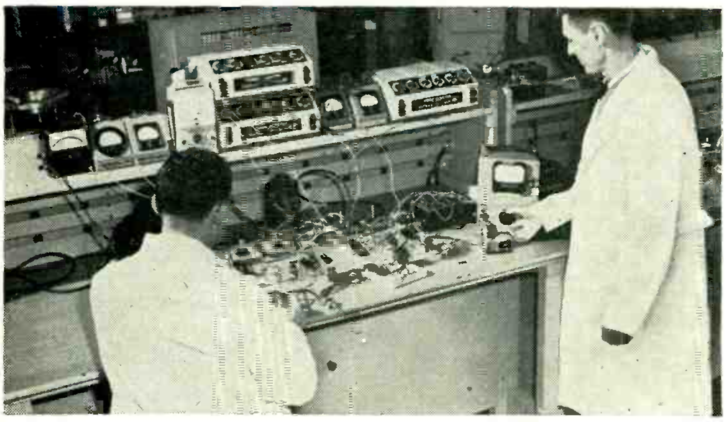
SYNCHRO

SERVO MOTOR

RESOLVER

Ketay offers a complete range of sizes and types of rotating components . . . synchros, servo motors, and resolvers. Specifications for 116 of them are contained in an illustrated brochure, available upon request.



Ketay leadership is the result of sound, imaginative engineering. From the design of a specialized component to the fabrication of complete systems, Ketay engineers create the "standards of tomorrow".

Costs, quality, and stringent delivery schedules, are best controlled when critical manufacturing is done "on the premises" . . . under close supervision. Ketay plants are fully equipped with modern machines and equipment. This Heald Borematic Department is but one of many such divisions at Ketay.

Ke

. . . leader in the development and manufacture of Synchros, Servo Motors, Resolvers, Amplifiers, Airborne instruments, and Automatic Controls.

Ketay leadership is the result of a combination of research, experience, and outstanding manufacturing facilities. Some of these facilities are pictured here.

Ketay has produced many *firsts* in automatic controls. For example, in Synchros, Ketay was first to produce miniaturized Synchros so remarkable for their high accuracy and unmatched reliability. Ketay was *first* to produce high temperature and corrosion resistant Synchros.

Today, Ketay produces literally hundreds of different

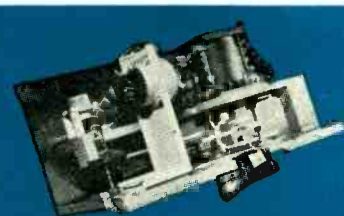
Ketay
Manufacturing Corporation

Executive Offices:
555 Broadway, N. Y. 12, N. Y.

New York Division
Electronic Instrument Div.

MAGNETIC AMPLIFIER

RESOLVER AMPLIFIER



ELECTRO-MECHANICAL ASSEMBLY

Components for complete systems including gear trains and amplifiers of conventional and miniaturized types are available to meet the most demanding of design requirements.

FUEL TOTALIZING INDICATOR

FUEL FLOW TRANSMITTER

DUAL FUEL FLOW INDICATOR

Electronic control devices are among the many instruments Ketay manufactures for aircraft, missiles, marine, ordnance, and civilian application. Special designs to meet the limitations of space and operating conditions.

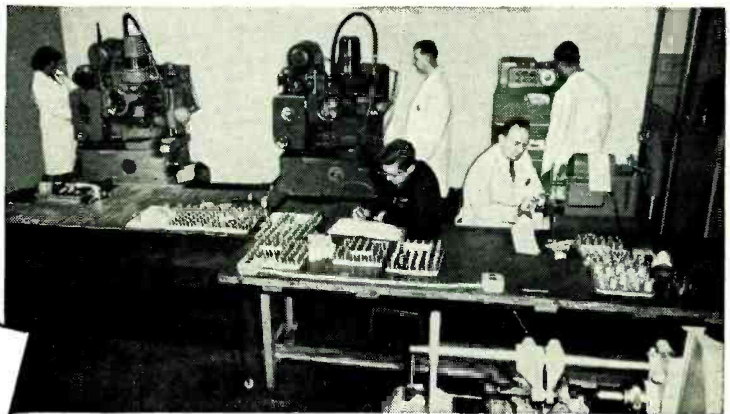
tay

Inspection of all parts, sub-assemblies, as well as completed instruments, is a fetish at Ketay. For instance, all bearings are inspected with specially developed equipment in air conditioned work space. This is just one of the many techniques that assure maximum performance when Ketay units are specified.

electro-mechanical devices some of which are illustrated on these pages. Currently, original Ketay developments are providing instrument performance far above present standards—many of which were set by earlier Ketay developments.

Ketay successfully applies its production facilities and experienced research personnel to specific problems for the leaders in automatic control.

Your interest will be well served by learning fully of the products and services you may obtain from Ketay.



Precision of manufacture is vital in every Ketay unit. To assure continuing reliability for its products, Ketay employs the very latest facilities and techniques. Typical is this "gear room" where modern gear cutting machinery produces gears to the finest of tolerances.

Write, today, for descriptive specifications of those types of Ketay instruments which may be applied to your designs.

Pacific Division:
12833 Simms Avenue, Hawthorne, Calif.

Kinetix Instrument Div., Pacific Div.
Research & Development Div.

TACHOMETER GENERATOR

PANCAKE SYNCHRO GYRO PICKOFF

SYNCHRO OVERLOAD TRANSFORMER

Many specialized units have been designed by Ketay engineers and are in quantity production. Custom engineered units for specific application are also available.

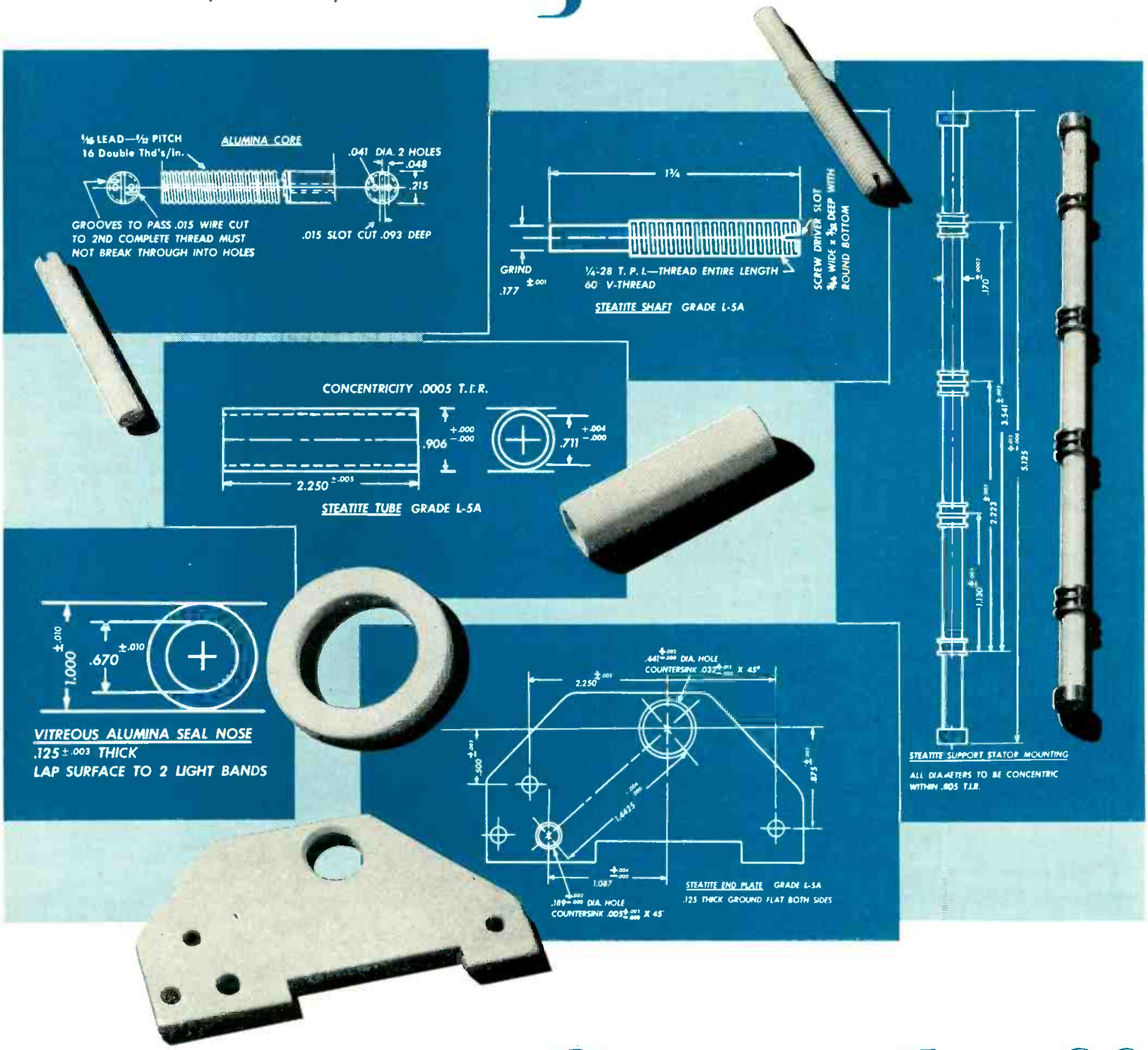
PRECISION CERAMICS

ALUMINA, STEATITE, ZIRCON, MAGNESIA, STUPALITH®
PORCELAIN, FORSTERITE, CORDIERITE

MANUFACTURED IN

PRODUCTION QUANTITIES

FOR PRECISE ASSEMBLIES



Stupakoff

CERAMIC &

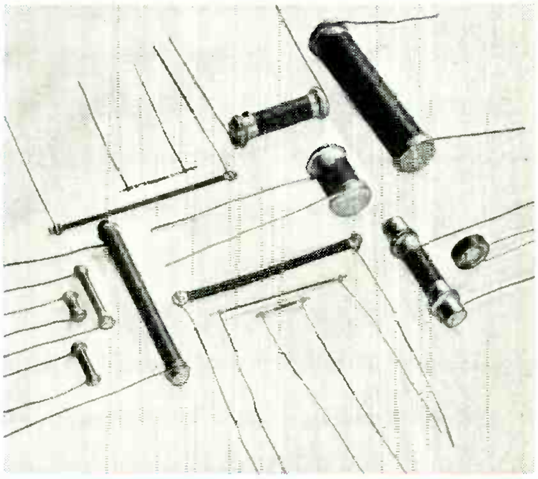
DIVISION OF *The* **CARBORUNDUM** *Company*

Temperature Sensitive Resistors

Used for compensation, measurement and control of temperature, these units *decrease* in resistance in the order of 3% per degree centigrade *rise*.

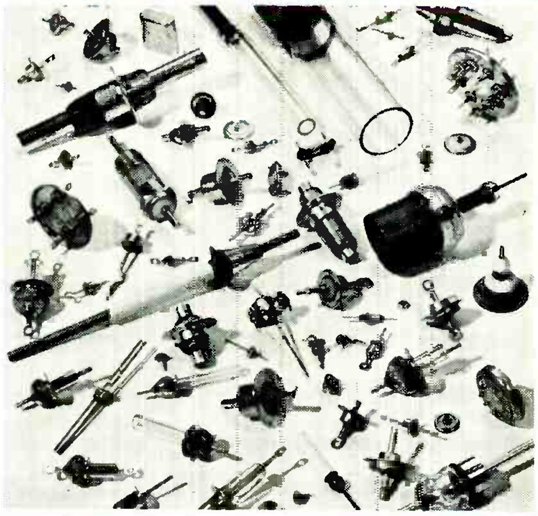
Volume Resistivity Range: 10 to 7500 ohms cm^3
Manufacturing Tolerances: Resistance—±5%
Temperature Characteristic—±5°
from −60° to 30° C.

Available in rods (.010″-.500″ dia.); tubes (.020″-.500″ OD x ID up to 75% of OD); discs, bars, washers and simple shapes.



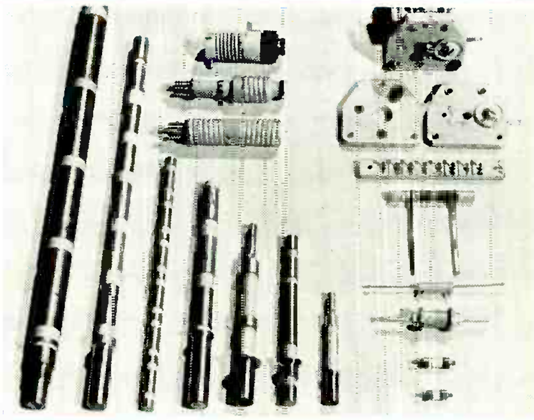
Kovar—Hard Glass *Seals*

The use of hard glass offers superior thermal endurance; high dielectric strength, particularly at high temperatures; and chemical stability. Used in combination with Kovar, Hard Glass produces an exact thermal coefficient match between metal and glass, maximum bond strength, and chemical interfusing between metal and glass for vacuum-tight interface between metal and glass. Thin section, light weight, flexible eyelets can be used. *Bulletins 453-A and 145.*



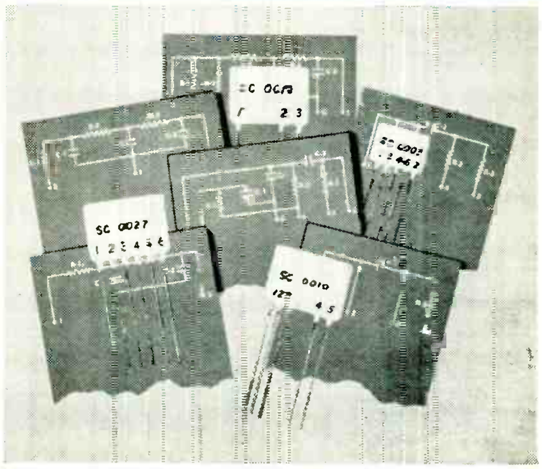
Assemblies

Assembly line problems and sub-assembly scrap loss can be minimized or eliminated by using Stupakoff Assemblies. Alumina, low-loss Steatite or other ceramics are combined with silver, copper, brass, stainless steel, monel or Kovar. Ceramics are metallized where required for electrical connection or mechanical assembly. Critical tolerances are precisely held.



Printed Circuits on Ceramic

These compact RC circuits, printed on high-K ceramic plates, protected from abrasion and humidity by a tough plastic coating, provide stable, moisture-proof circuitry ideal for miniaturized, ruggedized electronic applications. *Bulletin 1151-A.*



MANUFACTURING COMPANY

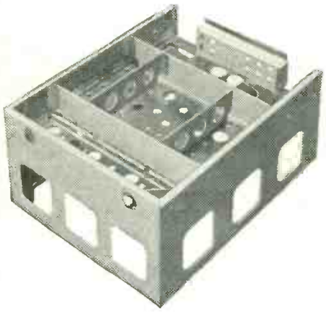
LATROBE, PENNSYLVANIA

Want more information? Use post card on last page.

If MECHANICAL DESIGN is your problem... here's how BUD can help you SOLVE IT!

1. The Place of Mechanical Design

The function of mechanical design is not new to Bud Radio. For over 25 years we have made electronic components and devices involving the designing of housings, wiring systems and other equipment to improve appearance and add utility not only to our own products but to those of other producers. Economical fabrication, precise design engineering and prompt delivery combine to provide our customers with utmost value, outstanding performance and high quality service. Proper mechanical design assures that components as well as housings will be available at a relatively inexpensive cost and with reasonably short delivery. What better source of supply than BUD Radio Inc. with 1500 stock items in our catalog?



2. Designing the Chassis

Bud regularly makes more than 100 standard sizes and types of chassis for our own account besides constantly supplying special types for other manufacturers of electronic devices. Every facet of chassis construction from selection of metal to careful finishing is checked to insure a superior product. The processes of forming, stamping and welding are performed on the most modern machines by experienced workman before passing through rigid inspection.

3. Making Small Parts

Each day thousands of small parts pass through the Bud plant. Fabricated by machining, stamping and other methods, these products must meet specified standards as do all Bud products. Their mechanical and electrical properties assure proper working qualities when combined with other parts.

4. Shielding and Potting Components

Boxes, shields and containers of various sizes and shapes comprise a large part of the standard Bud line of sheet metal products. Used for a multitude of electronic and electrical applications, these products have found wide acceptance in business and industry. Our long experience and skill in producing this type of component assures true-to-specification results while large volume production guarantees lower prices. Long or short runs of special sizes and designs receive equal attention.

5. Moving Parts

In constructing electronic devices Bud makes and selects only those component parts which will impart smooth motion and control. Coordination between these parts and the balance of the assembly provides proper working qualities. Careful inspection before and after assembly and careful testing are standard procedures at Bud.

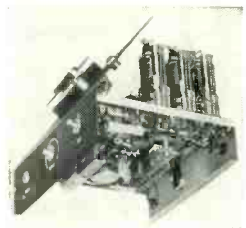
6. Power to Impart Motion

While Bud produces no motive power, our primary function is to provide housing for controls for motors, generators, etc. Sturdily built housings give protection to these sensitive controls.

7. Assembly Methods and Devices

A wide variety of plugs and jacks are fabricated by Bud. Precision made of highly conductive materials such as brass and silver while bakelite and other insulation is used. Accurate machining and heavy plating where required assures long, trouble-free service. A large number of plugs and jacks of varied sizes are manufactured.

8. Wiring and Soldering



Simple and complicated wiring operations are regularly performed both for our own electronic products and on a contract basis. These operations are accomplished on either subassemblies or complete devices. We provide all the components, including chassis and housings or wiring is done on parts supplied to us. The latest soldering techniques are employed using non-corrosixe fluxes and solders.

9. Designing the Cabinet

Employing sheet steel and aluminum Bud makes large and small cabinets as stock items and for numerous manufacturers of electrical and electronic equipment. Complete engineering and manufacturing facilities enable us to produce small and large quantities economically to rigid specifications. Special louvres, mounting strips and panels are furnished when desired. Careful finishing operations assure attractive appearance.

These and many other facets of mechanical design are a part of the daily operations at Bud Radio. We have an impressive list of customers purchasing thousands of parts every year. We invite inquiries for any electronic components and sheet metal products. Send us your blueprint for estimates, there's no obligation. We shall be glad to send you our catalog illustrating our own comprehensive line; some parts of which may fit into your own products with little or no change.

BUD RADIO, INC.

2118 EAST 55TH ST. DEPT. L CLEVELAND 3, OHIO

DU PONT
Better Things for Better Living
. . . through Chemistry

ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

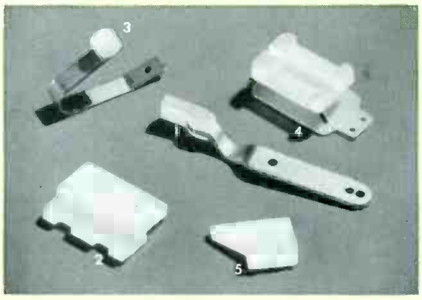
NO. 5 — 1954

Miniature Wire Insulated with Du Pont TEFLON® Speeds Soldering Operations, Saves Equipment Space

Abrasion-resistant "Zytel" nylon resin used for five key parts in dictating machine

Five key parts, molded of Du Pont "Zytel"* nylon resin, provide improved performance, simplified assembly, and lower production costs in one modern dictating machine.

"Zytel" used as *play-back and microphone lock lever* gives superior abrasion-



Parts of "Zytel" nylon resin in modern dictating machine. ***Play-back lever*** **(1),** ***microphone lock lever*** **(2),** ***microphone hook lever*** **(3),** ***recorder coil bobbin*** **(4) and** ***microphone switch lever*** **(5) all utilize one or more of the useful properties of Du Pont "Zytel".**

resistance to these moving parts. These parts of "Zytel" operate without lubrication and give long service life.

Dielectric Properties

The lightweight but tough *recorder coil bobbin* of "Zytel" nylon resin has good insulating properties. Because terminal fittings can be riveted directly to this coil, assembly time has been reduced.

The *microphone hook lever* features "Zytel" molded directly on metal to simplify assembly. The temperature resistance and compression strength of Du Pont "Zytel" are useful properties for the *microphone switch lever*.

A Material with Many Properties

These five parts are mass-produced to close tolerances by economical injection-molding. They illustrate why versatile "Zytel" nylon resin is used for many specialized parts having different property requirements.

** "Zytel" is the new trade-mark for Du Pont nylon resin.*

"Teflon" provides excellent thermal stability and dielectric properties

Du Pont "Teflon" tetrafluoroethylene resin has exceptional insulating properties for miniaturized electrical equipment. Where terminals are small and closely fitted, soldering hook-up wires is usually a difficult operation. However, hook-up wires made by the Tensolite Insulated Wire Co., Inc., Tarrytown, N.Y., are coated with heat-resistant "Teflon" so that operators can work more quickly with soldering irons. Heat won't burn or melt the insulation of "Teflon" to cause loss of time and equipment. The insulation is uniform, and space-saving.

This Inverter Control Assembly, which regulates output of DC to 400-cycle AC converters, used in aircraft, contains miniature Tensolite wire coated with Du Pont "Teflon". The equipment, which utilizes two Regohm Circuit Controllers, was developed by Electric Regulator Corp., Norwalk, Connecticut. It easily withstands ambient temperatures encountered—from −70°C. to 85°C.—and operates efficiently at high altitudes, the manufacturer states.

Saves Space

Insulation of "Teflon" also saves space in miniaturized equipment. It occupies about one third the space of other types of insulation for hook-up wire. In addition to space-saving advantage, wire coated with "Teflon" has exceptional stability.

Excellent Dielectric Properties

"Teflon" tetrafluoroethylene resin has excellent dielectric properties. The dielectric strength is high, and losses are very low. Volume resistivity is unaffected by moisture. These dielectric properties are especially important when wires and terminals are in close proximity.

(*Continued, column 1 back side*)

Flashlight case molded of Du Pont ALATHON®

The simple flashlight case is an interesting new application of Du Pont "Alathon" polyethylene resin. The battery section, end cap, and lens retaining ring are all molded of "Alathon", which gives the flashlight improved dielectric properties, extra strength, resiliency and corrosion-resistance.

Because Du Pont "Alathon" has outstanding dielectric properties, the contact points leading to the flashlight switch don't have to be insulated. Short circuits are avoided, which may appreciably lengthen battery life. And "Alathon" is warm to the touch even in coldest weather.

"Alathon" combines lightness with resiliency. If the flashlight is accidentally dropped, there's no danger that the threaded connection or case will shatter or dent. Resilient "Alathon" cushions

(*Continued, column 1 back side*)

OVER

DU PONT
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. . . through Chemistry

ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 5 — 1954

Miniature Wire *(Continued)*

Many Electrical Applications for "Teflon"

Du Pont "Teflon" has many applications in the electrical field—coaxial spacers and connectors, high frequency tube sockets, bases for subassemblies and stand-off insulators. For further information on the thermal, electrical, and mechanical properties of this unique Du Pont engineering material, mail the coupon below.

Flashlight Cases *(Continued)*

blows, minimizing damage to the bulb filament. The manufacturer, Gits Molding Corp., Chicago, Ill., thoroughly tested the case made of "Alathon" and guarantees it "unbreakable", if not wilfully abused.

This engineering material offers other advantages. It resists corrosion. The end cap and barrel of "Alathon" form a virtually waterproof seal.

Investigate Du Pont engineering materials in your product development programs

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

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

Construction well along on $3,000,000 Polychemicals laboratory in Wilmington

Du Pont is building a $3,000,000 Sales Service Laboratory in Wilmington, Delaware, to expand the present facilities of its Polychemicals Department. This new laboratory is to provide sales and engineering services to customers in the plastics and other industries.

The laboratory will have the most modern equipment available for developing technical data on the use and processing of Polychemicals Department products. Its facilities for providing technical services, especially in the field of plastic engineering materials such as "Alathon" polyethylene resin, "Teflon" tetrafluoroethylene resin, "Lucite" acrylic resin, and Du Pont "Zytel" nylon resin, will be several times those of the present laboratory in Arlington, New Jersey.

Parts of the new laboratory will be equipped especially for study courses on the utilization of new plastic engineering materials. Space for exhibits of these materials and products made from them is to be provided in a two-story reception area.

Large portions of the laboratory will be equipped for demonstrating new processing methods and for testing. Total floor space: 62,000 square feet.

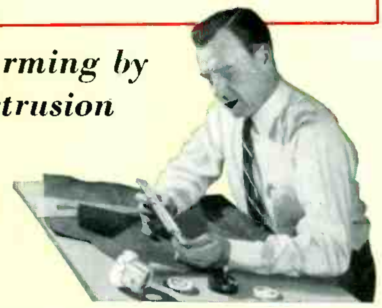
Preliminary work on the site is now under way and construction is expected to be completed late in 1954.

NEED MORE INFORMATION?

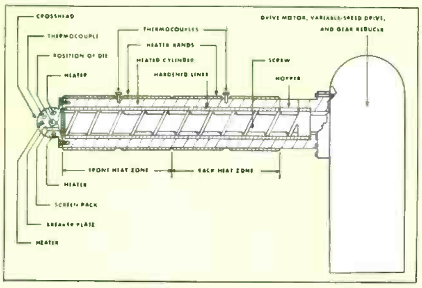
Clip the coupon for additional data on properties and applications of these Du Pont engineering materials.

POINTERS ON PROCESSING

Forming by Extrusion



Du Pont "Zytel" nylon resin, "Teflon", "Alathon" and "Lucite" all can be formed by extrusion techniques. Basically, screw extrusion consists of placing the granulated material in a hopper where it is moved down and forward



Components of typical screw extruder which might be used to extrude "Zytel" nylon resin.

along a one-piece heating barrel by means of a rotating screw. The screw then forces the softened material through a die, forming it into shapes such as tubing, rod, bars, and other shapes. This operation varies in a minor degree with the material being processed. Screw extrusion is applicable to "Alathon", "Lucite" and "Zytel".

A typical extrusion machine for "Zytel" nylon resin has these features: (see cut)

1. electrically heated barrel
2. metering type screw
3. screen and breaker plate

Extrusion of "Teflon" is best carried out by the ram extrusion method. A reciprocating ram in a cylinder compacts successive charges of "Teflon". The powder is introduced through a hopper at the back position of the ram. Preforming takes place at a cold section of the cylinder and the compacting material moves through the heated section of the cylinder where it is sintered.

Extrusion has certain economic advantages where continuous lengths of material are desired. For example, a coating of "Zytel" nylon resin used as a primary insulation on small wire can be applied at speeds up to 1600 feet per minute with suitable take-off equipment.

E. I. DU PONT DE NEMOURS & CO. (INC.)
Polychemicals Department,
Room 2210, Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont engineering materials checked:
☐ "Zytel"; ☐ "Alathon"; ☐ "Teflon"; ☐ "Lucite". I am interested in evaluating these materials for:

____

NAME ________________ POSITION __________

COMPANY __________________________

STREET ___________________________

CITY ________________ STATE __________

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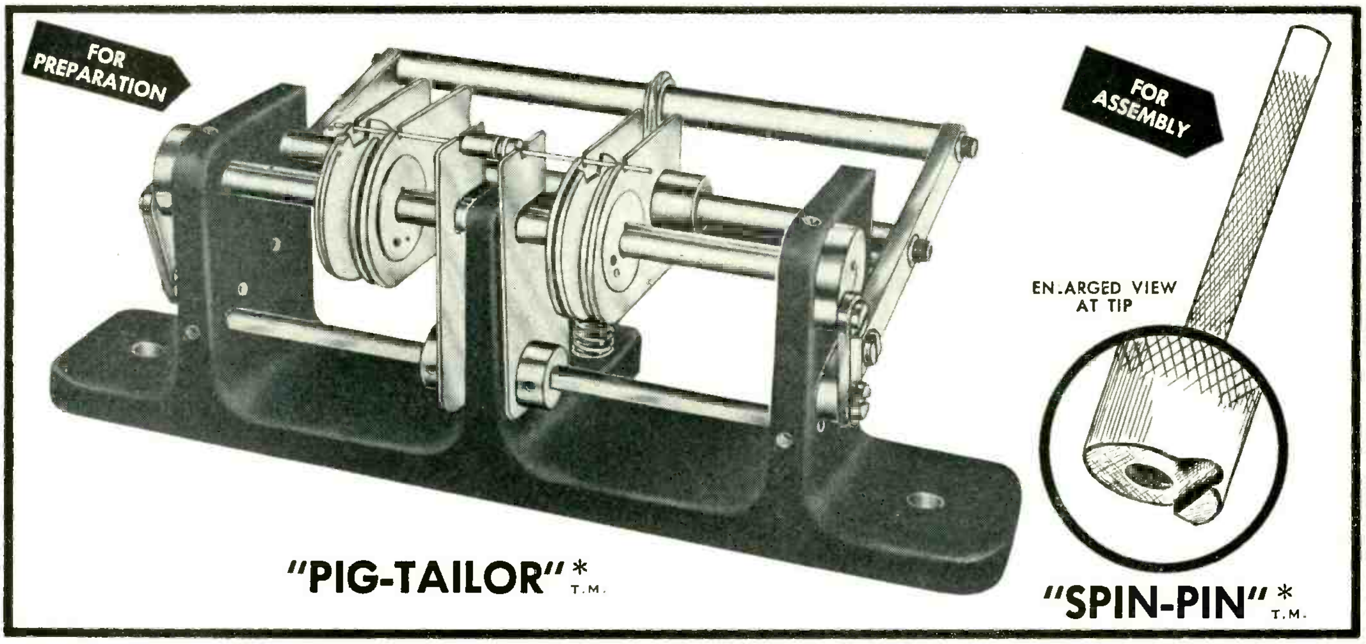
"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

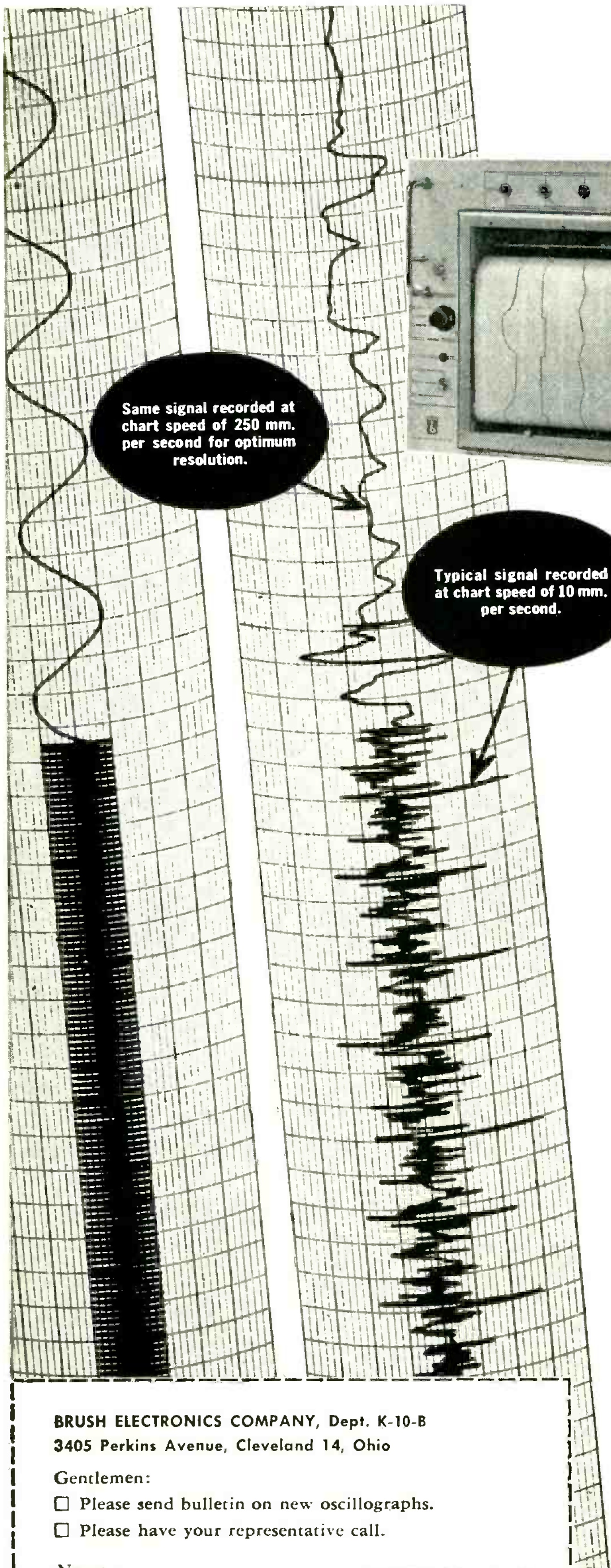
PIG-TAILORING eliminates:

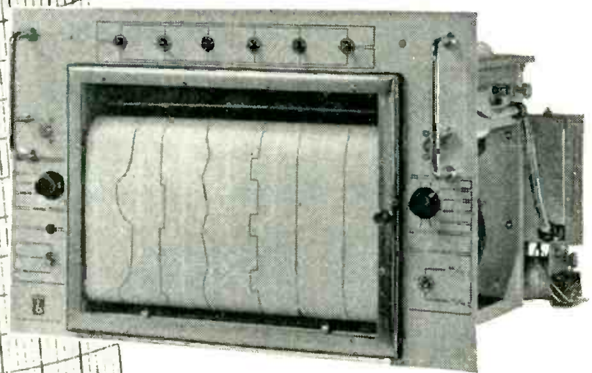
1. Diagonal cutters!
2. Long-nose pliers!
3. Operator judgment!
4. 90% operator training time!
5. Broken components!
6. Broken leads!
7. Short circuits from clippings!
8. 65% chassis handling!
9. Excessive lead tautness!
10. Haphazard assembly methods!

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. MD

BRUNO-NEW YORK INDUSTRIES CORPORATION
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.


Same signal recorded at chart speed of 250 mm. per second for optimum resolution.
Typical signal recorded at chart speed of 10 mm. per second.



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As rapidly as possible we publish bulletins on our products and they are always available upon request. Sometimes, though, we find the printing presses simply cannot keep up with our progress . . . So, for the best and most up-to-date facts about RADIO RECEPTOR semi-conductor products *we suggest you submit your specifications.* Our engineers will gladly make recommendations incorporating the very latest information at their command. Just address Section E-3.

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RADIO RECEPTOR COMPANY, INC.

SALES DEPARTMENT: 251 WEST 19TH STREET, NEW YORK 11, N. Y.
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These are our key people . . . an integrated team of engineers, production supervisors and field representatives who have made significant contributions to Uncle Sam's growing missile might.

Since 1946 when Bendix-Pacific began its activity in the guided missile equipment field, more than 500 man-years of experience has been accumulated by these people. They will produce many of the hydraulic and electronic systems for tomorrow's Air Force, Army and Navy missiles, with competence born of that experience. Backing up these key people are more than 2,000 skilled workers, experienced in meeting today's exacting missile requirements.

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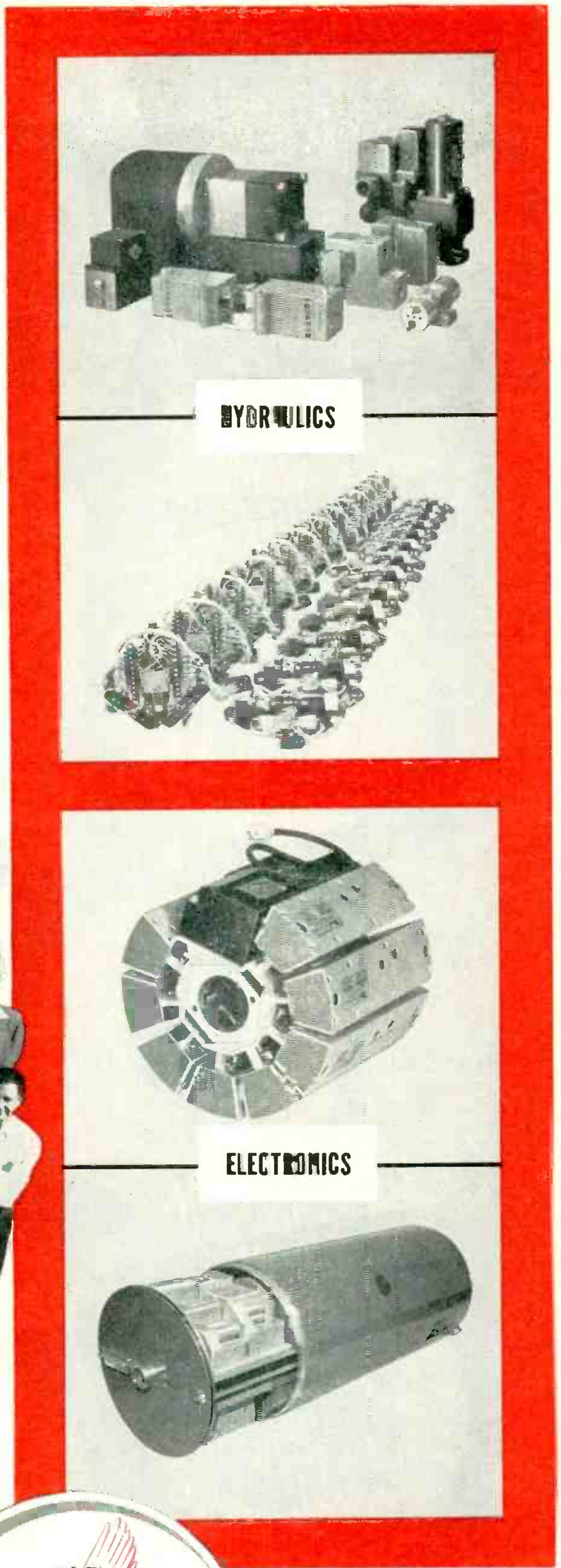

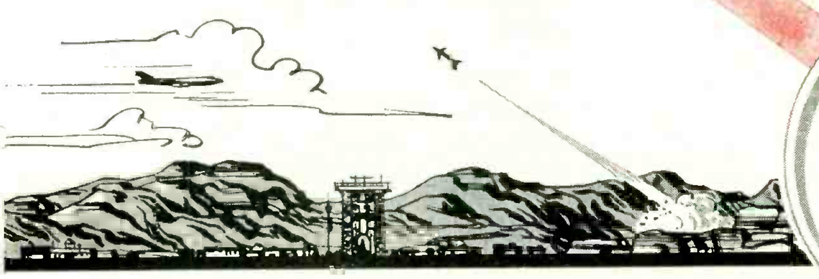

BENDIX PACIFIC

THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

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

Canadian Distributors: Aviation Electric, Ltd., Montreal 9

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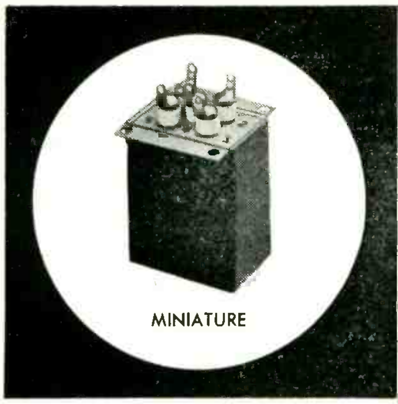

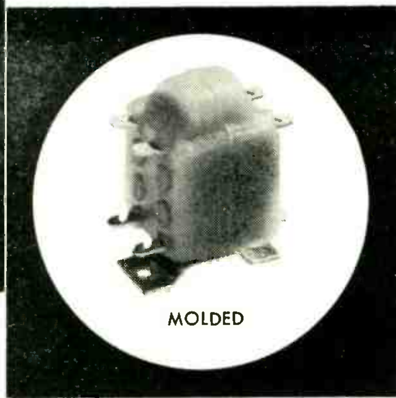

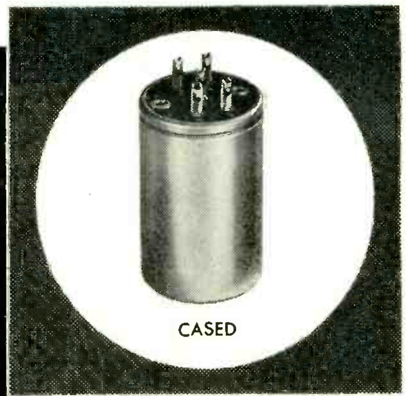

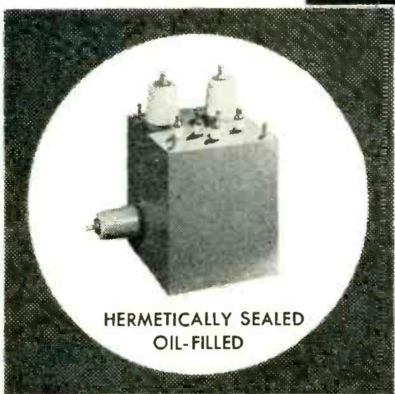

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Engineered and Built to Meet the Most Rigid Military and Civilian Requirements

Kenyon's engineering staff and production department have had more than fifteen years' experience in designing and building units which exactly meet the most rigid and unusual specifications. Your inquiries are invited.

Miniature—Molded—Cased—Hermetically Sealed Oil-Filled—A-Line—T-Line—Toroids—The Kenyon Twins, M-Line to meet all Mil-T-27 Requirements; C-Line for all commercial requirements.

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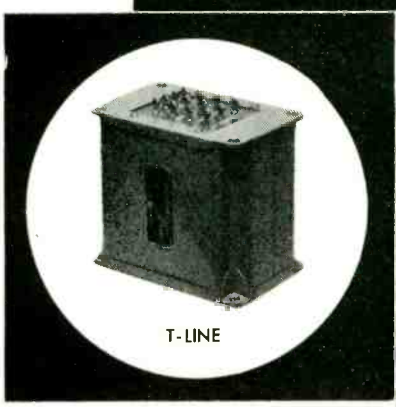

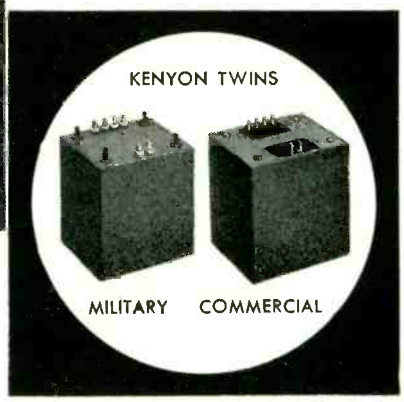

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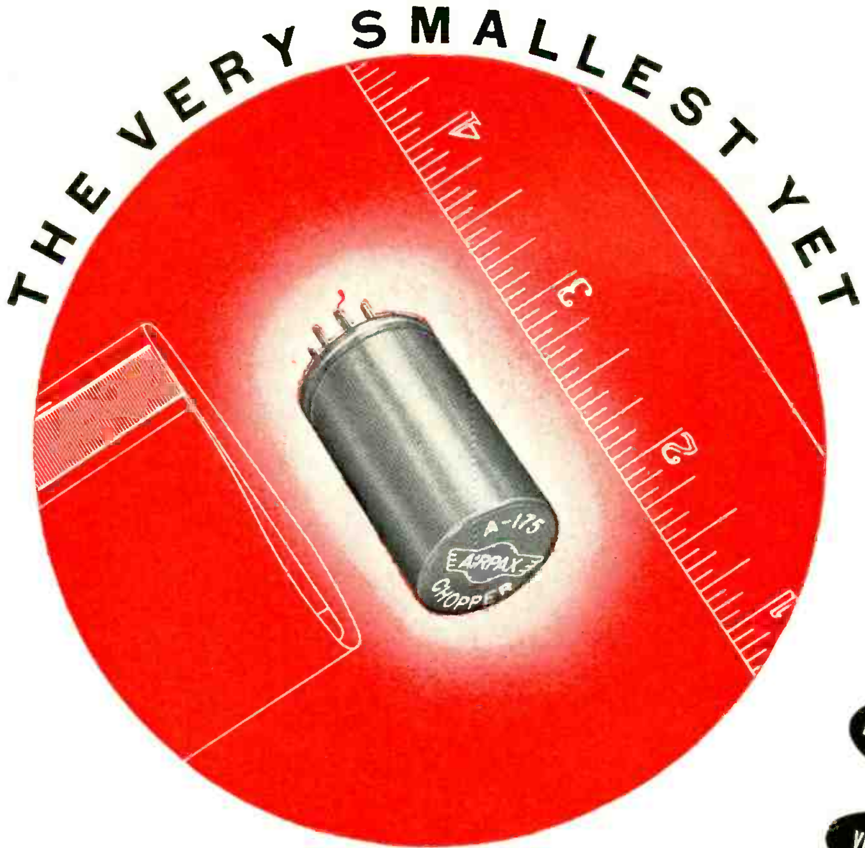
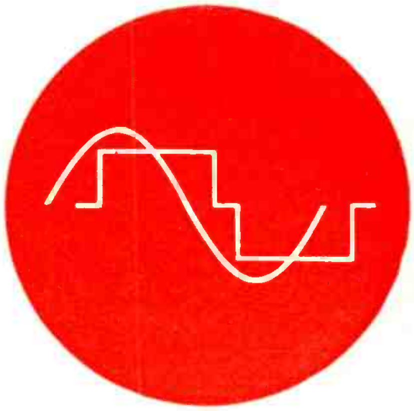


AIRPAX
A175 MIDGET
60 cycle chopper

- wide temperature range
- broad frequency range
- hermetically sealed
- very low noise
- long proven life
- vibration proof
- chatter free
- shock proof
- reliable
- rugged

Phase Angle at 6.3v, 60 cycles is 21° ± 5°, at 30 cycles is nominally 20°, at 100 cycles 26°.
Contacts are SPDT, break-before-make, and are rated up to 100 volts maximum, 1 ma maximum.
Dwell Time is approx. 170°. The nominal value of dwell time changes only slightly from 30 cycles to 100 cycles.
Coil demand at 6.3 volts, 60 cycles, is approximately 37 milliamperes, coil resistance approximately 165 ohms D.C.
Noise with all 3 contacts at one megohm impedance, and with wide band amplifiers, will have an effective value of 50 microvolts or less. The offset of narrow band amplifiers will be very much less. The specification of noise requires careful definition, users should refer to the detail specifications and bulletin 103.
Temperature may be any value from —65°C to 85°C. The nominal phase angle will vary from about 17 degrees at —65°C to 25 degrees at 85°C.
Vibration from 10 to 55 cycles will not damage the chopper up to as high as 30 G. At these higher G values there will be some modulation of the phase angle.
Frequency of operation may be any value from 25 to 110 cycles, to maintain full performance, balance, etc.
Humidity may be any value, except of course for external condensation on the header.
Shock values as high as 50G will not damage the chopper.
Altitude may be any value, as the unit is hermetically sealed.



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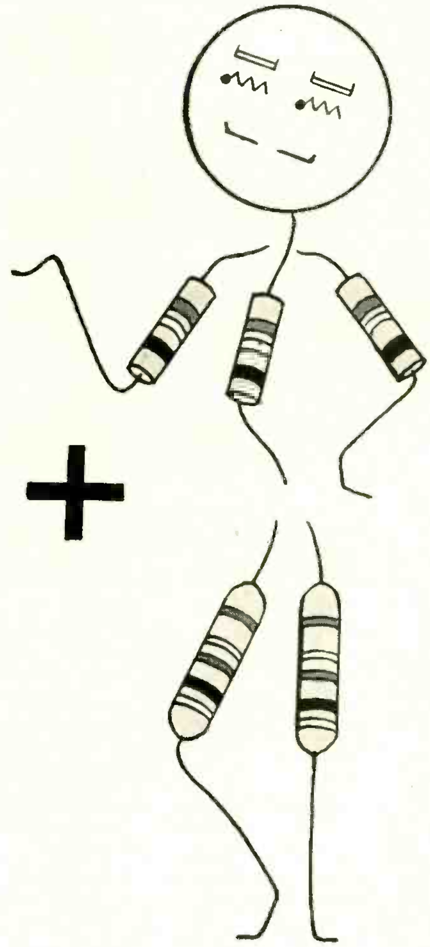
The **PERFECT** *Wedding*



TYPE 2003 FREQUENCY STANDARD

The Type 2003 contains, in addition to the tuning fork, all circuit components which are selected or critical.—The tube and remaining components — three resistors and two .01 capacitors — are external and can be laid out and integrated with your equipment.

TUNING FORK STANDARD, hermetically sealed.
SIZE — 4½ inches long. 1½ inches diameter.
SIMPLE EXTERNAL CIRCUIT, 1 tube, 3 resistors, 2 capacitors.
TUBE — Choice of 12AT7, 6201, 5751, 6BF7, 6BG7 or 6021.
POWER REQUIRED, 75 to 300 V at 1 to 5 m.a. — 6.3 V at 300 or 350 m.a.
AVAILABLE — in 400 or 500 cycles
ACCURACY guaranteed to .002%, 15° to 35° C.

Write for descriptive literature, specifying Type 2003.

Also TYPE 2007
(4½" x 1½")
COMPLETELY SELF-CONTAINED INCLUDING VACUUM TUBE

Manufacturer of high precision frequency and timing instruments controlled by tuning fork oscillators.

American Time Products, Inc.

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OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

General Ceramics

offering 3 complete services...

ENGINEERING-DESIGNING-PRODUCTION

on these 3 basic components...

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FERRAMIC® CORES
SOLDERSEAL TERMINALS

GENERAL
CERAMICS CORPORATION
STEATITE INSULATORS

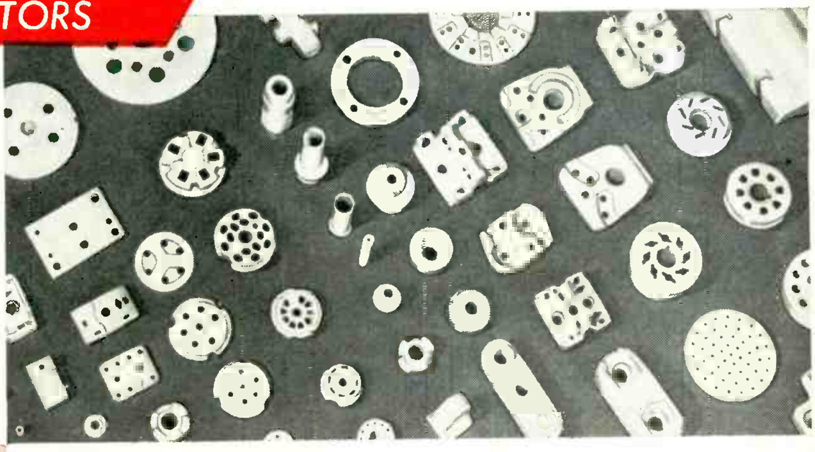
1. ELECTRICAL INSULATORS

STEATITE—For low power loss at high frequency. High dielectric strength through wide temperature range. Low thermal expansion.

PORCELAINS—An economical high voltage material of great hardness. Low thermal expansion. Wet or dry process.

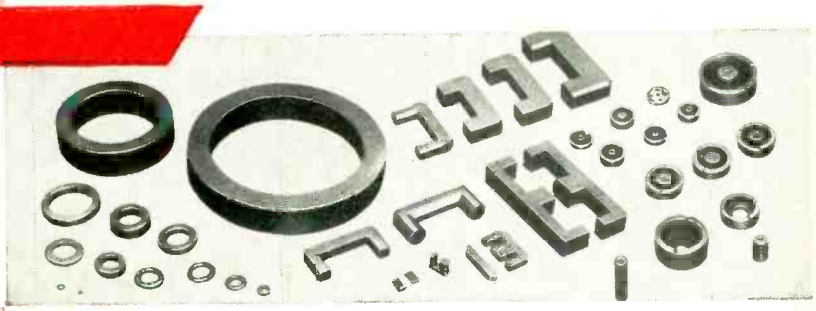
ALUMINA—Characterized by great hardness and chip resistance. Will withstand very high temperatures.

ZIRCON—Has low loss properties that vary inversely with frequency. An excellent high frequency material having good thermal shock resistance.



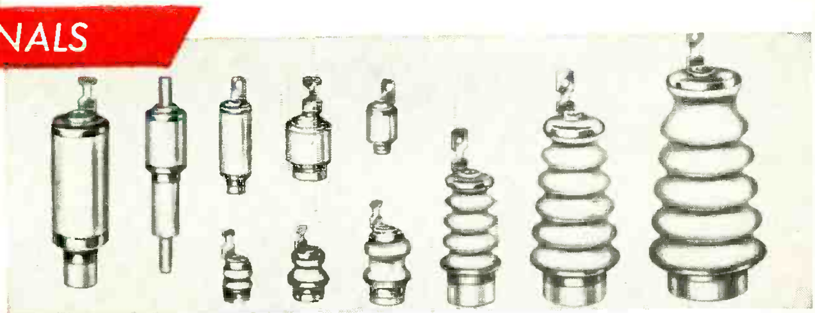
2. FERRAMIC CORES

General Ceramics Ferramic Cores are available in standard toroid, cup core and TV components. Standardization simplifies design problems, speeds delivery and lowers costs. The types illustrated are supplied in many grades of Ferramics for specific applications.



3. SOLDERSEAL TERMINALS

Featuring high mechanical strength, resistance to thermal shock and permanent hermetic sealing. Installation is easy and fast. Terminals are made of glazed Alumina Ceramic with lugs and eyelets hot tinned brass. Metallized areas are silver fired on ceramic, copper electroplated and tin fused for soft soldering.



Makers of STEATITE, ALUMINA, ZIRCON, PORCELAIN, SOLDERSEAL TERMINALS, CHEMICAL STONEWARE, FERRAMIC MAGNETIC CORES

For complete information on standard components, and recommendations on specific applications, call or write today; there is no obligation.

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These successful uses of

PHELPS DODGE BONDEZE*

magnet wire . . .

Suggest

UNLIMITED NEW

COILS

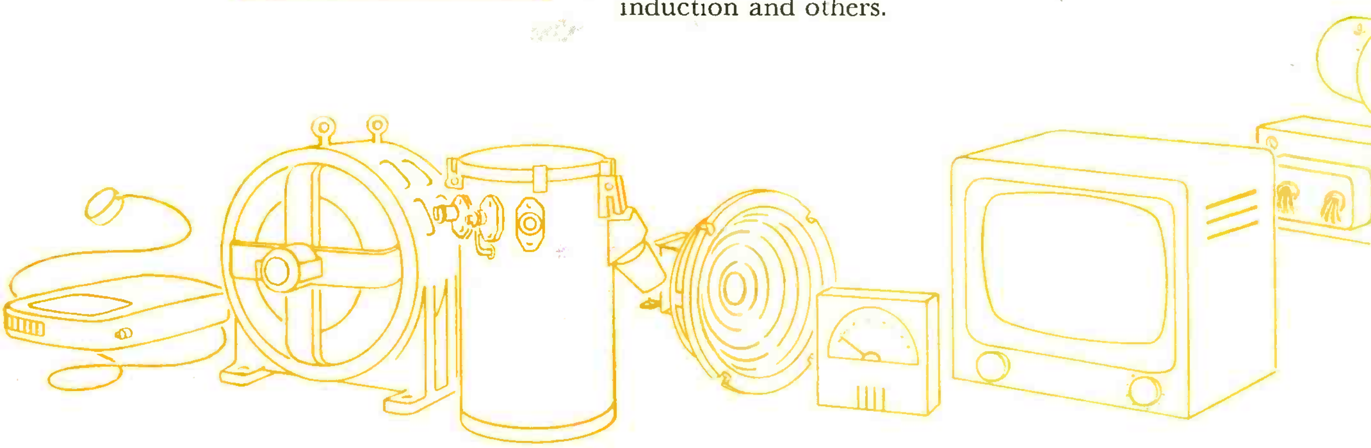
Random-wound, Layer or Paper-section for potentiometers, telephones, brakes and clutches, clocks and timers, hearing aids, instruments, speakers, relays, television, radio and other applications.

TRANSFORMERS

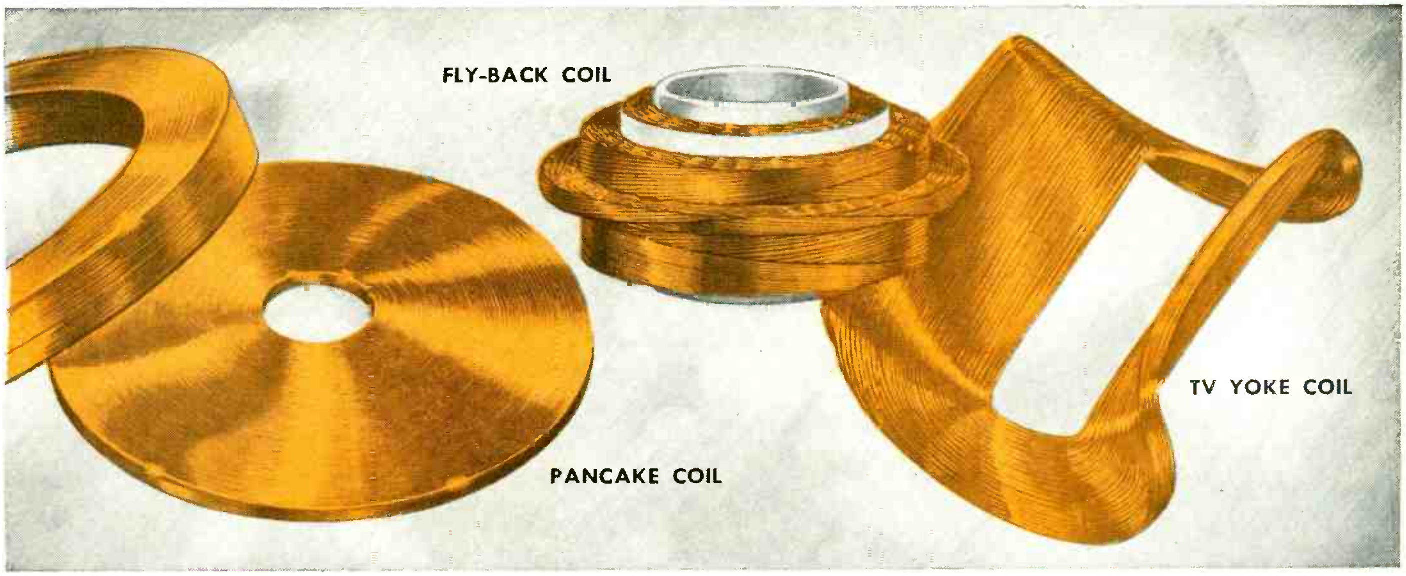
Paper-section, Random-wound, Oil-filled, Air-cooled and High Voltage for distribution, current, X-ray, television, radio and other applications.

MOTORS

Windings for shaded pole, series fields, instruments, induction and others.



First for Lasting Quality—from Mine to Market!



APPLICATIONS!

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

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

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

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

*BONDEZE is a Phelps Dodge Trademark

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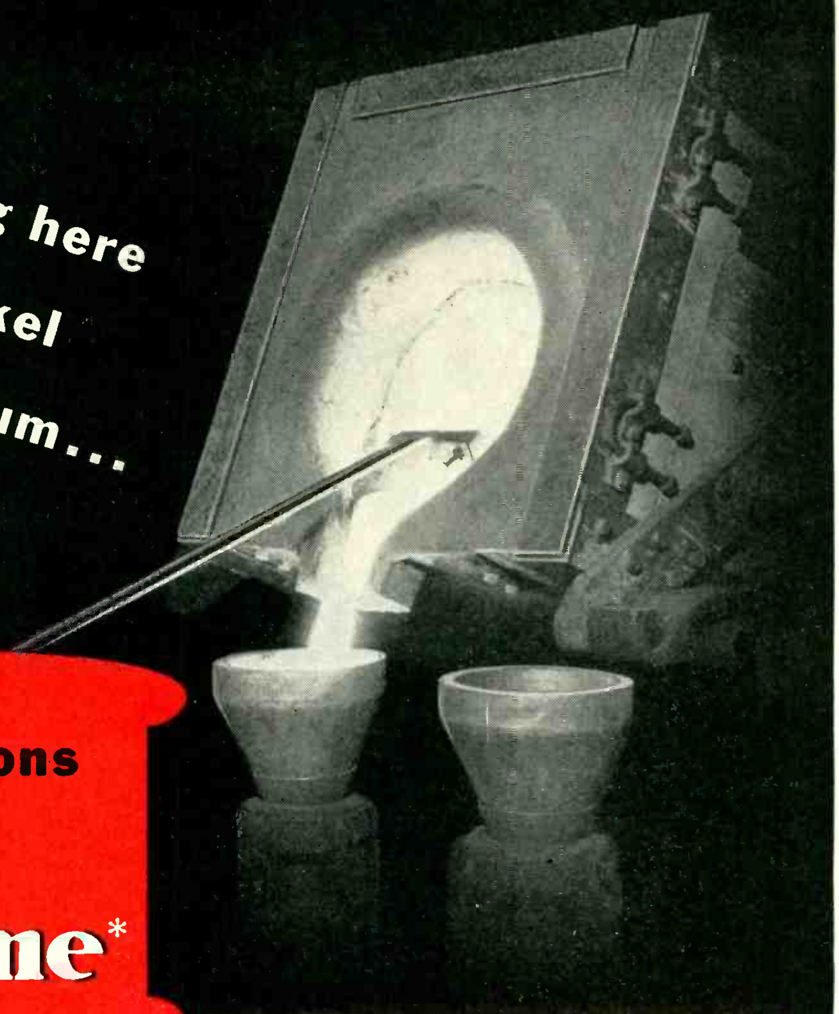
PHELPS DODGE COPPER PRODUCTS
CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

Want more information? Use post card on last page.

Starting here it's mostly nickel and chromium...



127 operations later, it's

Nichrome*

There are several excellent nickel-chrome combinations on the market. But there is only one Nichrome*.

What is it that makes this alloy the universal standard by which engineers judge the properties of heat and corrosion resistance? There is always at least one extra ingredient added to the nickel and chrome. That is . . . the supreme mastery of the Driver-Harris specialists, gained in their 55 years of melting and drawing experience. This hard-won skill of theirs is reflected in improved heating and quenching techniques . . . in specially developed deoxidizing anneals . . . in expert and precise control of every technical process of the entire manufacturing cycle. Sometimes, indeed, there are as many as 127 distinct operations between melting crucible and the finished wire strip, or rod.

In recognition of its unique properties, the United States Patent Office in August, 1908, granted solely and exclusively to us the trademark NICHROME. There is only one Nichrome, and it is produced by Driver-Harris.

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

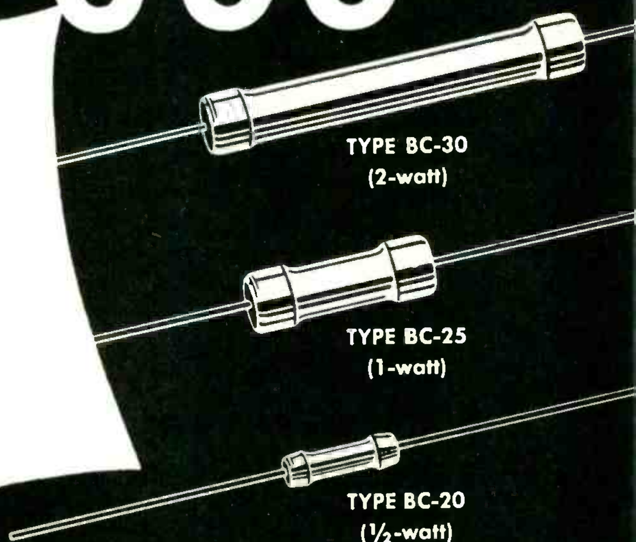
*T. M. Reg. U. S. Pat. Off.

Specify...

Shallcross

Borohm®

BORO-CARBON RESISTORS



TYPE BC-30
(2-watt)

TYPE BC-25
(1-watt)

TYPE BC-20
(½-watt)

STABLE—Typical average change after 1000 hours load life test 0.2%

ACCURATE—Within 1, 2, 5% on all standard types.

LOW T.C.—200 p.p.m. per °C above 20K.
100 p.p.m. per °C below 20K.

RUGGED—Epoxy resin coating remains elastic, cannot crack or chip.

Shallcross Borohm resistors are unusually stable, accurate, and long-lived as a result of Shallcross' basic research on carbon films and manufacturing processes. Complete control of the quality and distribution of the boro-carbon film on specially formulated ceramic rods assures minimum film variation within each unit, as well as from unit to unit.

Automatic machine handling of resistors throughout the carbon deposition process prevents contamination. Rigid automatic control of rod and gas temperatures during deposition eliminates soot formation in the carbon film. Resistance for a given size rod is therefore both predictable and reproducible.

Borohm resistors have negligible voltage coefficient, consistent temperature coefficient, and stability proven by temperature cycling, moisture resistance, and load life tests.

For detailed information as to sizes, styles, ratings, and performance test data results write for the new Shallcross Engineering Bulletin L-33.

1929—Our 25th year—1954

SHALLCROSS MANUFACTURING COMPANY

Representatives in principal U. S. cities, Toronto, Canada, and Vancouver, B. C.

522 PUSEY AVE.
COLLINGDALE, PENNA.

HERE'S WHY . . .

Shielding is a vital element in circuit design, and the Magnetics, Inc. "Performance-Guarantee" on your shields is your assurance that they have been designed and manufactured to meet *your* performance specifications. You then know, whether your shields have been made from Mumetal, A.E.M. 4750, or from any other commercially available magnetic or non-magnetic material selected to meet your needs, they will make money for you on the assembly line by eliminating waste.

You also know that these Performance-Guaranteed Magnetic Shields cost no more—indeed, despite the fact that you have a guarantee of performance, they are sold at prices standard in the industry. Let our Engineering Department design your shields and production engineer to your cost requirements . . . one more important Magnetics, Inc. service to our customers.

How Do You Like Your Shields? . . .

Painted, lacquered . . . or unfinished? Painted . . . to match any equipment shade you select? From *any* commercially available material to meet your performance and cost needs? That's exactly how they're furnished by Magnetics, Inc. . . . to meet *your* specifications.

WANT THE COMPLETE STORY?
Write us . . . on your company letterhead . . . we'll be delighted to answer your questions. No obligation, of course. . . .

MAGNETICS inc.

DEPT. E-14 BUTLER, PENNSYLVANIA

HERE'S WHY . . .

The Magnetics, Inc. "Performance-Guarantee" on molybdenum permalloy Powder Cores is a revolutionary concept in the communications and electronics industries, and opens the way to substantial savings in your production and assembly operations. The guarantee of performance *to your specifications* is your assurance that these Powder Cores are standarized to meet your circuit requirements.

These Performance-Guaranteed Powder Cores cost no more—indeed, despite the fact that you have a guarantee of performance, they are sold at prices standard in the industry. You can't afford not to investigate Magnetics, Inc. molybdenum permalloy Powder Cores.

Keep in Mind These Advantages of Powder Cores . . .

1. Low hysteresis and eddy current losses;
2. High electrical resistivity;
3. Constant permeability over widely varying flux densities;
4. Magnetic stability with dc magnetization.

WANT THE COMPLETE STORY? . . .

Write us . . . on your company letterhead . . . we'll be delighted to send you literature, delighted to answer specific questions. No obligation, of course. . . .

*Manufactured under a license agreement with Western Electric Co.

MAGNETICS inc.

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Want more information? Use post card on last page.

DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

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

Hermetic-Seal, Shock-Resistant Tube Sockets of Kel-F® Polymer Cut Heat, Moisture "Fade-Outs" at High Altitudes

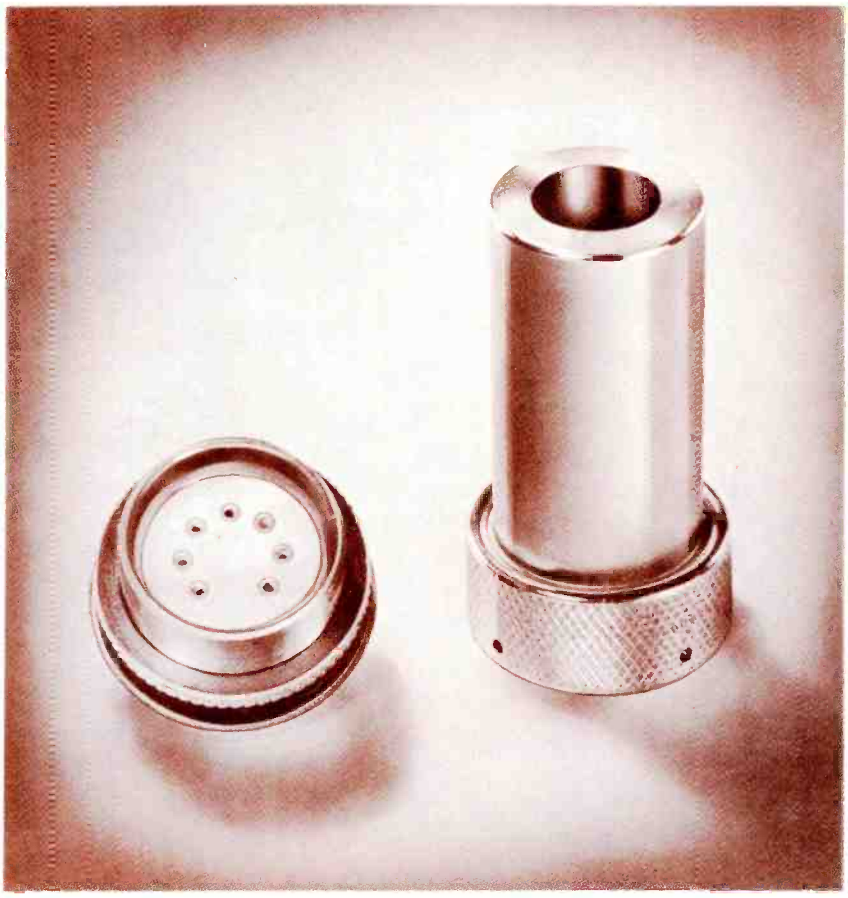
KEL-F polymer plastic, molded into a special metal base permitting complete enclosure of an electronic tube, provides this premium socket with a hermetic seal that defies heavy shock loads, extreme thermal cycling and aging. Tube "fade-outs", due to moisture condensation and collection, are eliminated, tube altitude "ceilings" have been raised significantly.

Positive electrical insulation is maintained under all thermal and moisture service conditions because of the high dielectric strength and low RF loss characteristics of KEL-F polymer.

The high impact and compressive strength of KEL-F polymer helps the socket withstand shock loads up to 100 G's without cracking or chipping of vital insulation.

The Elco Corporation, Philadelphia, Pa., injection-molds the complex socket from KEL-F polymer Grade 300. A metal tube cover with a silicone rubber gasket completes the assembly.

For further information ask for Application Report E-128



Electronic "Memory" Drum Insulated with Kel-F® to Eliminate Carbonization, Wear Damage . . . Extend Service Life

Two obstacles to efficient operation —carbonization shorting and insulation "wiping" onto vital contacts—are eliminated through the use of KEL-F plastic as insulation in this special commutator.

High dielectric strength and heat resistance assure positive insulation under all operating temperature and humidity conditions, prevent formation of carbonization tracks between drum contact points. Zero water absorption cuts moisture "shorts", arcing.

W. S. Shamban & Company of Culver City, Calif., transfer-molded this new commutator of unplasticized KEL-F polymer Grade 300 for use in a special digital-type converter manufactured by Genisco, Inc., Los Angeles, California.

For further information ask for Application Report E-129

(SEE REVERSE SIDE)

® Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

MOLDING POWDERS

KEL-F

FLUORO CHLORO CARBON PLASTIC

KEL-F

DISPERSION COATINGS

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

OILS WAXES GREASES

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

MOLDING POWDERS

KEL-F

FLUORO CHLORO CARBON PLASTIC

KEL-F

DISPERSION COATINGS

KEL-F

TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F

OILS WAXES GREASES

CONTINUED FROM PRECEDING PAGE

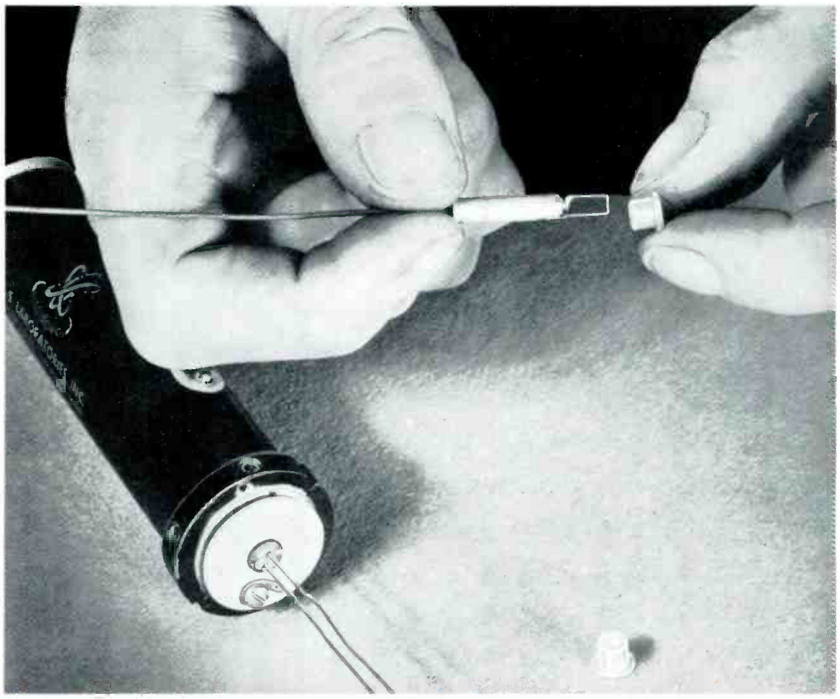
Paper-Thin Insulator of KEL-F® Polymer Solves Space, Precision "Specs" Problem in Microwave Cavity

Found to be the *only* high-frequency dielectric capable of being machined to close tolerances in this .009" thick insulator, KEL-F plastic effectively prevents pulse leaks between cavity and probe. These units, producing hundreds of watts peak power output, depend largely on the insulator for their 0.0005% per °C temperature coefficient.

The fluorocarbon's high dielectric strength over a wide temperature range and its dimensional stability assure complete insulation in the limited space provided. Zero water absorption of this fluorocarbon guards the insulator against any changes caused by moisture.

The precision insulator is machined from KEL-F polymer rod and installed in microwave oscillator assemblies by C.G.S. Laboratories, Inc. of Stamford, Conn. C.G.S. obtains its rod stock from the Resistoflex Corporation, Belleville, N. J. who extrude it from unplasticized KEL-F polymer.

For further information ask for Application Report E-127



Molders & Fabricators of the Month

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

Booker & Wallestead, Inc.

Minneapolis, Minn.
- Injection molding
- Compression & transfer molding (Specialize in short runs)

H & R Industries

Nazareth, Pa.
- Extrusion & injection molding
- Machining & forming
- Rod, tube, tape & strip
- Resistor sleeving

Electronic Wave Products, Inc.

New York, N. Y.
- Sealing of film
- Forming
- Container liners; gaskets

Reiss Manufacturing Corporation

(Rway Synthetic Products Div.)
New York, N. Y.
- Extrusion, compression & transfer molding
- Machining & forming
- Rod, tube & sheet
- Gaskets & diaphragms
- Valve seats

Recent Significant KEL-F Polymer Developments...

Blending equipment is now coated with "baked-on" KEL-F polymer dispersions to eliminate wasteful sticking of special plastics during processing. Chemical inertness and non-stick qualities of coating have cut maintenance and contamination.

Switch seals of the plunger type are now molded of fluorocarbon polymer to provide a hermetic seal that will withstand high altitudes and temperatures.

Valve seats machined from KEL-F polymer rod stock are used in a special valve required in nuclear research. Non-porous, tough plastic effectively keeps active Helium isotope from diffusing through the seat. Low "cold flow" keeps seats smooth and undamaged even after many "high torque" closings.

Covers for high-frequency components are compression molded of fluorocarbon polymer for electrical insulation as well as maximum visibility of contained parts. High impact strength and resistance to aging eliminates need for special protective or reinforcing shields or guards.

OFF THE PRESS . . .

Revised "BUYERS GUIDE" listing KEL-F polymer products, molders and fabricators.

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

Technical Service

CHEMICAL MANUFACTURING DIVISION

THE M. W. KELLOGG COMPANY

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

KELLOGG — SUBSIDIARY OF PULLMAN INCORPORATED

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CROSLEY

COLLINS

Hoffman

Admiral

Magnavox

GREAT NAMES IN COMMUNICATIONS . . .

RELY ON *Midland* CRYSTALS

These companies—and many others in leadership position in the field—depend on Midland crystals for completely reliable frequency control in their products.

THAT FACT IN ITSELF is testimonial enough to the kind of performance Midland Quality Control has built into millions of crystals for every communications use.

Whatever your Crystal need, conventional or highly specialized
When it has to be exactly right, contact

Midland MANUFACTURING COMPANY, INC.
3105 Fiberglas Road, Kansas City, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS

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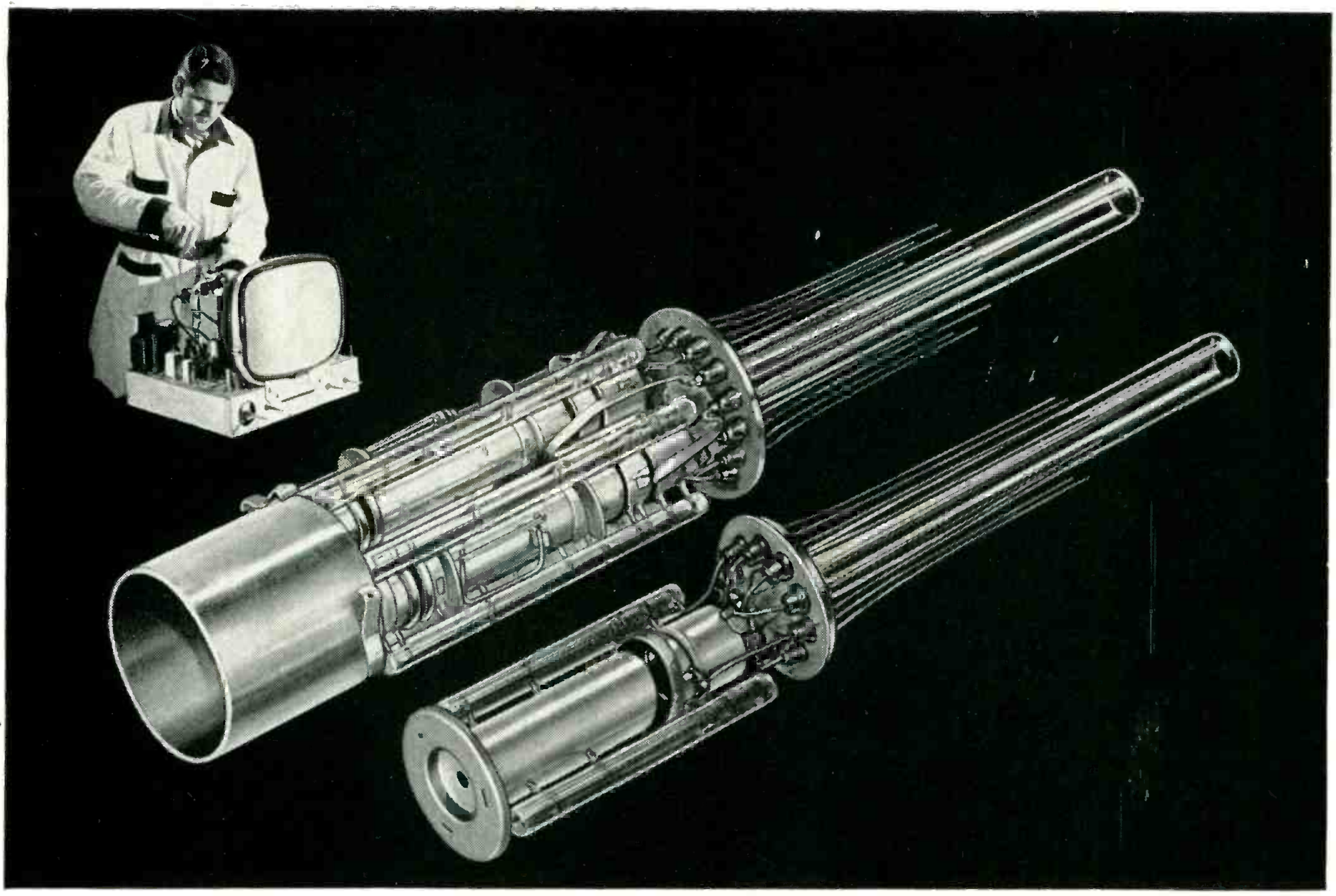


Miniature TV Tri-color cathode gun solves designer's dilemma

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____________________________

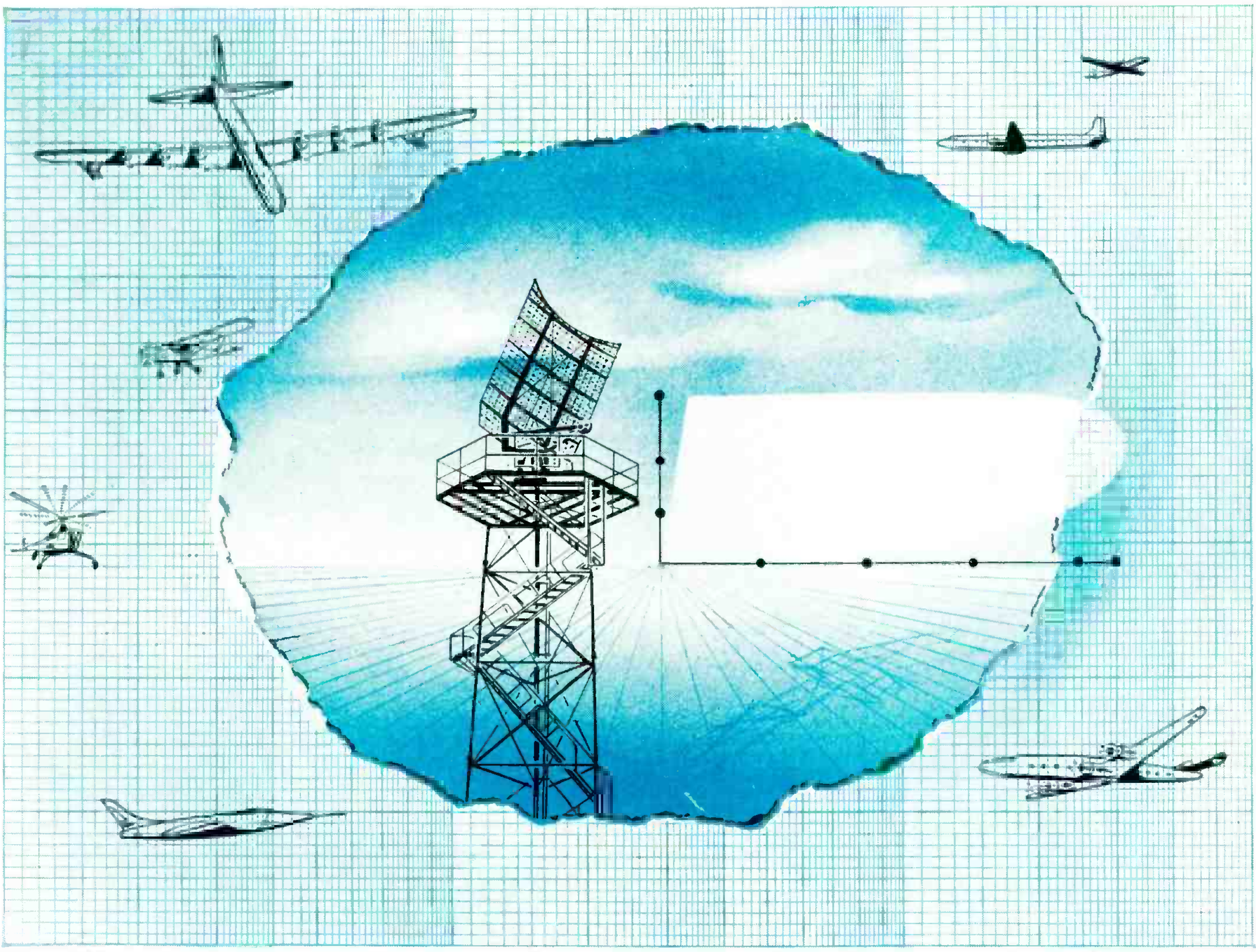
Address____________________________

City________________Zone______State________

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.



Airport "Traffic Cop"

General Electric developed this unique radar system to track, position and control plane traffic with maximum safety.

It provides many advantages over conventional systems. The special shape of the antenna radiates a beam 12,000 ft. vertically and from 30 to 60 miles horizontally, providing control of all planes in proximity to the airport. Within the pattern of this beam all aircraft are easily detected.

The Special Products Division of I-T-E was asked by General Electric to undertake the production, design and fabrication of this antenna to rigid tolerances. Although 10 feet wide and 12 feet high, the finished product deflected only ¼ inch in actual use when covered with ice and subjected to a 90 knot wind.

This is another of the many ways in which I-T-E technology and specialized fabricating background helps solve production problems for industry. Special Products has an experience in a wide variety of fields. Their engineers might have the solution to your problem.

Why not send for Publication SP-100 E-10 today. It shows what has been done to help others.

RADAR ANTENNA SYSTEMS
design, development and fabrication

JET ENGINES
manufacture of major hot-end components

THERMODYNAMICS
design, development and fabrication of equipment to operate on advanced theories

GUIDED MISSILES
advanced fabricating techniques

TITANIUM
proven welding, forging, forming, spinning techniques with this hard-to-work metal

SPINNING
combining spinning and drawing to an almost limitless variety of designs in a wide range of metals

TECHNOLOGY
ABILITY
FACILITIES

SPECIAL PRODUCTS DIVISION

I-T-E CIRCUIT BREAKER COMPANY

601 East Erie Avenue • Philadelphia 34, Pa.

Progress through Problem Solutions

SP 10.4

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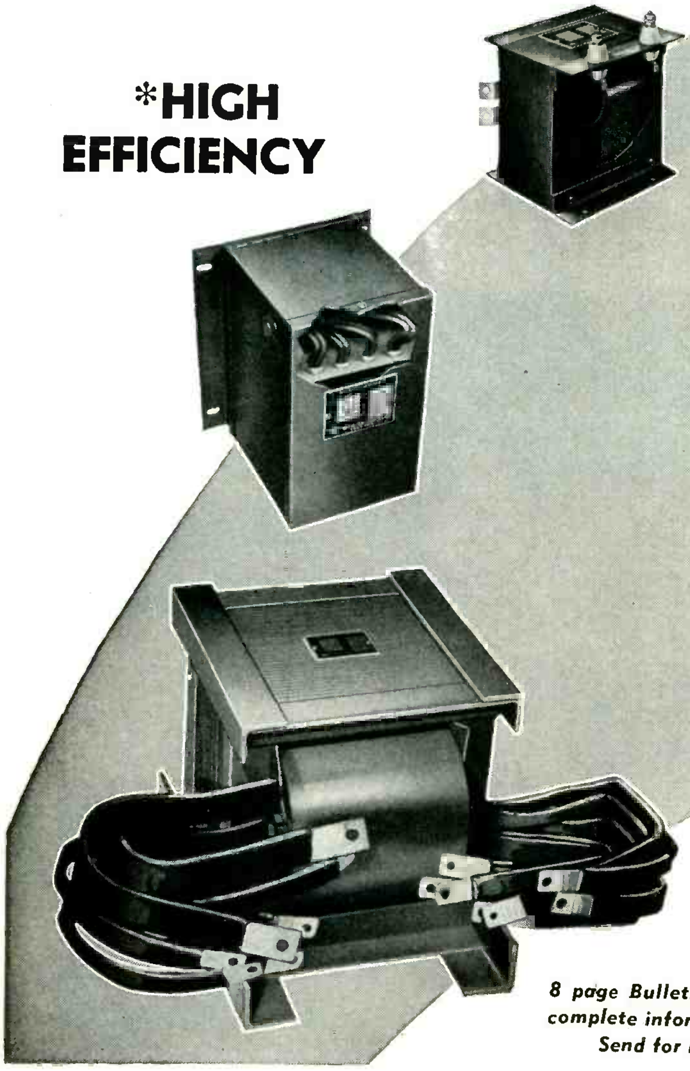
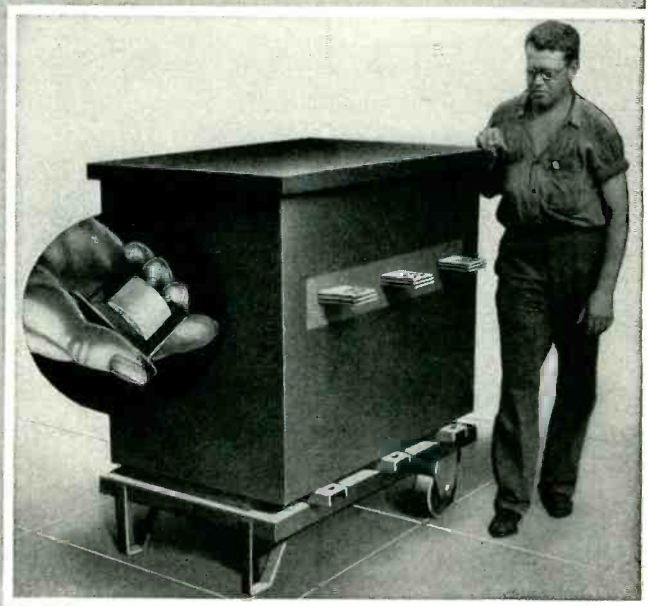
interested in **H-E*?** ...... *send for 8 page Bulletin*

YOU GET *Tops* IN *Transformer* PERFORMANCE

WHEN BUILT BY NOTHELFER

***HIGH EFFICIENCY**





NOTHELFER Transformers are superior because they are vacuum-pressure impregnated, and all joints over 10 amperes are silver-soldered. Bus leads of over 100 amperes are silver-plated, conservative copper and steel.

Laminations, oriented and most silicon steels are annealed in accurately controlled nitrogen atmosphere electric furnaces.

We also manufacture air and iron core reactors, and saturable core reactors.

8 page Bulletin gives complete information. Send for it!

From 10 VA to 300 KVA Dry-Type only. Both open and encased. 1, 2, and 3 Phase. 15 to 400 Cycles.

NWL

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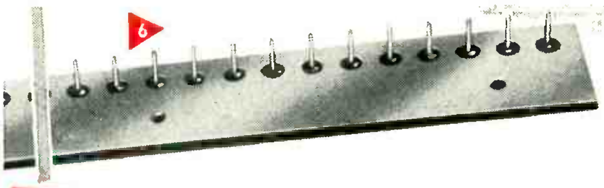
Nothelfer **WINDING LABORATORIES**

9 ALBEMARLE AVE. TRENTON, NEW JERSEY

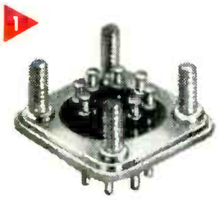
MEMBER

Manufacturers of Electrical Transformers— Testing Equipment

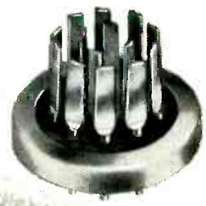
NEMA MEMBER



Get a head-start in mechanical assembly



Let Hermetic's Vac-tite* Headers win part of the race for you with mechanical designs to solve your problems.



Here are just a few Hermetic Vac-Tite* seals that eliminate extra production operations and save you money!

1. **Unit Header with Studs Attached**—Saves space; shaped to fit enclosure or can; eliminates extra welding and soldering operations.
2. **Weld Seals**—Has the proper projections for leak-tight welds.
3. **Lock-Ring "Safety" Seal**—Simple, sure method for installing headers that is not dependent on solder alone for mechanical security; removable.
4. **Threaded Bushing Seal**—Firm mechanical connection has maximum shock and vibration resistance and adaptability for positioning and adjustment.
5. **Taper Tab Headers & Terminals**—Quick, solderless connections adaptable to many applications.
6. **Terminal Strip**—Pre-mounted terminals offer advantages of a conductive surface for heat dissipation, arc-resistance of glass, one piece assembly.
7. **Attached Bracket Seal**—Supports entire assembly on built-in structural member.

Write for engineering assistance, data, prices

SEALED IN by HERMETIC HEADERS

HERMETIC SEAL PRODUCTS CO.

31 South Sixth Street, Newark 7, New Jersey

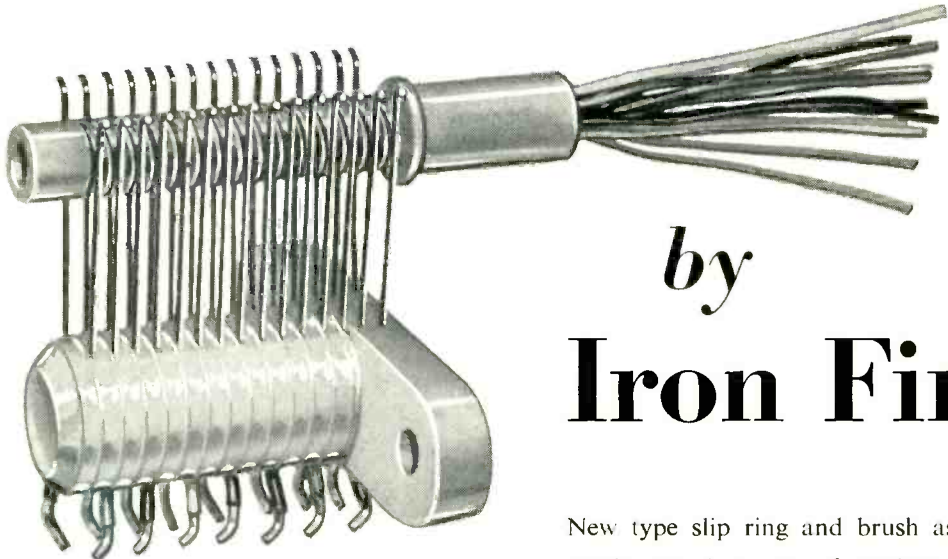
*VAC-TITE is HERMETIC's exclusive vacuum proof compression construction glass-to-metal seal.

FIRST AND FOREMOST IN MINIATURIZATION

Want more information? Use post card on last page.

Miniature

Slip Rings and Brushes



Drawing of typical assembly.

by Iron Fireman

New type slip ring and brush assemblies to meet the precise requirements of modern control systems! Iron Fireman has developed a new production technique which makes possible these improved features:

- ★ Low cost
- ★ Extremely low static and dynamic friction
- ★ High dielectric strength between adjacent circuits
- ★ Multiple circuits in unusually compact assemblies
- ★ Matched color coded leads

Send for informative catalog

This catalog contains complete data on Iron Fireman miniature slip rings and brushes. Write for your free copy today.

TYPICAL APPLICATIONS

RESOLVERS	TORQUERS	TELEMETERS
COMPUTERS	POTENTIOMETERS	SYNCHROS

Custom made to your requirements

We will design and produce slip rings and brushes to meet the exact requirements of your project.

Other Iron Fireman Electronic and aircraft components

Vertical Gyros	Special Motors	Sensitive Relays
Fire & Heat Detectors	High Speed Relays	Choppers

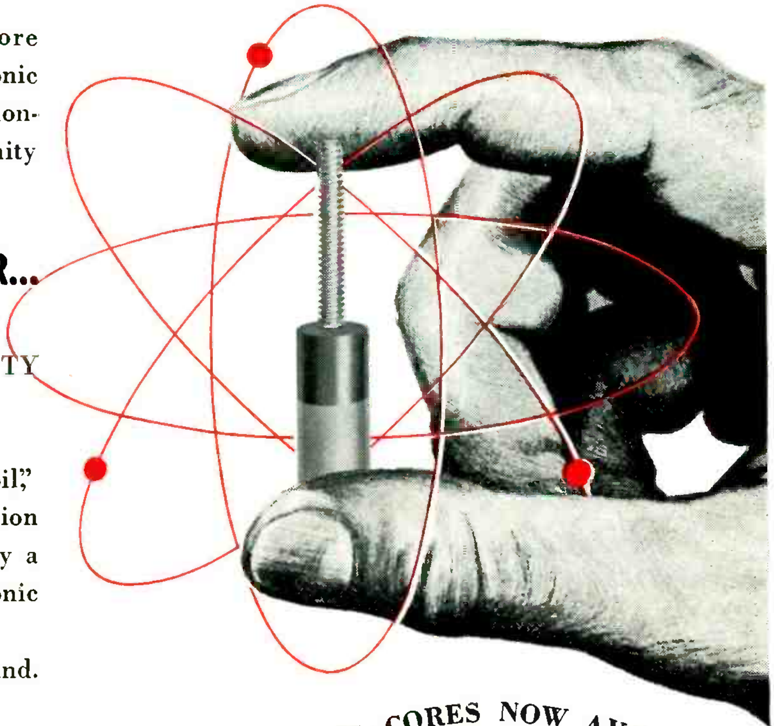
®**Iron Fireman** *Electronics* **DIVISION**

2800 S. E. 9TH AVENUE, PORTLAND 2, OREGON

EVERY ELECTRONICS ENGINEER HAS DESIGNED COILS TO UTILIZE

MOLDITE CORE "STANDARDS"

Consistently dependable, Moldite core "Standards" are in demand wherever electronic engineering requires the finest in precision-manufactured cores with absolute uniformity from first to last.



MOLDITE CORE "STANDARDS" OFFER...

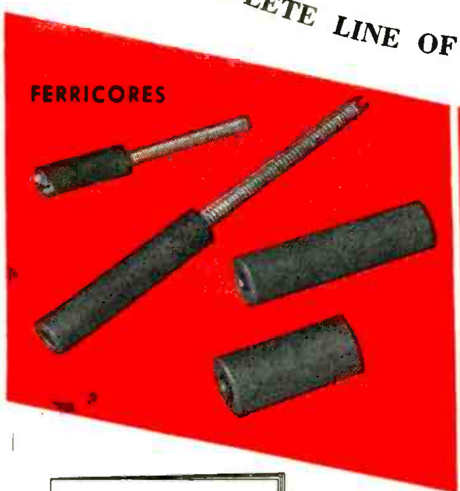
ECONOMY	HIGH QUALITY
AVAILABILITY	INTERCHANGEABILITY
UNIFORMITY	FLEXIBILITY

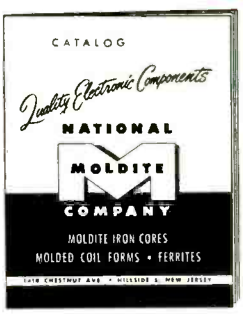
"The right Moldite core for the right coil," is a byword at National Moldite whose precision production facilities have given the industry a superlative core or coil form for every electronic application.

Design with Moldite Core Standards in Mind.

COMPLETE LINE OF MOLDITE ECONOMY-ENGINEERED CORES NOW AVAILABLE

FERRITE CORES
MOLDED COIL FORMS
(iron and phenolic)
MAGNETIC IRON CORES
FILTER CORES
THREADED CORES
SLEEVE CORES
CUP CORES





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THE MOST COMPLETE LINE OF CORES IN THE INDUSTRY!

NATIONAL MOLDITE COMPANY
1410 CHESTNUT AVE., HILLSIDE 5, N. J.

Robert T. Murray 614 Central Avenue East Orange, N. J.	Jerry Golten Co. 2750 W. North Ave. Chicago 22, Ill.	Arnold Andrews 521 Cumberland Ave. Syracuse, N. Y.	Perlmuth-Coleman & Assoc. 1335 South Flower Los Angeles, Cal.	Jose Luis Ponte Cordoba 1472 Buenos Aires

Want more information? Use post card on last page.

COMMON CHARACTERISTICS OF ALL
TYPE 2028B MOTOR GENERATOR UNITS

Pinion Data	10T.96P. 20° P.A.
O.D. of Case	1.000 inch
Overall Length	2 37/64 inches
Weight	5 ounces
Frequency	400 cycles
No. of Poles (Motor)	6
No Load Speed (Min.)	6500 rpm
Rotor Inertia	1.1 gram-cm²

ELECTRICAL CHARACTERISTICS
OF TYPICAL TYPE 2028B MOTOR GENERATORS

TYPE NO.	MOTOR					GENERATOR		
2028B —	EXCITATION FIXED	EXCITATION CONTROL	INPUT PER PHASE	STALL TORQUE	Theoretical Acceleration AT STALL	EXCITATION FIXED	INPUT	OUTPUT PER 1000 rpm
0411110	26	26	2.3	0.4	25600	26	1.8	.51
0412120	26	26	4.0	0.6	38500	26	2.2	.68
0413120	26	26	1.8	0.3	19200	26	2.2	.68
0460600	115	115	4.0	0.6	38500	115	2.6	1.00
0470600	115	P-P	4.0	0.6	38500	115	2.6	1.00
	volts	volts	watts	Oz-n	rad/sec²	volts	watts	volts

OUTSTANDING FEATURES OF TYPE 2028B MOTOR GENERATOR

- New methods of manufacture result in high efficiency
- High torque to inertia ratio to give fast response
- Available for 115 volt -115 volt two phase or single ended tube operation
- High impedance winding for direct plate to plate operation available
- High generator output voltage with excellent signal to noise ratio
- Zero degree phase shift in generator
- All metal parts corrosion resistant
- Extremely wide operating temperature range

a new peak of efficiency in small servo motors

Input per phase only 1.8 watts

A new line of units has been added to the Kollsman "Special Purpose Motors" family combining precision machining, advanced electrical design and the latest in new materials. This new line consists of Induction Motors and Induction Generators supplied separately or combined in a single case one-inch in diameter. The new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators have been designed to give the maximum output voltage with the minimum residual voltage and phase shift.

One of the principal features of the Kollsman "Special Purpose Motors" is the interchangeability of parts which permits numerous electrically different combinations of motor and generator windings within the same case.

Another unusual feature of the new line is the integral gear head unit. Contained within a single case is the gear train and motor; or gear train, motor and generator. Gear ratios as high as 300:1 can be supplied.

Other models of one inch O.D. units

TYPE NO.	DESCRIPTION
2103	Induction Motor
2101	Geared Induction Motor
2131	Geared Motor Generator

kollsman INSTRUMENT CORP.

Latest catalog and/or complete specification drawings will be sent upon request.

80-22 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

Want more information? Use post card on last page.

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.**

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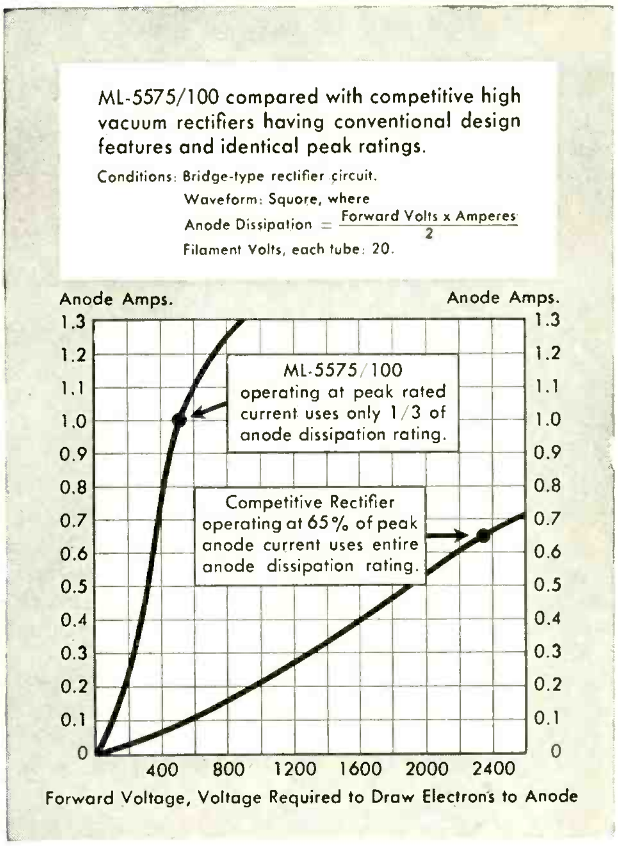

Compare Machlett High Vacuum Rectifier Tubes with any other make

ML-5575/100 operates at 100% of current rating with 300% safety factor for anode dissipation. Competitive high vacuum rectifier tube operating at 65% of peak anode current is at limit of anode dissipation.

Machlett High Vacuum Rectifier Tubes give maximum rectification efficiency and high working load capacity with no increase in anode dissipation requirements, because . . . unique Machlett catenary type filament, eliminating need for electrostatic shielding, gives . . .

Highest Operating Efficiency
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Longest Life

For particle precipitation, chemical recovery, hold-off diode application and general high voltage requirements, a broad range of Machlett High Vacuum Rectifier Tubes are available. Included among the higher power tubes are:

ML-102A	75 PKV, 0.75 max anode amps; 750 watts anode dissipation.
ML-5575/100	100 PKV, 1.00 max anode amps; 750 watts anode dissipation.
ML-5576/200	150 PKV, 2.00 max anode amps; 1000 watts anode dissipation.
ML-199*	110 PKV, 10.00 max anode amps; 1500 watts anode dissipation.

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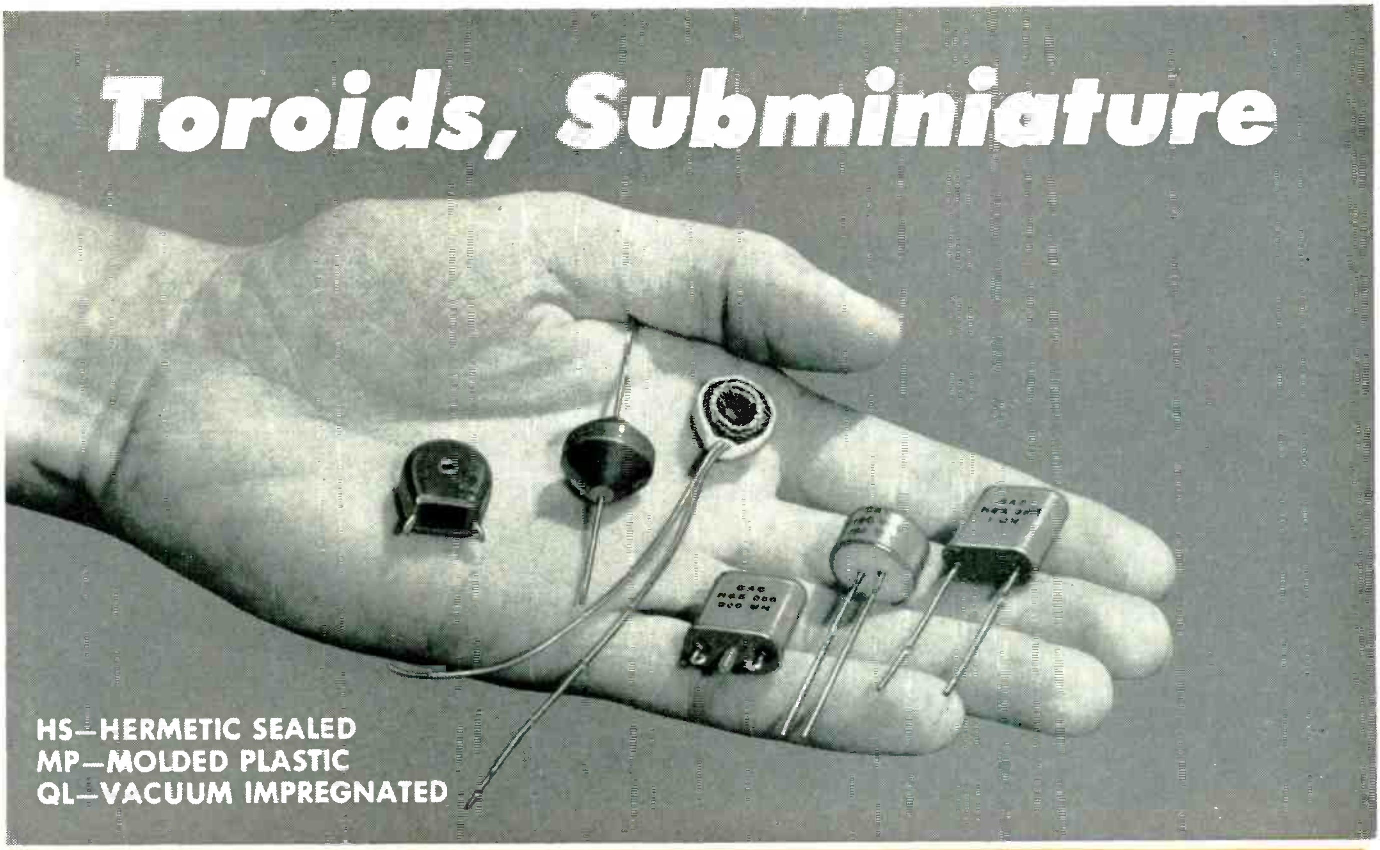

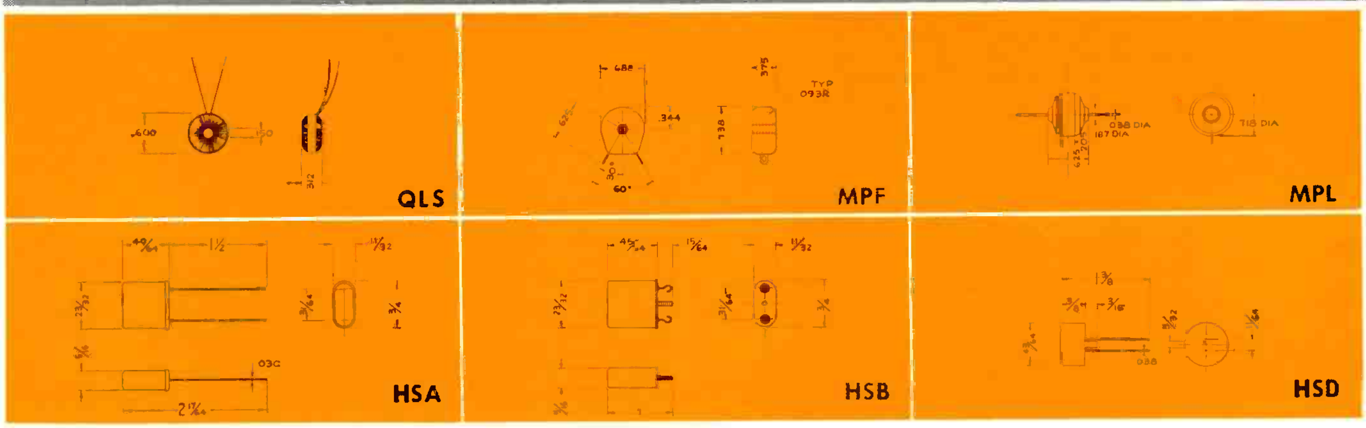

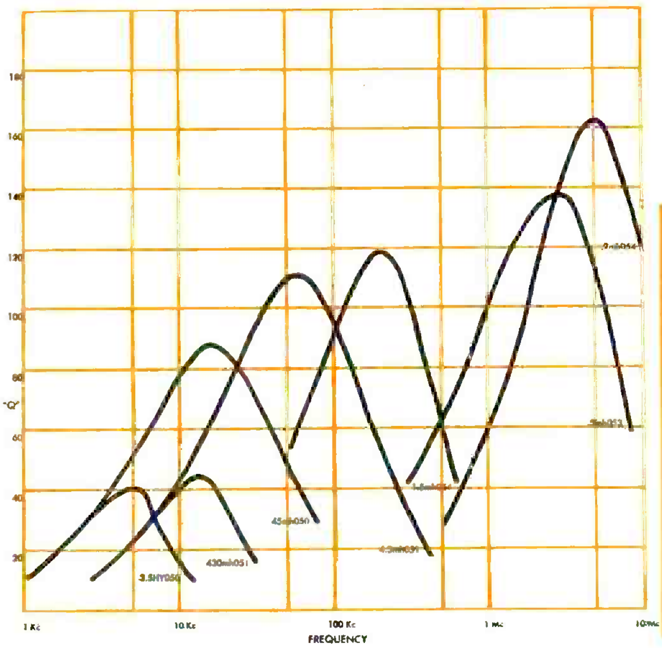

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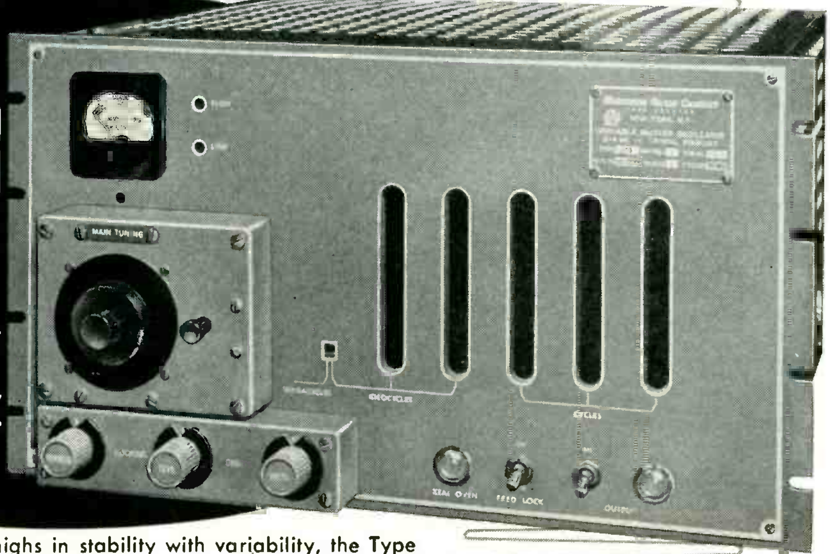

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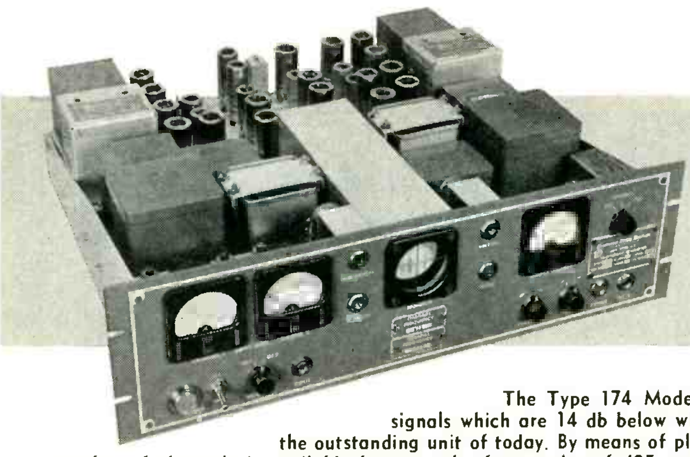
- Long-time stability 1 cycle per megacycle
- Variable to ANY frequency from 2 to 4 mc within 1 part per million

In addition to accomplishing these new highs in stability with variability, the Type 173 Model 1 is so easy to operate that it can be handled by completely unskilled personnel: frequency is continuously displayed.

It is excellent as the basic control oscillator for diversity receivers, HF transmitters, and other communication devices, or as a laboratory standard. It also provides both a crystal-controlled BFO and a time base 100 kc crystal oscillator as a secondary standard; stability of the latter is 1 part in 5 million. The power supply for this model is housed in a separate panel.



NEW! FREQUENCY SHIFT DIVERSITY CONVERTER

- for use with *either* single-receiver frequency diversity systems or two-receiver space diversity systems

The Type 174 Model 1 provides solid copy of signals which are 14 db below white noise level—making it the outstanding unit of today. By means of plug-in units, any reasonable number of channels is available between the frequencies of 425 and 3315 cps for either frequency or space diversity operation. For standard FS operation, the plug-in networks provide shift adjustments from 100 to 1000 cps shift. Normal Input Level: —40 to +10 VU (Zero VU = 1 MW into 600 ohms). Satisfactory operation on fades to — 60 VU.

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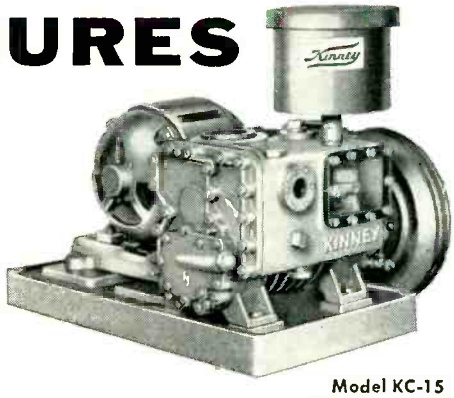
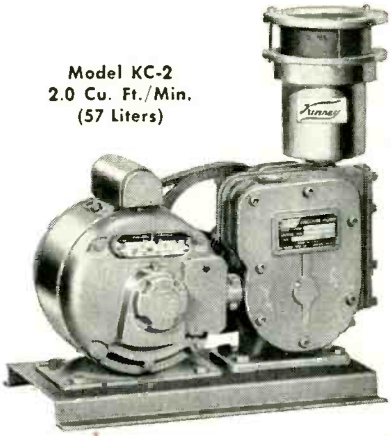
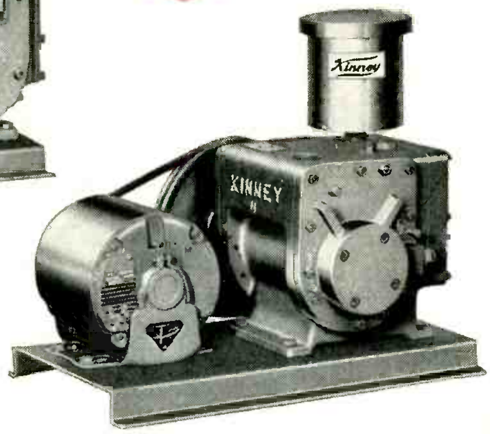


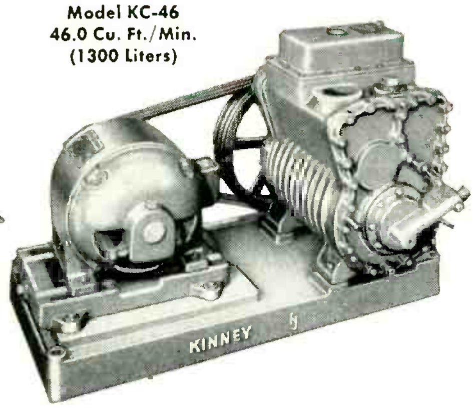
Model KC-15
15.2 Cu. Ft./Min.
(430 Liters)



Model KC-2
2.0 Cu. Ft./Min.
(57 Liters)



Model KC-5
4.9 Cu. Ft./Min.
(140 Liters)



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46.0 Cu. Ft./Min.
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Kinney Compound Vacuum Pumps produce low absolute pressures of 0.2 micron (McLeod) or better completely unassisted. They are quick starting, high pumping speed units, designed to answer every requirement of the laboratory or pilot plant. All four of these pumps can be effectively ***gas-ballasted*** for handling water-vapors.

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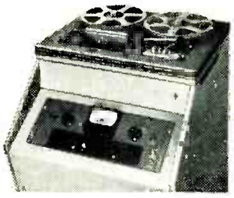
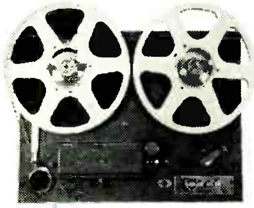


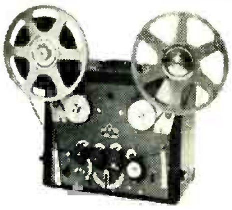
NEW PRESTO SR-11

Complete studio console tape recorder. Never before so much quality, operational ease and value at such a modest price. Embodies the famous PRESTO R-11 tape mechanism, matching amplifier — power supply in sturdy well-designed console cabinet. Three motors for complete flexibility; 15" and 7½" per sec. speeds.



PRESTO R-11

A tape recording mechanism of truly modern design in engineering and operation. Mechanism includes three-head assembly, solenoid operated brakes and employs the exclusive Capstan drive unit. Tape reels mounted directly on heavy-duty torque motors.



PRESTO R-7

Rugged, portable tape recorder with separate recording, reproduction, and erasing heads. Built around a sturdy, three-motor drive eliminating friction clutch, the RC-7 contains the same high-quality components found in PRESTO'S fine studio equipment. Heavy-duty construction throughout.

PRESTO PB-17A

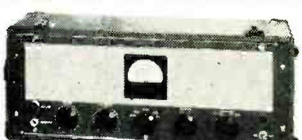
Reliable, long-playing tape reproducing mechanism. Automatically reversible for continuous playback for background music in eight hour cycles. Frequency response uniform from 50 to 8000 cps. Tape speed: 3¾" per sec. Reels up to 14" diam. (4800' of tape) with dual track.

PRESTO 900-A

Precision tape amplifier for portable use or rack mounting. Composed of individual record and reproduce (monitor) amplifiers on a common chassis; separate power supply; three-microphone input, 250 ohm low level mixer; illuminated V.U. meter. Output of reproduce amplifier. 500 ohms, plus 20 db maximum. May be used with any model PRESTO tape recorder.

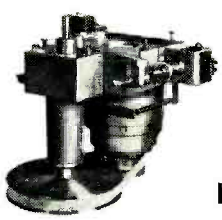
PRESTO TL-10

Turntable-driven tape reproducer. Unique, low-cost unit that adapts any 16" turntable for reproduction of tape at 7½"/sec. or 15"/sec. with exceptional accuracy. No pre-amplifier required; plugs into standard studio speed input equipment.



PRESTO A-920

More compact than the 900-A. In carrying case or for rack mounting. Consists of microphone preamp, a reproduce preamp, power amplifier and power supply — all on a common chassis. Two small speakers mounted behind front panel for playback. Single mike input: 250 ohms. Playback output: 15 ohms, 10 watts.



PRESTO CDR-200 CAPSTAN DRIVE UNIT

Heart of all Presto tape recorders and reproducers. Motor, capstan and flywheel, pressure pulley and pressure pulley solenoid are mounted on independent cast aluminum chassis. Positive, very quiet tape drive with minimum of parts.

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Response is zero to 5000 cycles on the Ampex 306
100 to 100,000 on the Model 307
and 0 to 70,000 on the Ampex 311.

MORE CHANNELS AT ONCE **hundreds, if desired**

Up to 14 parallel tracks are standard
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Magnetic data is convertible to oscillograph traces,
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Tape has recorded accurately in rough riding
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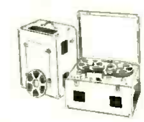
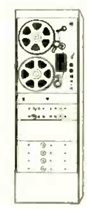
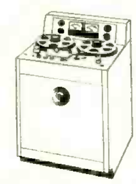
Ampex was first to build tape recorders for data and control — has accumulated broadest experience in their application — and today builds more types than any other manufacturer.



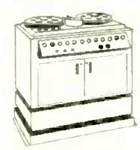
Model 303 — Pulse width data, hundreds of low-frequency channels simultaneously.



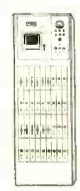
Model 306 — 0 to 5000 cycles, high instantaneous accuracy by FM-carrier technique.



Model 307 — 100 to 100,000 cycles, direct recording system.

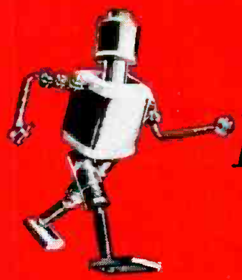


Model 500 — Most stable tape motion ever achieved, 100 to 100,000 cycles.



Model 700 — Seismic drum type, 26 tracks.

Specialized and combination recorders — Numerous other specialized and combination types have been developed by Ampex under government and private contract. This wide variety of experience is available to help solve your special instrumentation problems.



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Why let lack of adequate coil winding machinery cost you money — in lost production and higher operation and maintenance expenses? Universal's two new Pay-As-You-Profit Plans provide the benefit of modern coil winding machines — without jeopardizing cash, capital position or borrowing power. Take your choice of two Plans.

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Advantages of Plan I include:

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Advantages of Plan II include:

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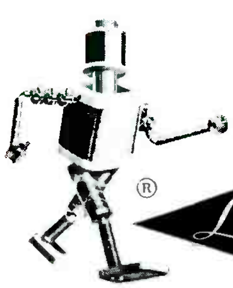
Take advantage of the Pay-As-You-Profit Plan that best meets your needs. Contact your Universal Representative or write direct to UNIVERSAL WINDING COMPANY, P. O. Box 1605, Providence 1, R. I., or 9 South Clinton St., Chicago, Ill.



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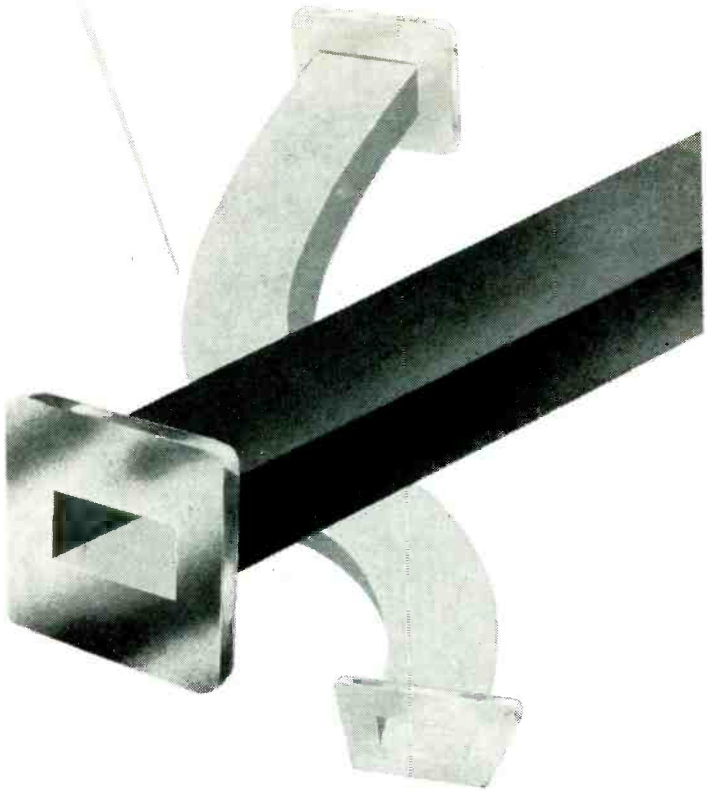

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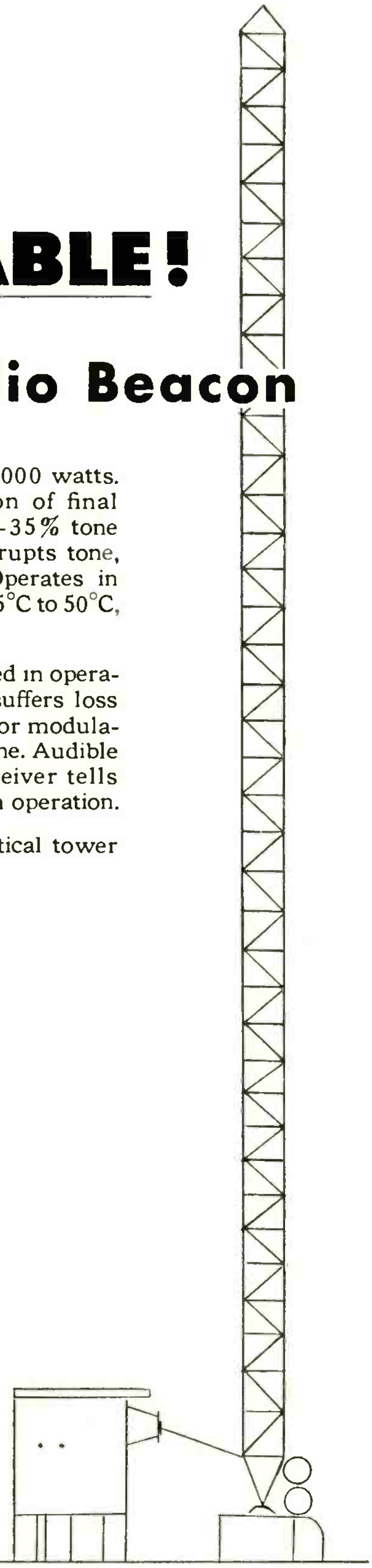
Aerocom's Dual Automatic Radio Beacon



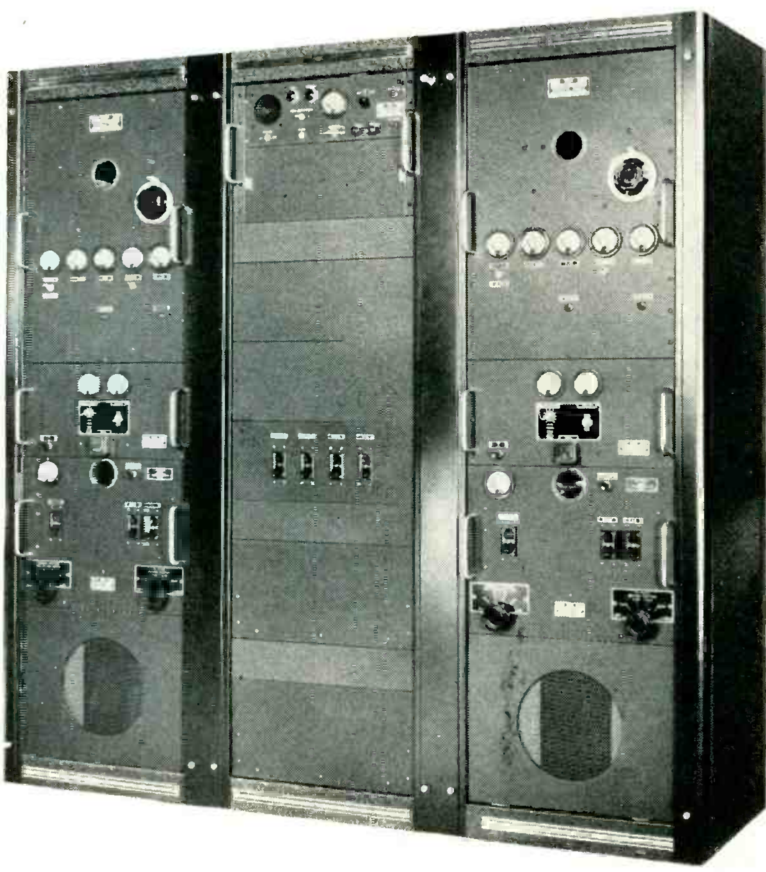
Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with keyer (2 keyers if desired), automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate standard rack cabinet, with controls in rack cabinet between the transmitters.

Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, giving 30%-35% tone modulation. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from -35°C to 50°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.



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Now you can get terminals especially designed to meet the new MIL-T-27 Twist Test *right from stock*, for *immediate* delivery. Heldor's four types of lock-in terminals lick "twist test" troubles . . . they can't turn, twist or loosen. They can be revised to meet your special requirements. They incorporate the basic advantages of *all* Heldor Bushings, *plus* increased electrical insulation due to an increased length of steatite.

Use them with Heldor Cans and Covers. You'll effect further and very substantial economies when you avail yourself of Heldor's complete "package" — cans and covers with these new Lock-In terminals already installed, and the final assembly and hermetic sealing of your components in the cans.

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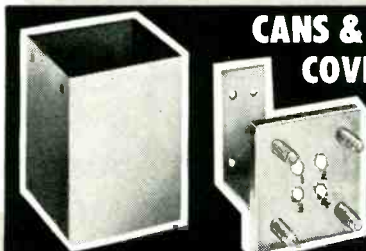

built to meet MIL-T-27 and Commercial Specifications.

Write today for samples and prices based on your requirements!

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238 Lewis Street • Paterson, N. J.

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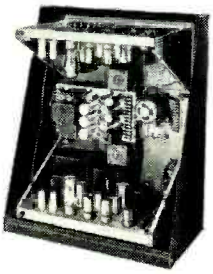
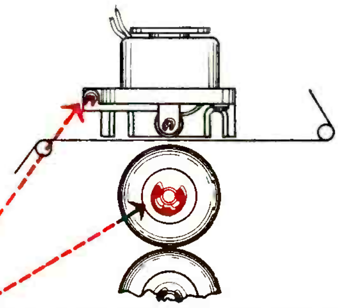
Potter's New Digital Magnetic Tape Handler



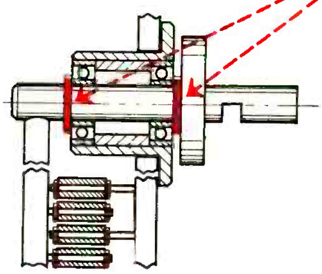
■ Prime requirements: fast starts, fast stops, fast tape speeds, great accuracy. Using Truarc rings, this new model starts and stops the tape within 5 milliseconds, has tape speeds up to 60 inches per second.

Solenoid Mount and Capstan Assembly



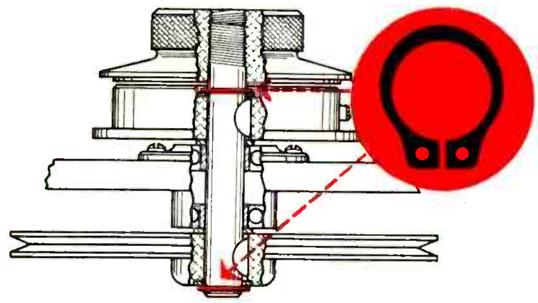
■ Miniature Truarc E-Rings on .040 diameter shaft and on continuously running capstans eliminate projecting bolts and screws. Rings permit rapid assembly and disassembly, fast replacement of worn rubber capstans.

Tension Shaft Assembly



■ Truarc E-Rings snap quickly into place, act as shoulders for the ball bearings with a minimum of friction. Additional Truarc Rings are used as spacers on shafts, can be located accurately to extremely close tolerances.

Reel Shaft Assembly

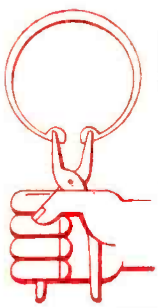


■ Truarc Standard Rings (Series 5100) hold the reel shaft assembly firmly in place and permit the use of quick-lock hubs so that the reel tapes can be changed in seconds as they are finished.

Potter Instrument Company, Inc., of Great Neck, L. I., uses 30 Waldes Truarc Retaining Rings in their new Model 902 High Speed Digital Magnetic Tape Handler. In addition to solving a variety of fastening problems, Truarc Rings facilitate the rapid acceleration and fast stopping needed in these machines.

Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Truarc Rings are precision engineered, quick and easy to assemble and disassemble. They save time and increase operating efficiency.

Find out what Waldes Truarc Retaining Rings can do for you, toward saving costs and improving your product. Send your blueprints to Waldes Truarc Engineers for individual attention without obligation.



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WALDES

TRUARC

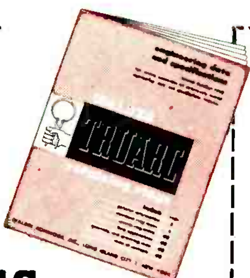
REG. U. S. PAT. OFF.

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; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING

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



E106

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* ....

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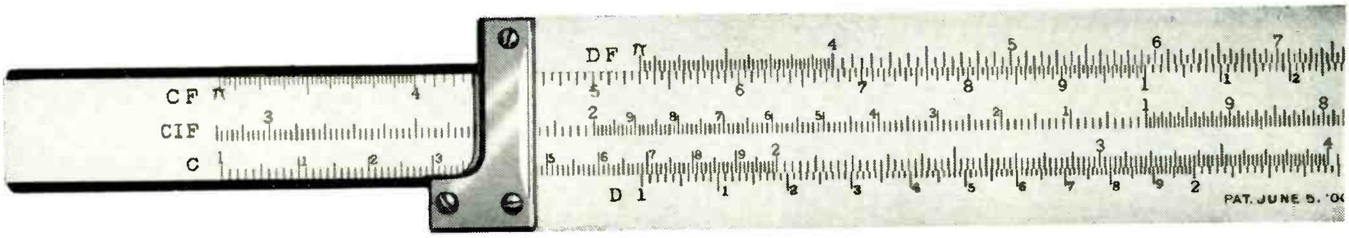
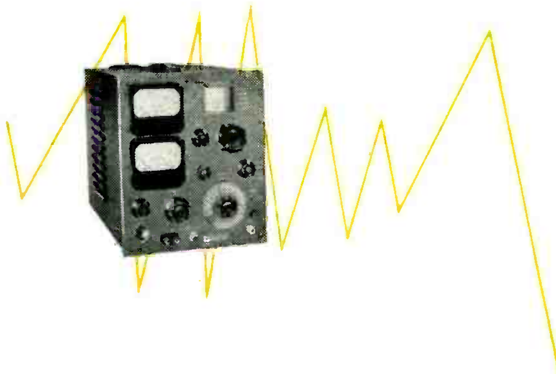
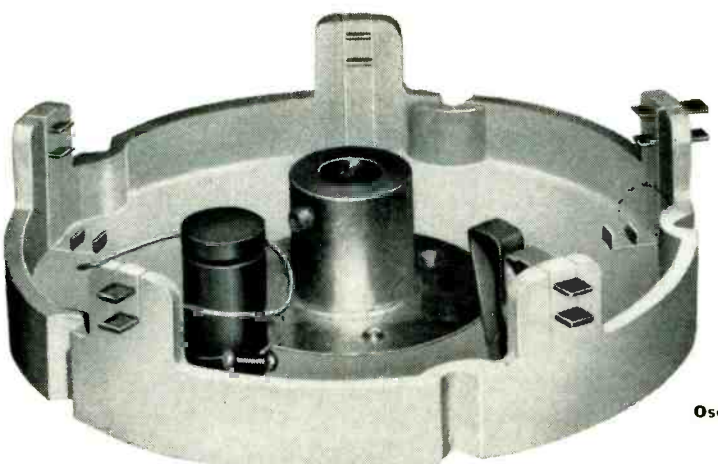
Where precision is essential...





industry turns to PLASKON® Alkyds



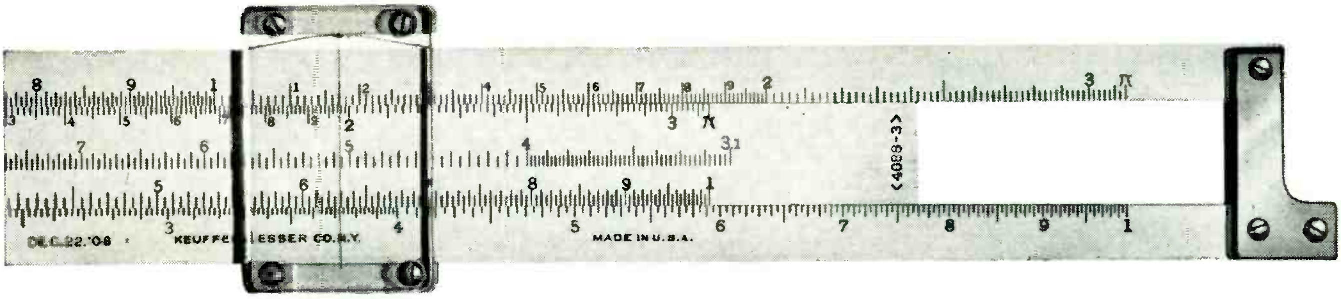
Oscillator Turret

THE HEWLETT-PACKARD COMPANY of Palo Alto, California, as a manufacturer of electronic equipment, has found that PLASKON Alkyds molding compounds can and do meet all of their exacting specifications!

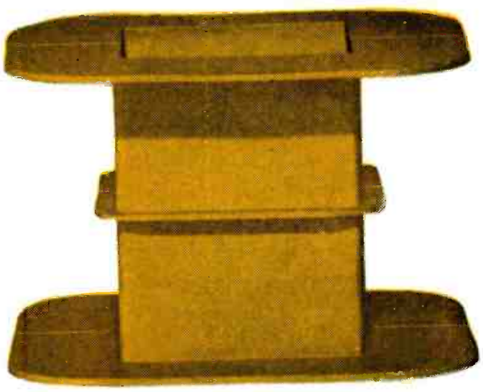
In the VHF Signal Generator pictured above, for instance, a material was needed that could guarantee *absolute* dimensional stability to a component part, thus assuring the instrument's unfailing accuracy. It had to be strong enough to hold silver inserts without loosening during a life of 50,000 cycles. It had to have a low coefficient of thermal expansion, be readily molded and offer high resistance to heat and arcing.

According to Hewlett-Packard, glass-reinforced PLASKON Alkyd molding compound is "the only plastic that met all our requirements." In other instruments, H-P has had equal success with PLASKON Products using both mineral-filled and glass-reinforced alkyds.

We pass this "success story" on to you, with the thought that what PLASKON Products can do for others, they can do for *you* too.



1. Transformer Terminal



2. Transformer Bobbin

3. Probe body Insulator

4. Coil Case

"PLASKON Alkyd molding compounds' fast cure has cut our costs considerably," says Ralph E. Lee, production engineer at Hewlett-Packard. "We also get appreciable savings by molding parts such as probe body insulators which formerly had to be machined. PLASKON Alkyd molding compounds' outstanding electrical properties result in higher quality for our components too."

1. PLASKON Alkyd molding compounds give these transformer terminals high insulation and moisture resistance.

2. Transformer bobbins have high strength, even when walls are molded as thin as .040".

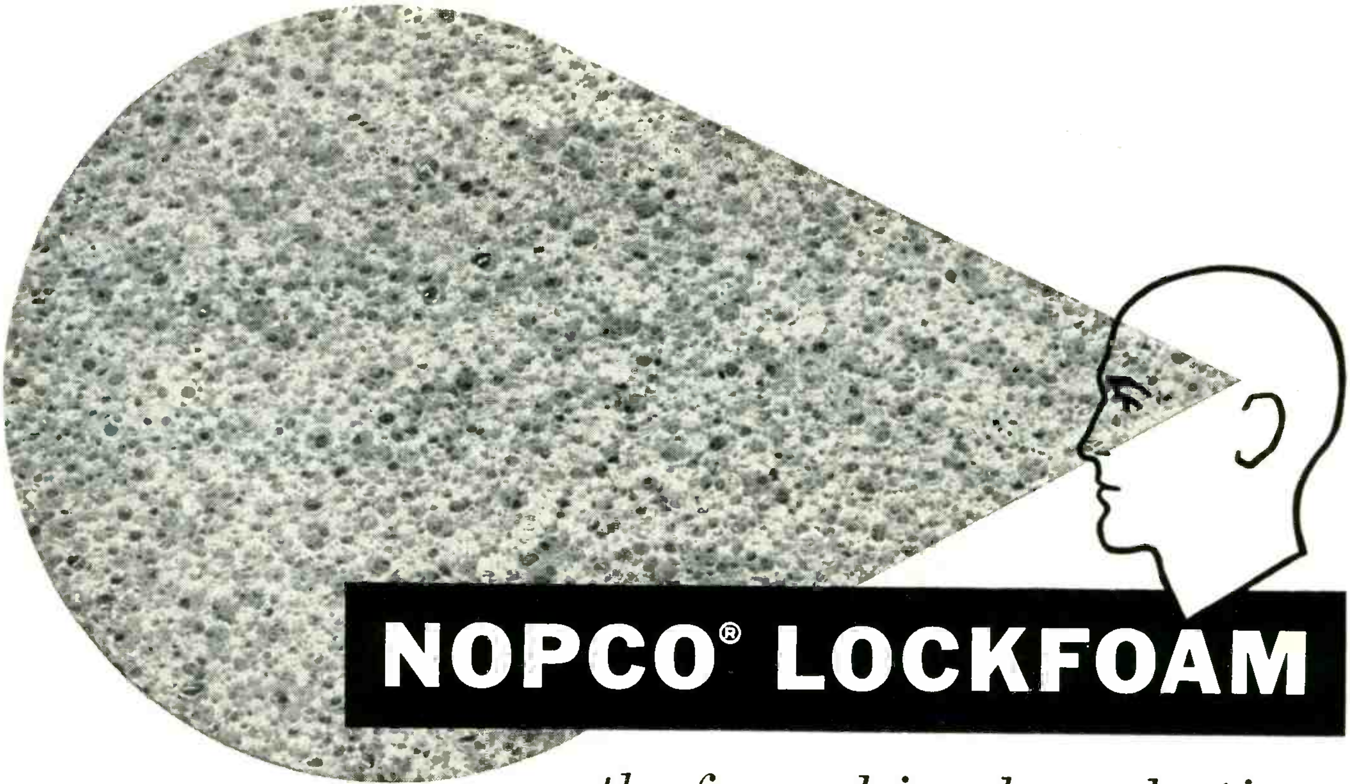
3. Probe body insulator has a resistance of at-least 100,000 megohms between terminals, with dimensional stability over long periods at 150°F.

4. Through using PLASKON 422 Alkyd molding compound H-P cuts costs by building only one cavity mold for coil cases instead of many.

Barrett PLASKON®

For further information on PLASKON Plastics and Resins address BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector St., New York 6, N. Y. Hanover 2-7300

Allied Chemical



NOPCO® LOCKFOAM

...the foamed-in-place plastic that places no limits on your ingenuity!

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

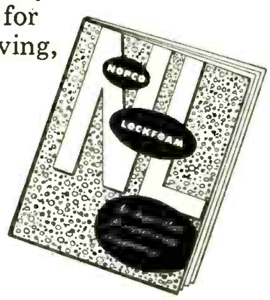
Good Thermal Insulation
"K" Factors
.018 at 8 lb/cu ft
to .025 at 11 lb/cu ft

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

Great Versatility
50 different formulations
available

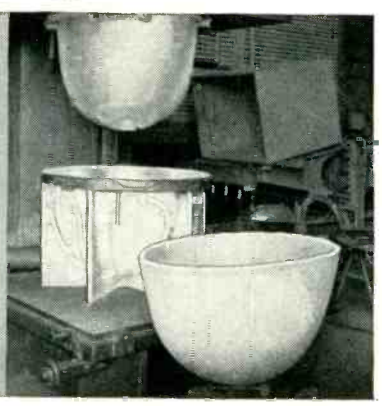
The magnificent range of physical and electrical properties of Nopco Lockfoam—plus its unique pour-in-place versatility and convenience—is rapidly finding many applications in electrical and electronic manufacturing, as well as in aviation.

For Nopco Lockfoam literally "goes where you want it"—fills exactly the configurations of any cavity into which it is poured. It is ideal for fabricating lenses for electronic devices. It is ideal as a space-saving, vibration-free potting material for holding electrical components of circuits in a fixed position. It is sure to find many other practical uses.



You'll surely want the full story. Write today for the Nopco Lockfoam booklet.

AIRPLANE RADOMES, for both military and civilian planes, are but one of the first conspicuous uses which have taken advantage of Nopco Lockfoam's excellent electrical properties, its strength/weight ratios, and the simplicity and economy resulting from its pour-in-place technique.



Plastics Division
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CHEMICAL COMPANY
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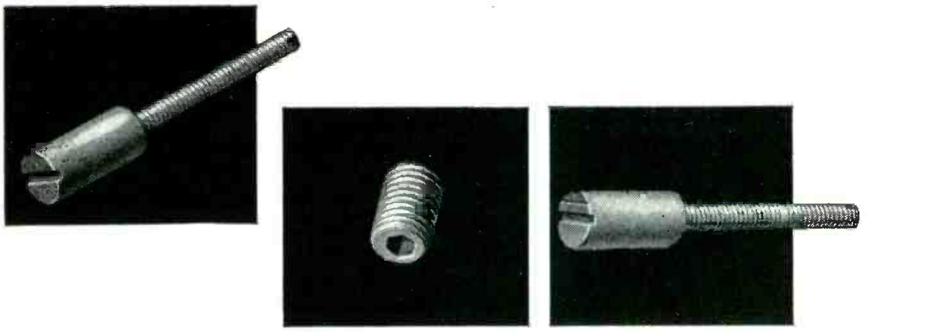
NOPCO
TRADEMARK
EVOLVED THRU RESEARCH

NEW LOS ANGELES BRANCH. To aid West Coast manufacturers with complete field service on Nopco Lockfoam, our new office at 4858 Valley Blvd., Los Angeles 32, is now ready to serve you. Drop in and get acquainted, or write.



CUT IRON CORE COSTS

with Stackpole "PREFERRED TYPES"

"EE" SERIES... FOR ENGINEERED ECONOMY

Made to well-known Stackpole quality standards, these new "EE" Cores are available only in commonly needed grades and sizes. They're ready for delivery from stock . . . at low prices . . . and without the usual set-up charge for custom-engineered cores. Mechanical specifications conform to the latest MPA recommendations. Electrical standards fully meet 8 out of 10 requirements of radio, TV, and communications equipment. Write, wire, or 'phone for details.

Electronic Components Division

STACKPOLE CARBON COMPANY
St. Marys, Pa.

STACKPOLE

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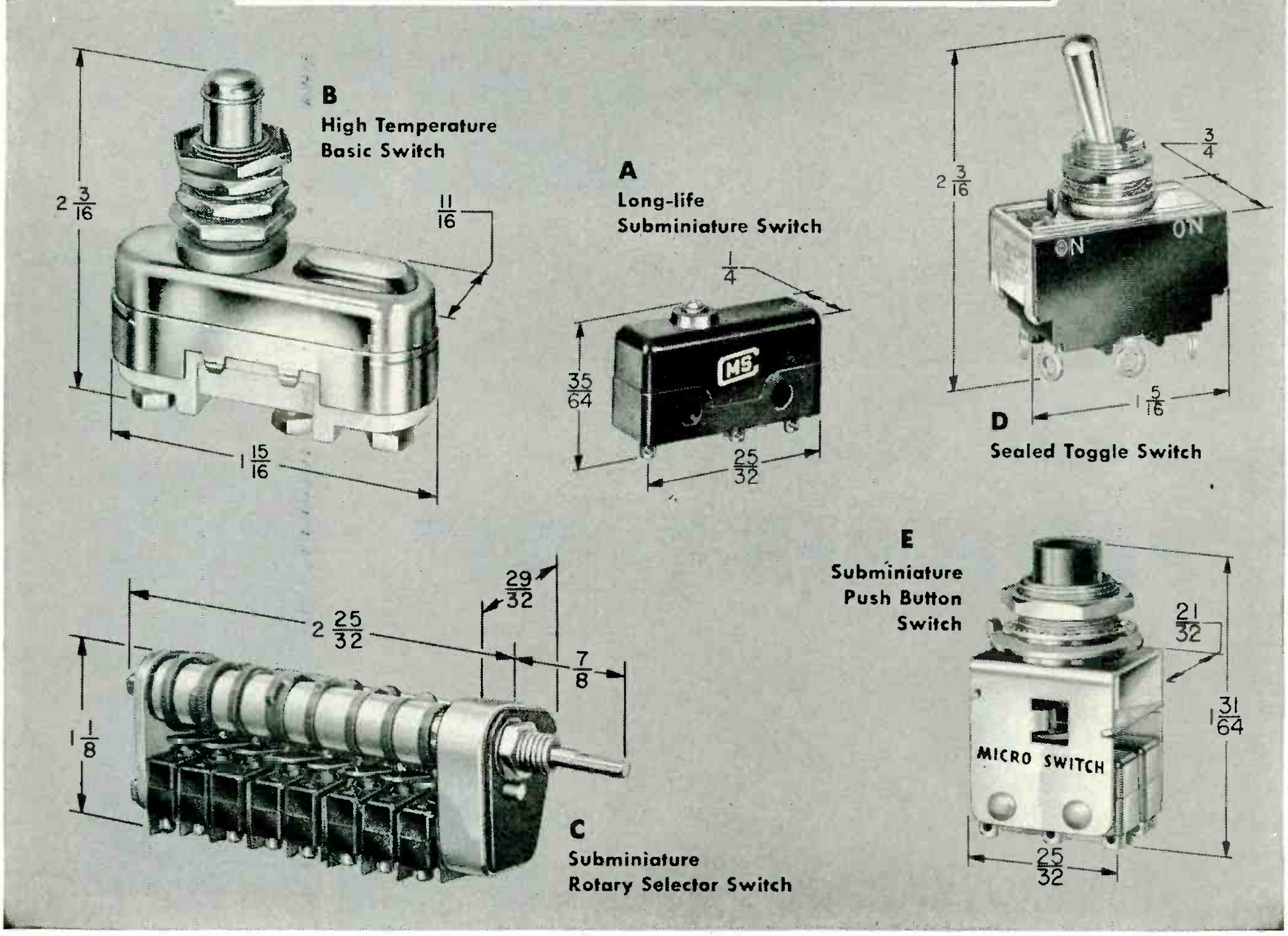
MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN



There are uses unlimited for these small MICRO SWITCH precision switches in electronic devices and instruments

A This subminiature switch is capable of operations in excess of 20 million. It is an improved type of the basic subminiature switch and is available with either solder post or turret type, wrap-around terminals.

B The high temperature basic switch will operate satisfactorily in a temperature range of from $-50°$ to $+1000°$F. Originally designed for jet aircraft applications, it is equally useful for any application which requires a high-temperature switching component.

C The subminiature rotary selector switch uses from 2 to 8 single-pole, double-throw subminiature switches to control from 2 to 16 electrical circuits. It permits 2 to 8 switching positions with spring or manual return to neutral position.

D This sealed toggle switch is supplied with an external panel seal and an internal bushing seal below the bat handle. It has a bushing for panel mounting and may also be supplied with keying tab.

E The subminiature push button switch assembly is composed of two single-pole, double-throw subminiature switches. The plunger provides an unusually good snap make and break. Available with red or black plastic buttons and either solder post or turret-type, wrap-around terminals.

MICRO SWITCH *engineering service, fully experienced in every type of switch use, is available at 16 branch offices to consult with you on your switch application problem. A call to the branch office near you may save time and money. There is no obligation.*

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

MICRO SWITCH
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
FREEPORT, ILLINOIS

Military Equipment Designers:

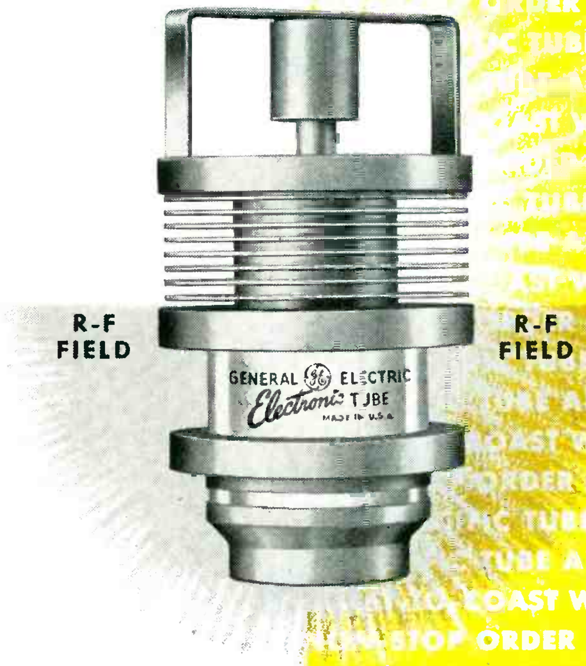
GET POWER GAIN 10-to-1 AND UP WITH GL-6283 U-H-F TETRODE!

Wide frequency range a feature!
Tube will operate anywhere between low audio bands and 900 mc at full input—above 1,000 mc at reduced input.

GET 150 w of useful CW power—*dependably,* with 300 w plate dissipation to back up performance! Apply this output, as oscillator or amplifier tube, *at any frequency* from kilocycles up to 900 mc! Type GL-6283 meets both these design needs . . . does so efficiently, with a 10-to-1 or better power gain (depending on the circuit) that spells real economy.

Forced-air-cooled; compact; easy to plug in or remove—these are GL-6283 installation advantages. The tube is ideal for voice-communication transmitters . . . coded-communication transmitters which control pilotless planes and guided missiles . . . other military circuits calling for a tube with low-to-medium power that's versatile, efficient, and rugged.

G-E Tube Design Service developed the GL-6283 with *your* power needs directly in mind. Full ratings, performance curves, and descriptive facts will be rushed on request. Wire or write *Tube Department, General Electric Co., Schenectady 5, N. Y.*



R-F EFFICIENCY IS *DESIGNED IN!*

Note how radiator area of G.E.'s GL-6283 is completely external to r-f field (terminals and tuned circuitry) . . . so that the r-f paths are short and uninterrupted.

- ★ Gives a DEPENDABLE 150 w of useful CW output.
- ★ 300-w plate dissipation means extra margin of operating safety.
- ★ Forced-air-cooled for convenience. Only 23 cu. ft. per min. required.
- ★ Installs in seconds. Just grasp tube by handle and lower into cavity.
- ★ Wide areas for spring-finger contacts assure good electrical connections.
- ★ Compact—less than 2½" wide, 4½" high. Weighs approx 1 pound.
- ★ Sturdy, shock-resistant, with strong internal supporting members.
- ★ Long-lived. Durable ceramic construction; high-efficiency ceramic-to-metal seals.

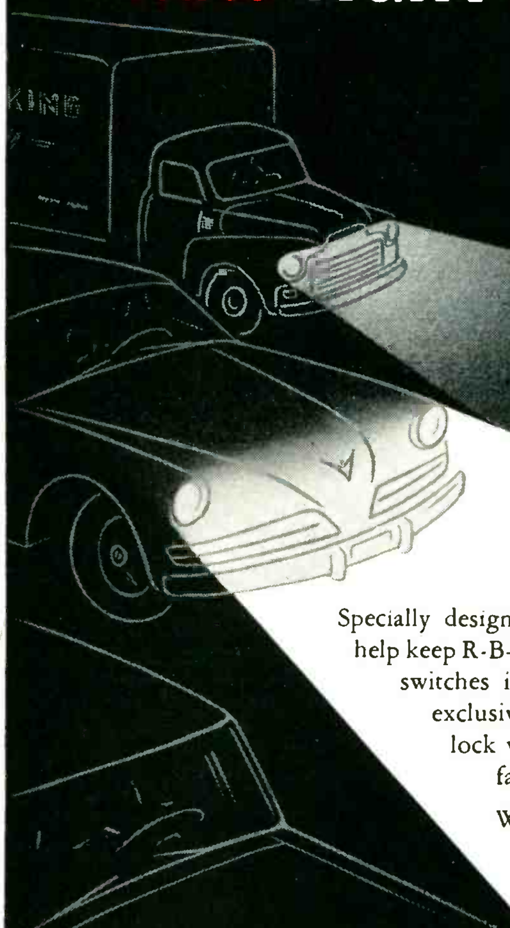
Progress Is Our Most Important Product

GENERAL ELECTRIC

162-10II

Wires TIGHT mean SAFE, SURE LIGHT

thanks to



Everlock

"CHISEL EDGE" LOCK WASHERS

The Washer That Has The Edge

on R-B-M automotive light switches

Specially designed EVERLOCK lock washers help keep R-B-M foot dimmer, headlamp, and horn switches in ever-ready operating order. With their exclusive deep-bite, alternating chisel edges, EVERLOCK lock washers hold the vital screws and connecting wires fast and secure.

Wherever permanent, vibration-proof fastenings are indicated—call on EVERLOCK. With EVERLOCK, you can fasten it and forget it. In sizes and materials to meet any specifications.

Write for information or contact your nearest EVERLOCK Representative

A Full Line of EVERLOCK
LOCK NUTS and LOCK WASHERS

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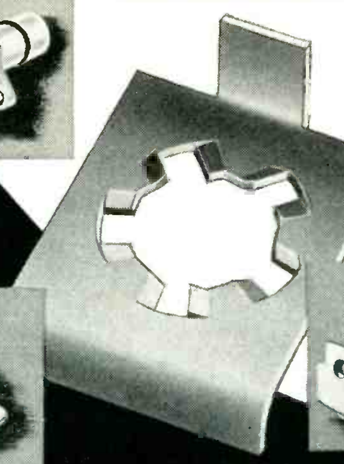
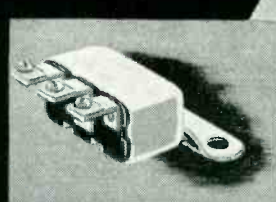
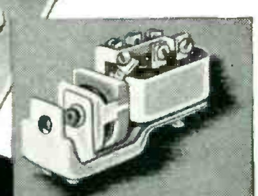
Special EVERLOCK Lock Washers used on Switches Manufactured by R-B-M DIVISION, ESSEX WIRE CORPORATION, Detroit, Michigan

R-B-M Foot Dimmer Switch





R-B-M Horn Relay

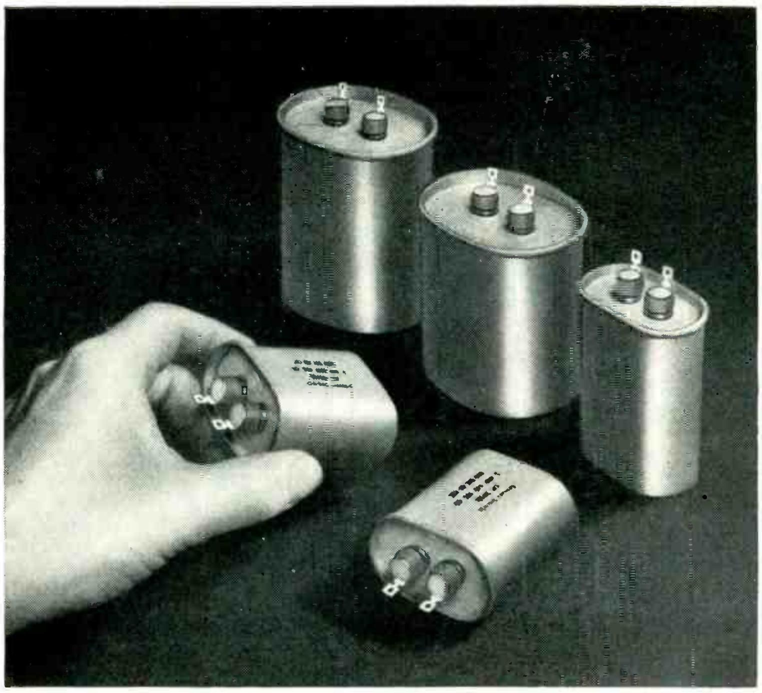


R-B-M Headlamp Switch

"EVERLOCK" IS THE REGISTERED TRADEMARK OF THOMPSON-BREMER & COMPANY

THOMPSON-BREMER & COMPANY • 520 N. DEARBORN STREET, CHICAGO 10, ILLINOIS

SUBSIDIARY OF AMERICAN MACHINE AND FOUNDRY COMPANY • NEW YORK, N. Y.



RATINGS of G-E drawn-oval capacitors range from 1 to 10 uf, 600 to 1500 volts d-c, and 330 to 660 volts a-c.

G-E drawn-oval capacitors save space and cost less

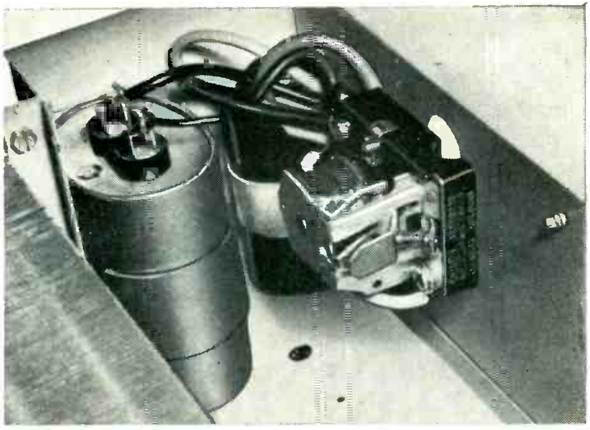
If you use fixed paper dielectric capacitors, G-E drawn-ovals offer you an opportunity to save up to 20% on weight, and as much as 10% to 20% on cost. The oval-shaped container, developed by General Electric, offers more capacitance per dollar than similarly rated rectangular capacitors. And, by conforming to the natural shape of the winding, it results in a smaller, lighter unit, too. They're available in ratings from 1 to 10 uf, 600 to 1500 volts d-c, or 330 to 660 volts a-c, 60 cycles.

G-E drawn-ovals feature: A double-rolled seam, between case and cover that makes a mechanically strong, hermetic seal which stays leak-proof even under severe operating conditions; a choice of eyelet, fork-type, or quick-connect (solderless) terminals; silicone bushings between terminal and cover, that effectively maintain a high insulation resistance despite long operation and wide temperature variation.

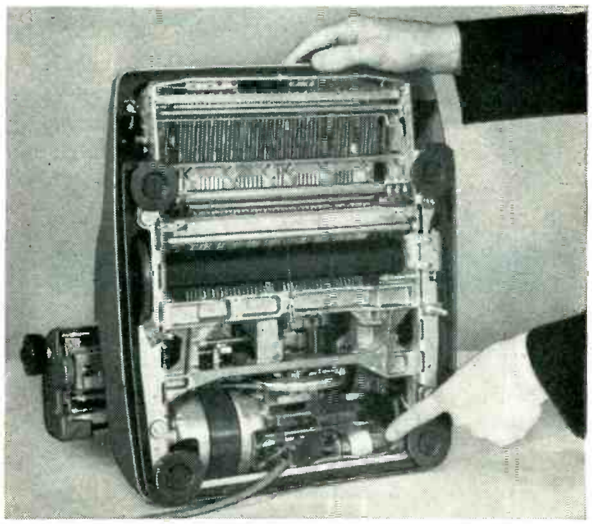
General Electric drawn-oval capacitors are being used in room air conditioners, business machines, fluorescent lighting ballasts, and industrial and military control systems. If you would like specific application assistance, contact your local General Electric Apparatus Sales Office. General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

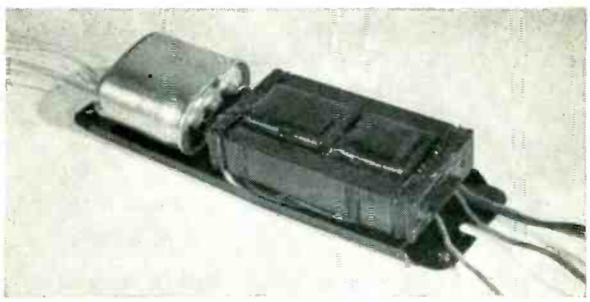
GENERAL ELECTRIC



IN ROOM AIR-CONDITIONERS G-E drawn-oval improves power factor and reduces running current.



IN ELECTRIC TYPEWRITERS AND BUSINESS MACHINES, the compact G-E drawn-oval is used with split-phase capacitor-run motors.



IN FLUORESCENT LAMP BALLASTS, G-E drawn-ovals (left) improve power factor.

CAN YOU USE THIS VERSATILE CAPACITOR?

General Electric Co.
Section C442-19
Schenectady 5, New York

Please send me Bulletin GEA-5777.

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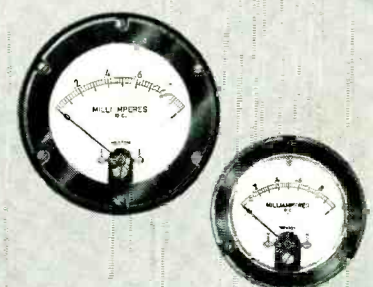
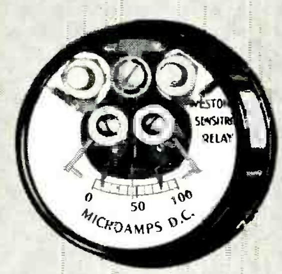
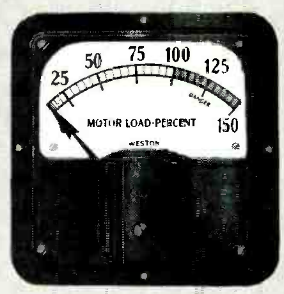
INSTRUMENT guide



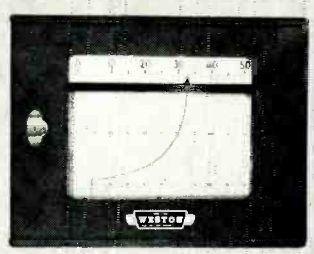
RUGGEDIZED INSTRUMENTS —to military specifications, available in 2½", 3½" and 4½" sizes in D-C, movable iron A-C, rectifier type A-C and thermo instruments. All have sealed, externally operated zero correctors—shock-resisting, flat plastic windows—and connection terminals molded into internal rubber.



ULTRA-SENSITIVE RELAYS —extremely compact and rugged relays which operate on values as low as ½ microampere or ¼ millivolt, direct from thermocouples, resistance bulbs or other generators of minute current. Handle substantial wattage at 110 volts on non-chattering magnetic contacts. Available with single or double contacts, fixed or adjustable, manual or solenoid reset.



"MOTOR LOAD %" METERS —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 objects. Other scale calibrations available.

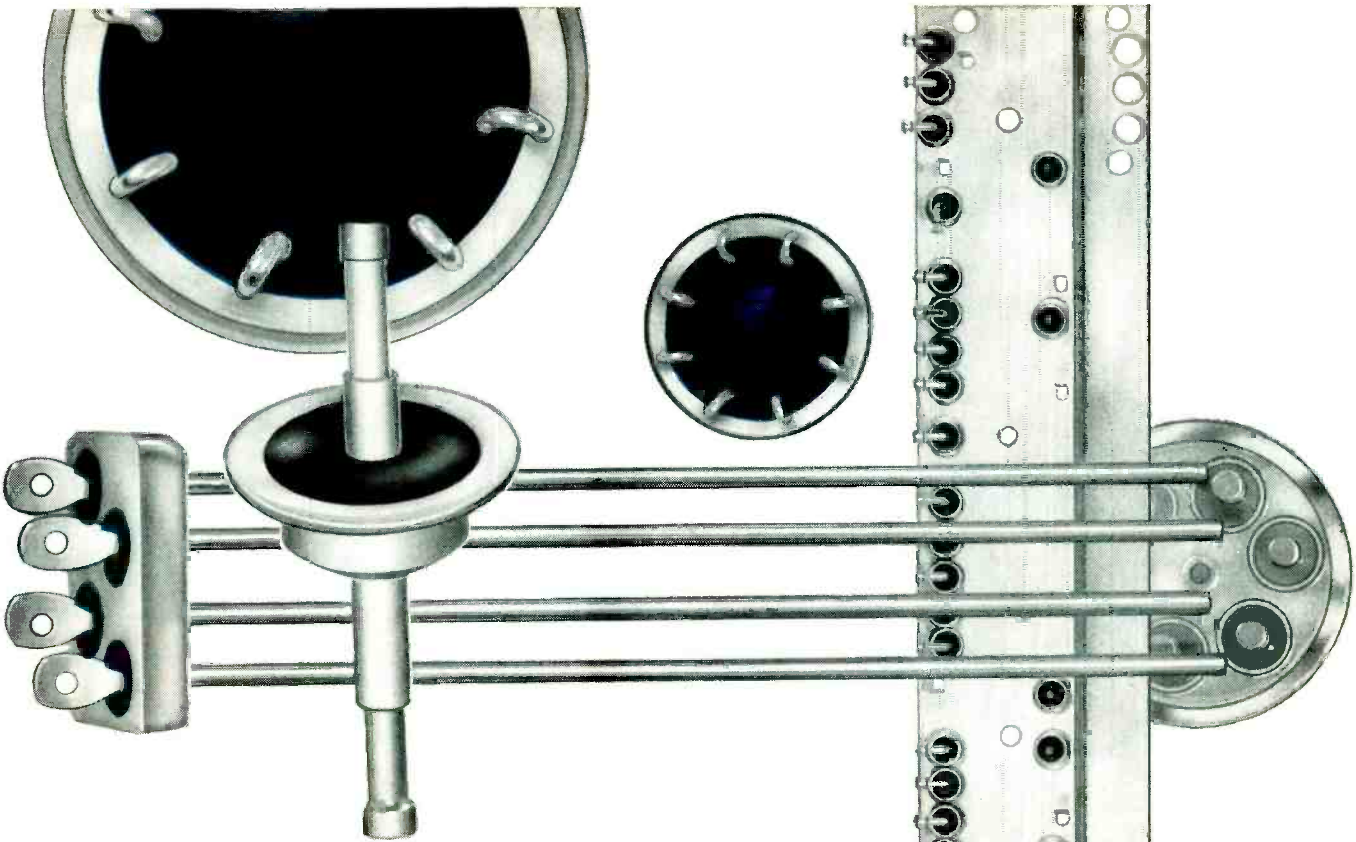


RECORDING POTENTIOMETER —ideal for built-in needs because of its extreme compactness plus ruggedness and simplicity. Ranges changed simply by inserting required range standards. Chart speeds changed by simple screwdriver adjustment. Plug-in amplifier removed in a jiffy since no soldered connections are used.

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

8106

WESTON *Instruments*



SEALTRON SEALS

quality high, price low.

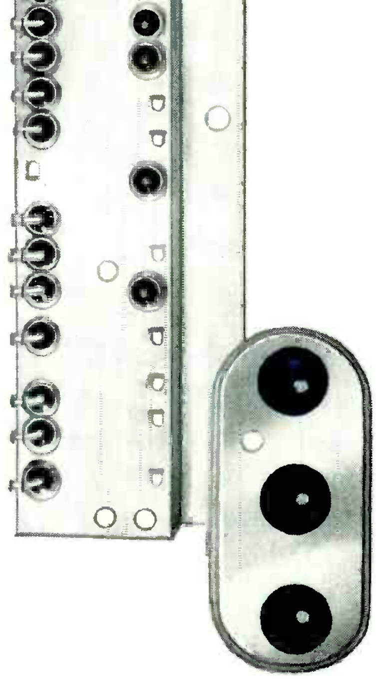
PLUS COMPLETE SERVICE FACILITIES.

Due to our expanded production facilities and improved manufacturing techniques, we have been able to lower the unit cost of our Hermetic Seals. This in turn is passed on to you in the form of hermetic seals of the highest quality, but at a lower price. Strong believers in modernization, we at Sealtron are well aware of the fact that our progress is your benefit.

Prompt Delivery. No hold up of inquiries and orders at Sealtron. Our flexible engineering and production facilities are geared to give you prompt service and delivery at all times.

Design Service. Design and project engineers look to Sealtron for tailor-made, highly specialized forms of hermetic seals and seal assemblies. Our fully staffed and experienced engineering department will design hermetic seals to fit any product specification.

Seal-Assembly Service. We will solder seals, mount studs, inserts and brackets into complete packages. We will also stamp or form brackets and panels. Eliminate your specialized operations. Cut down overhead and release personnel for other work.



SEALTRON, manufacturers of the world's most complete line of Hermetic Seals . . . over 1600 types.

SEALTRON

SEALTRON CORPORATION

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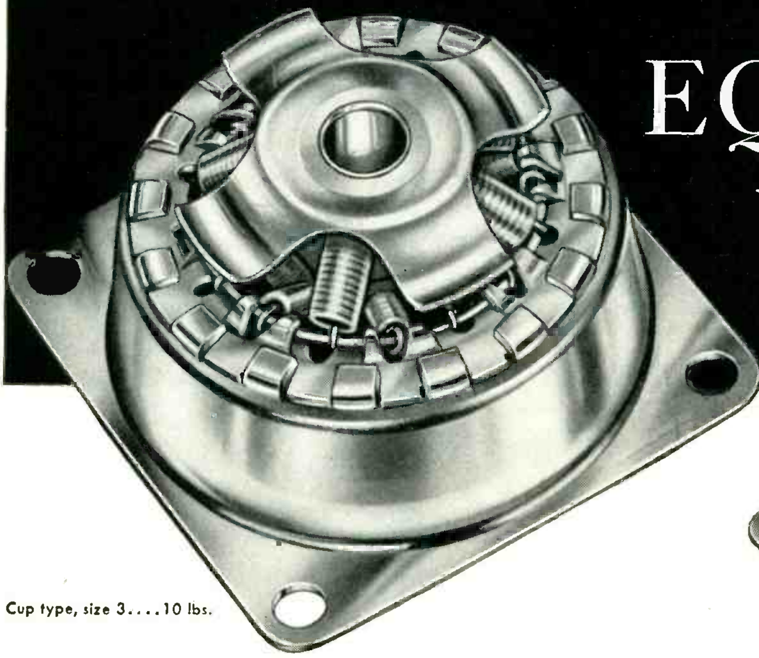
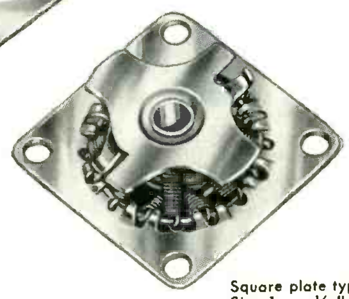
Ucinite EQUIFLEX vibration isolators



Cup type, size 3....10 lbs.

Cup type, size 1....½ lb.



Square plate type, Size 1....¼ lb.

Standard Equiflex mountings come in two basic types...the Square Plate and the Circular Cup. Both types are available in three different sizes . . . size 1 for light loads or small equipment, size 2 for medium loads or medium duty equipment, size 3 for heavy loads or heavy duty equipment.

Equiflex mountings withstand 100 hour salt spray tests, take 15G shocks without damage and will keep equipment captive up to 30Gs. Extra-damped mountings are available in which each multiple coil spring is shrouded with polyethylene or Teflon tubing.

Equiflex vibration isolators can be supplied to cover load ranges from ¼ to 35 lbs.

- Greatly prolonged service life.
- Wide temperature range.
- Controlled damping.
- Can be loaded in any direction or position.
- Absence of drift or permanent set.
- Equiflex action or 1:1 ratio of radial and axial spring rates.
- Integral single unit assembly with safety washers included and attached.

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

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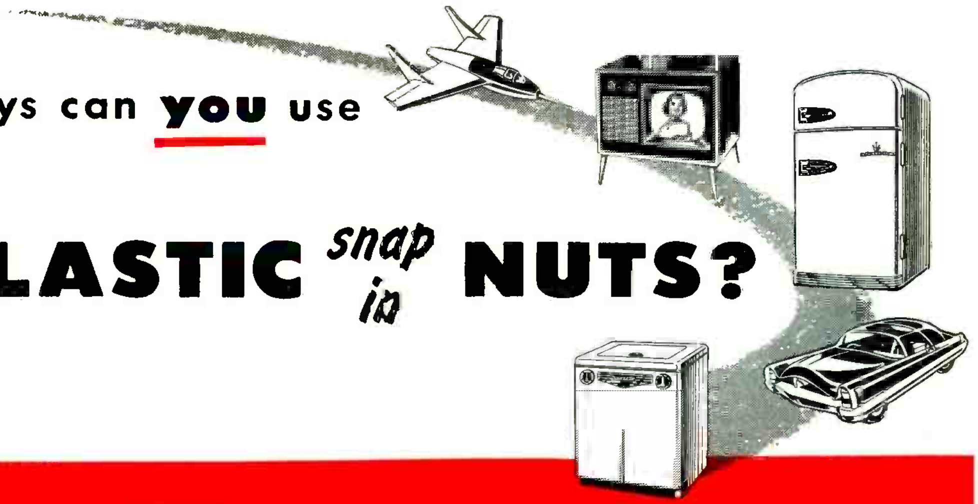
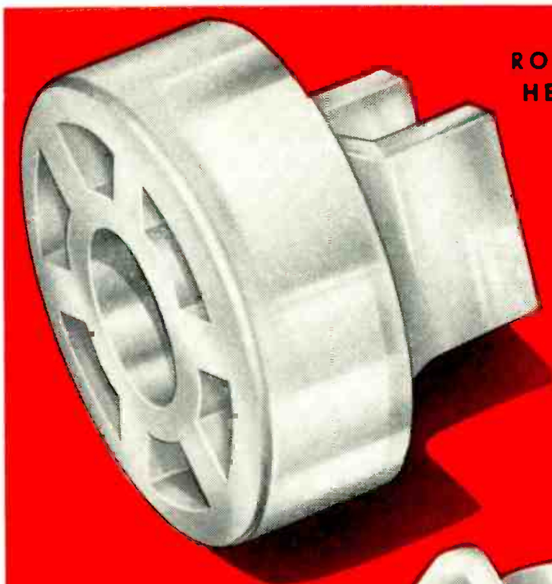
How many ways can you use

DOT PLASTIC snap in NUTS?

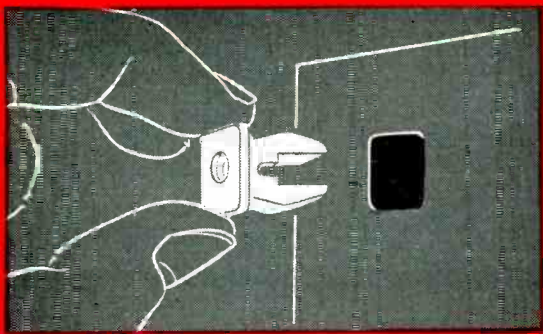


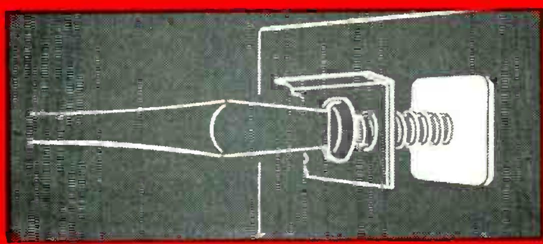


ROUND HEAD

QUICK, EASY ASSEMBLY

Nut is pressed into square hole punched in sheet metal.





SQUARE HEAD

Ordinary sheet metal screw cuts its own threads as it is driven into the nut, expands fingers, locks nut and screw securely.

United-Carr's new self-locking, plastic nut is designed for blind application and can be used with all types of metal finishes without scratching or chipping the surface. Its plastic fingers provide rigid anchorage yet will not mar paint, polished metals or even porcelain.

Inexpensive sheet metal screws cut their own threads and expand the nut's fingers as they are driven, locking both nut and screw tightly in place. Screws can be removed and replaced several times without damage to the nut.

DOT plastic snap-in nuts are electrically non-conductive and provide a high degree of insulation against heat transfer. For all practical purposes, they also provide an effective vapor seal.

Available in several styles and sizes. Write for full information and samples or contact your nearest United-Carr representative.

UNITED-CARR FASTENER CORP.

CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DOT FASTENERS

Want more information? Use post card on last page.

GPE SERVES INDUSTRY THROUGH *coordinated*

CAPACITIES OF THE GPE PRODUCING COMPANIES

- PRECISION MECHANICS and CERAMICS
- ELECTRICAL EQUIPMENT and COMPONENTS
- ELECTRONICS
- HYDRAULICS and LIQUIDS HANDLING
- PROFESSIONAL and INDUSTRIAL TELEVISION EQUIPMENT
- INSTRUMENTATION
- SERVOS and CONTROLS
- AUTOMATIC COMPUTERS and COMPONENTS
- ULTRASONICS
- RADAR and MICROWAVE
- MOTION PICTURE and SOUND EQUIPMENT
- OPTICAL DEVICES

The producing companies of General Precision Equipment Corporation are engaged in the development, production and sale of advanced technological products. These products all have a broad common base: 1) they represent precision equipment in some form; 2) they derive from similar fields of technical competence; 3) they save labor, increase productivity, or achieve results which cannot be attained with even limited use of on-the-spot manpower.

A general view of the technical capacities of the GPE Producing Companies is given in the chart. But the chart cannot show the very close interrelation of these capacities nor the highly flexible application of facilities, techniques and capabilities which exists among these companies. This is achieved through GPE's basic operating policy—Coordinated Precision Technology.

GPE Coordinated Precision Technology operates in all areas—in research, development and manufacture. The record of the GPE Producing Companies in solving advanced technological problems and meeting the demand for high speed, precision, reliability, light weight and compactness at competitive prices is the result of this coordination, the constant application of the newest and most highly advanced techniques, and unremitting insistence on highest quality.

Perhaps the most conspicuous advantage of GPE Coordinated Precision Technology is that the concept and development of equipment and systems, and of solutions to the underlying technical problems, are not restricted by being confined to the specialized techniques of a particular field. In short, GPE Coordinated Precision Technology permits each company to seek the optimum solution for the customer by the application of all relevant techniques within the total capacities of the entire group. Address inquiries to:

Over **2200** scientists, engineers, draftsmen, testers and other technical personnel in the GPE Companies work in the fields covered by this chart.

GENERAL PRECISION EQUIPMENT CORPORATION

92 GOLD STREET, NEW YORK 38, NEW YORK

THE GPE PRODUCING COMPANIES

Simplex — INTERNATIONAL PROJECTOR CORPORATION—BLOOMFIELD, N. J.

Peerless — J. E. McAULEY MFG. CO. CHICAGO

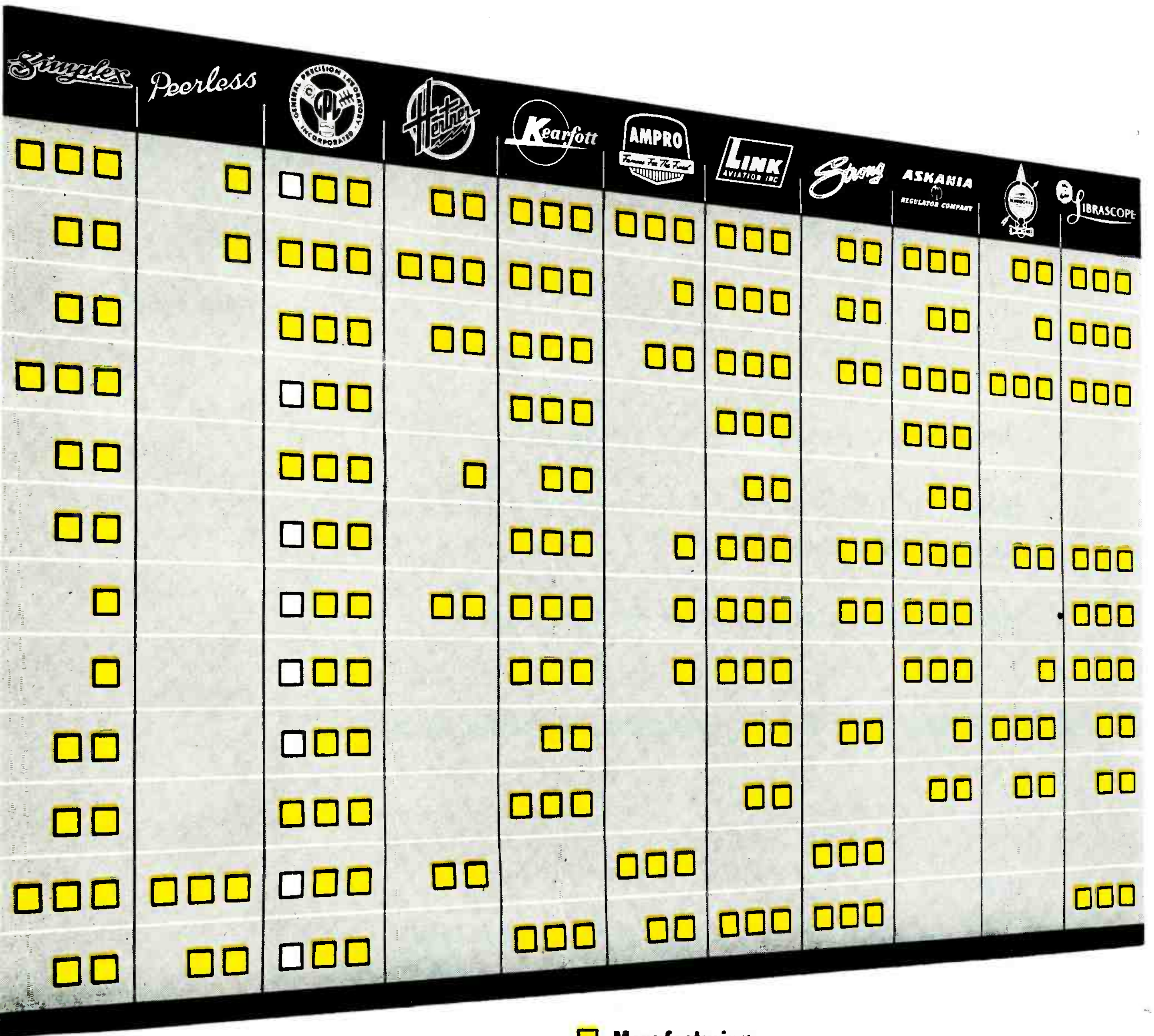
GPL — GENERAL PRECISION LABORATORY INCORPORATED—PLEASANTVILLE, N. Y.

Hertner — THE HERTNER ELECTRIC COMPANY—CLEVELAND

Kearfott — KEARFOTT COMPANY, INC. LITTLE FALLS, N. J.

One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

precision technology



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THE STRONG ELECTRIC
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LIBRASCOPE, INCORPORATED
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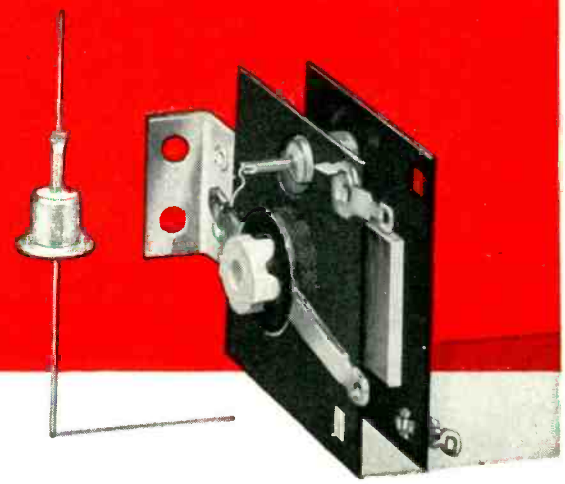
G. E.'s LATEST CONTRIBUTION TO

STACKED



CUSTOM BUILT TO PROVIDE
143 POWER COMBINATIONS!

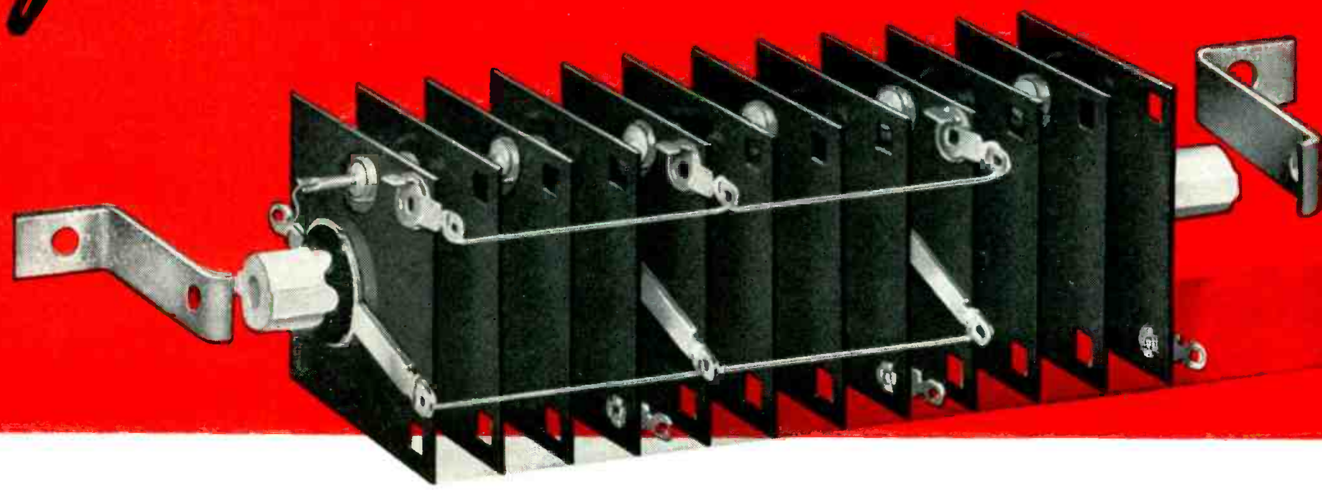
- **Smallest unit size yet developed!**
- **Most reliable performance of any rectifier within this category!**
- **Hermetically sealed for lifetime use!**

The following germanium rectifier stacks, each occupying a volume of only 1.62" x 2.5" x 6.00", are typical of the 143 standard stacks in G. E.'s new rectifier line.

CIRCUIT	D.C. OUTPUT (55°C Resistive Load)
Half Wave	2 amps @ 280 volts or 3 amps @ 190 volts
Full Wave Center Tap	2 amps @ 280 volts or 3 amps @ 190 volts
Full Wave Bridge	1 amp @ 565 volts or 3 amps @ 210 volts
Three Phase Half Wave	1.12 amps @ 420 volts or 4.5 amps @ 140 volts
Three Phase Bridge	1.3 amps @ 575 volts or 2.6 amps @ 280 volts
Three Phase Star	1.8 amps @ 280 volts or 3.6 amps @ 140 volts

THE PROGRESS OF POWER...

Germanium RECTIFIERS



Plus IMMEDIATE DELIVERY

General Electric leads the industry again! Announcement of this revolutionary G-E Stacked Germanium Rectifier opens up new avenues of power progress that were heretofore thought impossible to travel. Now, the amazing total of 143 power combinations has been provided with this one product! Your specifications requiring series or parallel stacks in single or polyphase circuits are custom-completed at G-E's factory.

This unit is smaller, weighs less, is more reliable, lasts longer, has better power ratings than any other dry rectifier made *any place by any other company*. AND, G.E. offers you *immediate delivery*.

Designed and built to deliver new *power performance*, the G-E Stacked Rectifier is 75% less by volume and weight than any other comparable dry type rectifier. And, rectifier losses are reduced to one-third or less of those encountered with any other type of rectifier. You can count on extreme reliability . . . tested for compliance to 10,000-hour standards. Note also that there are no forming or aging effects.

WRITE US TODAY! GET ALL THE FACTS ON THIS IMPORTANT NEW PRODUCT!

General Electric Company, Section X4104,
Electronics Park, Syracuse, New York

GENERAL ELECTRIC

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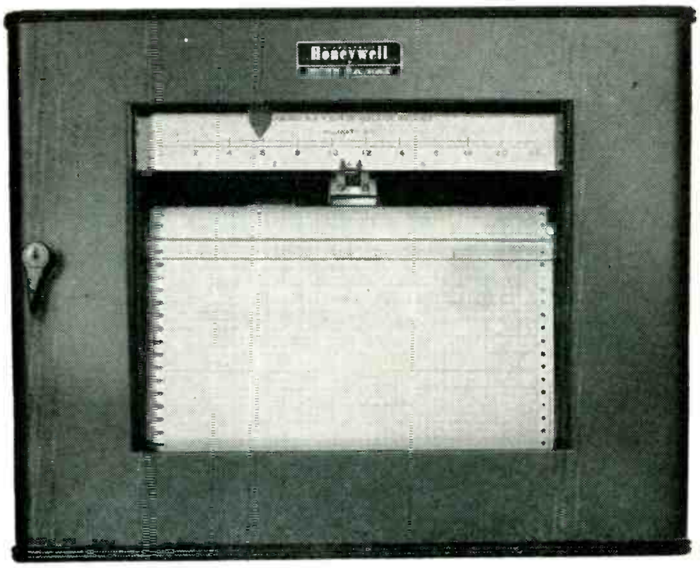
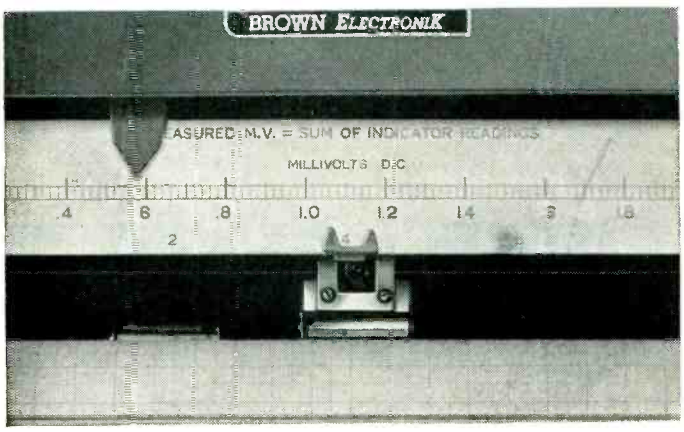


Now...the answer to high-resolution recording of test data

...*the* Extended Range *ElectroniK* Recorder



Closeup of indicating scale. Upper pointer shows millivolts within the span; lower pointer indicates millivolts to be added. Total reading: 4.58 mv.

DESIGNED especially for recording variables which change over a wide range, this new *ElectroniK* instrument records on a chart effectively *55 inches in width*. It has five equal measuring spans. Whenever the variable being measured reaches either the upper or lower limit of one of these ranges, the instrument automatically steps to the adjoining range and continues recording.

Two indicating pointers show the range in use and the value within the range. Connected to each pointer is a pen; one draws a purple record showing the range, the other draws a red record of the variable itself. To get the complete reading, you simply add both pen or pointer indications.

The complete range is 10.2 millivolts, in five 2-millivolt steps with an extra 0.2 millivolts on the high end of each span to provide an overlap that facilitates measurements near the change-over point. Pen speed of $4\frac{1}{2}$ seconds full scale affords rapid response to quickly changing variables.

You'll find this new instrument particularly valuable in strain gage measurements and in dozens of other uses where high resolution aids interpretation of data. Your nearby Honeywell sales engineer will be glad to discuss your specific application . . . and he's as near as your phone.

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

● **REFERENCE DATA: Write for Data Sheet No. 10.0-18, "Extended Range Recorder."**

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MINNEAPOLIS
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First in Controls

PROVEN: KARP ENCLOSURES ARE YOUR MOST ECONOMICAL BUY

Karp customers, large and small, from coast to coast, know that Karp's complete "package"— ready for components—means lower costs.

Over 300 different jobs go through our plant every day. This volume allows us to apply mass production techniques to every job—whether simple or complex, long run or short —*and we pass the savings on to you.*

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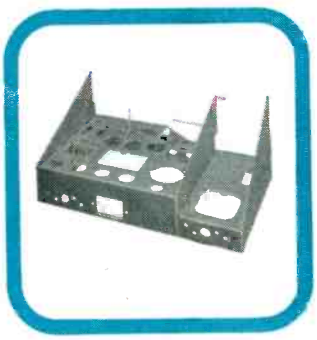
We will prove to you that your sheet metal requirements in aluminum or steel can be *individualized and yet be low in cost.* We will prove to you that our complete "package" service will lower your costs. Send us samples, sketch or prints and a prompt quotation will follow.



KARP METAL PRODUCTS CO.
Division of H & B American Machine Company
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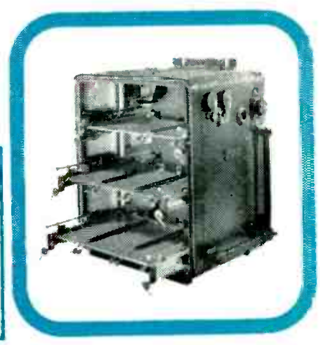
FACILITIES FOR ENGINEERED SHEET METAL FABRICATIONS: in aluminum or steel • long run or short • spot, arc, gas or heliarc welding • any type finish

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



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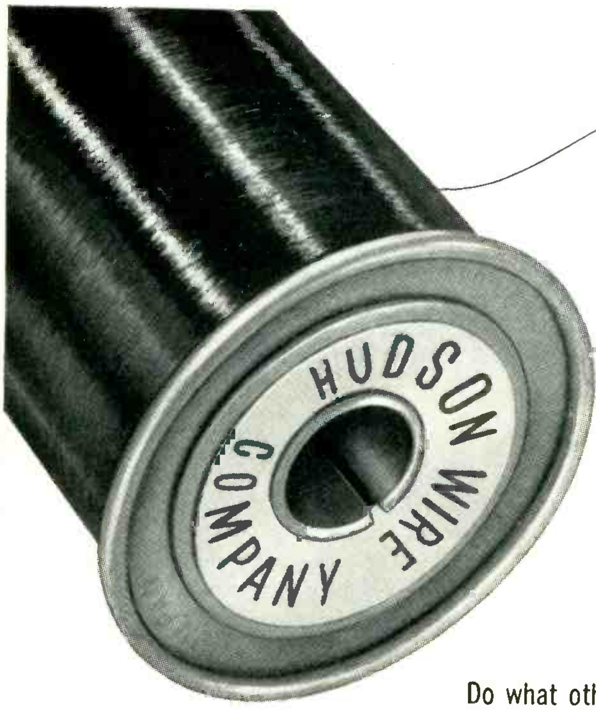

FINE WIRE

made finer

Do what other electronic and electrical manufacturers have done for years: Turn your fine-wire problems and requirements over to Hudson Wire. You will be served promptly, satisfactorily, economically, by craftsmen backed by over 50 years of fine-wire specialization.

BARE WIRES

- Coppers
- Brasses
- Bronzes
- Phosphor-bronze
- Nickel-silvers
- Zinc
- Lead
- Tin
- Cadmium
- Oxygen-free Copper
- Silver
- Fuse
- Stainless Steel
- Brush Wires

SPECIALTY WIRES

- Silver-plated Coppers, Brasses, Bronzes
- Electro-tinned Copper
- Stranded and Bunched Silver-plated
- Aluminum and Silver-Plated Tape for Voice Coils
- Flat-Wire Ribbons

TEXTILE-COVERED WIRES

- Nylon
- Celanese
- Silk
- Cotton
- Rayon
- Fiberglas

Available on bare or enameled wire, single- or double-coated

INSULATED WIRES

MATERIALS	TYPES	COVERINGS
Copper	Instrument Tubing	Plain and Heavy Enamel
Aluminum	Litz	Formvar
Iron	Multiple and Twisted	EZsol (Liquid Nylon)
Copper-clad Steel		Cement-coated Enamel
		Dow-Corning 1360 Silicone

FOR BARE & SPECIALTY WIRES
Hudson Wire Company
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FOR INSULATED WIRES

Winsted Division
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Hudson Wire Company
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Here's your own
WIRE DEPARTMENT!

Research and development facilities to solve your problems. Exceptionally flexible production to provide "custom" service. Lowest cost with highest quality.

HUDSON WIRE COMPANY

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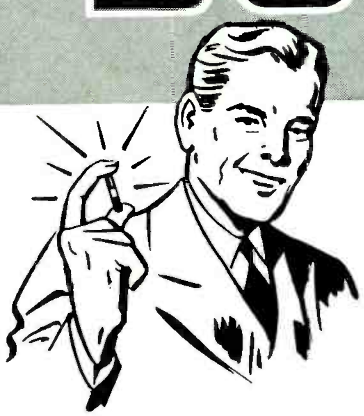
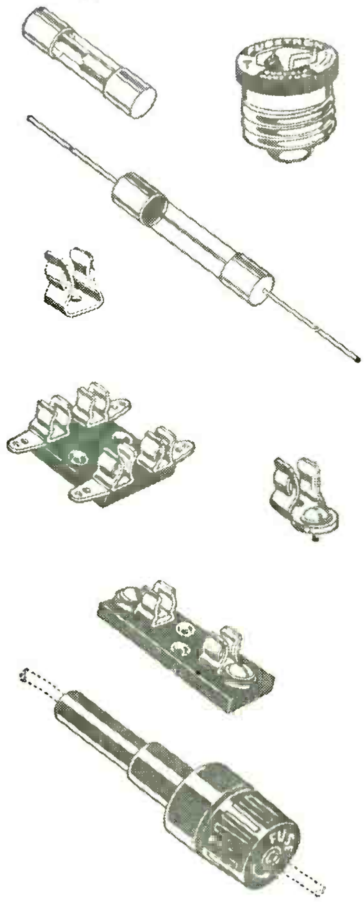
BUSS.. ONE SOURCE TO MEET ALL YOUR FUSE NEEDS!...



Constant research and engineering over the past 39 years have resulted in a most complete line of BUSS fuses: dual-element (slow blowing), renewable and one time types . . . in any size from 1/500 amperes up — plus a companion line of fuse clips, blocks and holders.

To make sure that BUSS fuses meet the highest standards of dependability . . . every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device that automatically rejects faulty fuses.

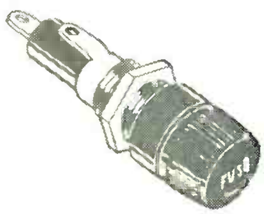
Many manufacturers and service organizations have standardized on BUSS fuses to simplify their buying, stock handling and records — and to safeguard their good-will and reputation. You too, will find it good business to let BUSS meet all your fuse needs.



Let BUSS save you engineering time

If you should have a special problem in electrical protection, BUSS places at your service the world's largest fuse research laboratory and its staff of experienced engineers to help you determine the right fuse for the job and if possible, one available in local wholesalers' stocks.

Makers of a complete line of fuses for home, farm, commercial, electronic and industrial use.



FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

FOR MORE INFORMATION MAIL THIS COUPON

BUSSMANN Mfg. Co. (Div. McGraw Electric Co.)
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Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

Name...Title......................
Company...
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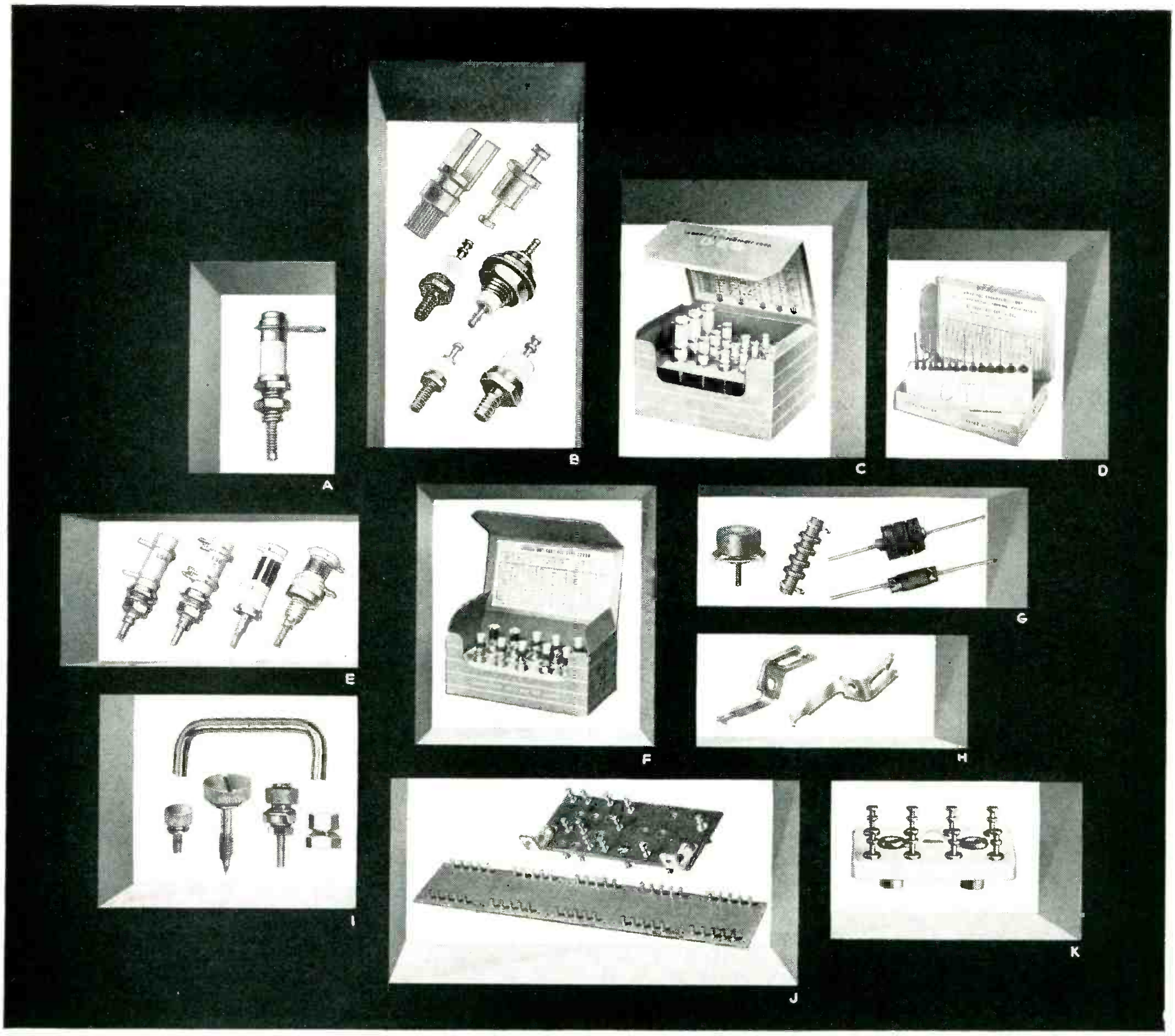

CTC Components shown include: A. capacitor; B. standard and insulated terminals; C. coil form kit; D. RF choke kit; E. coil forms and coils; F. coil kit; G. RF chokes; H. diode clips; I. panel hardware; J. standard and custom terminal boards; K. ceramic board.

One big family with a single thought

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

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

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

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

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard

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"Easy to Wrap" says Jones & Laughlin

IRVINGTON heat-resistant TEMFLEX* 105 Tape

COILS FOR 6600-VOLT STATORS are *easily* and *thoroughly* insulated at the coil repair shops of Jones & Laughlin Steel Corporation — by wrapping with strong, flexible Temflex 105 Tape. With its excellent elongation, this tape can be readily hand wrapped over coil bends and other irregular surfaces — and high modulus of elasticity makes it equally adaptable for use in taping heads to produce close, carefully lapped wraps.

USING THE SAME BASIC FORMULATION AS TEMFLEX 105 TUBING — which is approved by Underwriters' Laboratories for continuous operation at 105° C. in air and 90° C. in oil — Irvington Temflex 105 Tape withstands prolonged baking cycles and continuous high-temperature service.

USE TEMFLEX 105 TAPE for insulating coils, cable, bus bars — and for corrosion protection of piping and other equipment located underground or in corrosive atmospheres.

WRITE FOR TECHNICAL DATA SHEET

Look to
IRVINGTON
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- INSULATING VARNISH
- VARNISHED CAMBRIC
- VARNISHED PAPER
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- INSULATING TUBING
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11 ARGYLE TERRACE, IRVINGTON 11, N. J. • PLANTS: IRVINGTON, N. J.; MONROVIA, CALIF.; HAMILTON, ONTARIO, CANADA

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Plenty of Copper..

today and tomorrow

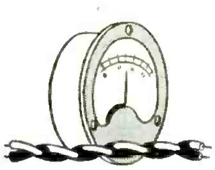
The assurance that copper is in abundant supply and *can be used without restrictions* is the "go ahead" for industry. You can now rate PERFORMANCE over AVAILABILITY when choosing materials. By using copper and its alloys, brass and bronze, your product is easier to fabricate, better and more durable.

We can get more copper than we now have. Although industry and government have been consuming more copper than in any previous peacetime period, production has kept pace with this increased demand. And producers are not working at full capacity!

More copper keeps on coming. Eleven major new projects in the U. S. will start producing in the next 3 years. These mines will add 250,000 tons to our annual production—more than *¼ of all the domestic copper mined during 1953*. In addition, recent improvements in mining techniques now make it possible to obtain copper from ores considered commercially unworkable in the past.

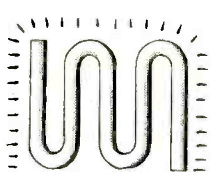
Copper is virtually indestructible. At least 3 out of every 4 pounds of copper used in today's products, when scrapped, can be re-used in the future. Every day we are adding to our "copper capital". The more copper we use . . . the more we have!

Copper or its alloys provide these advantages . . .

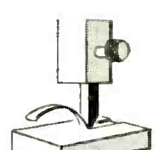


Best conductor of electricity commercially available.

Does not rust . . . high corrosion resistance.

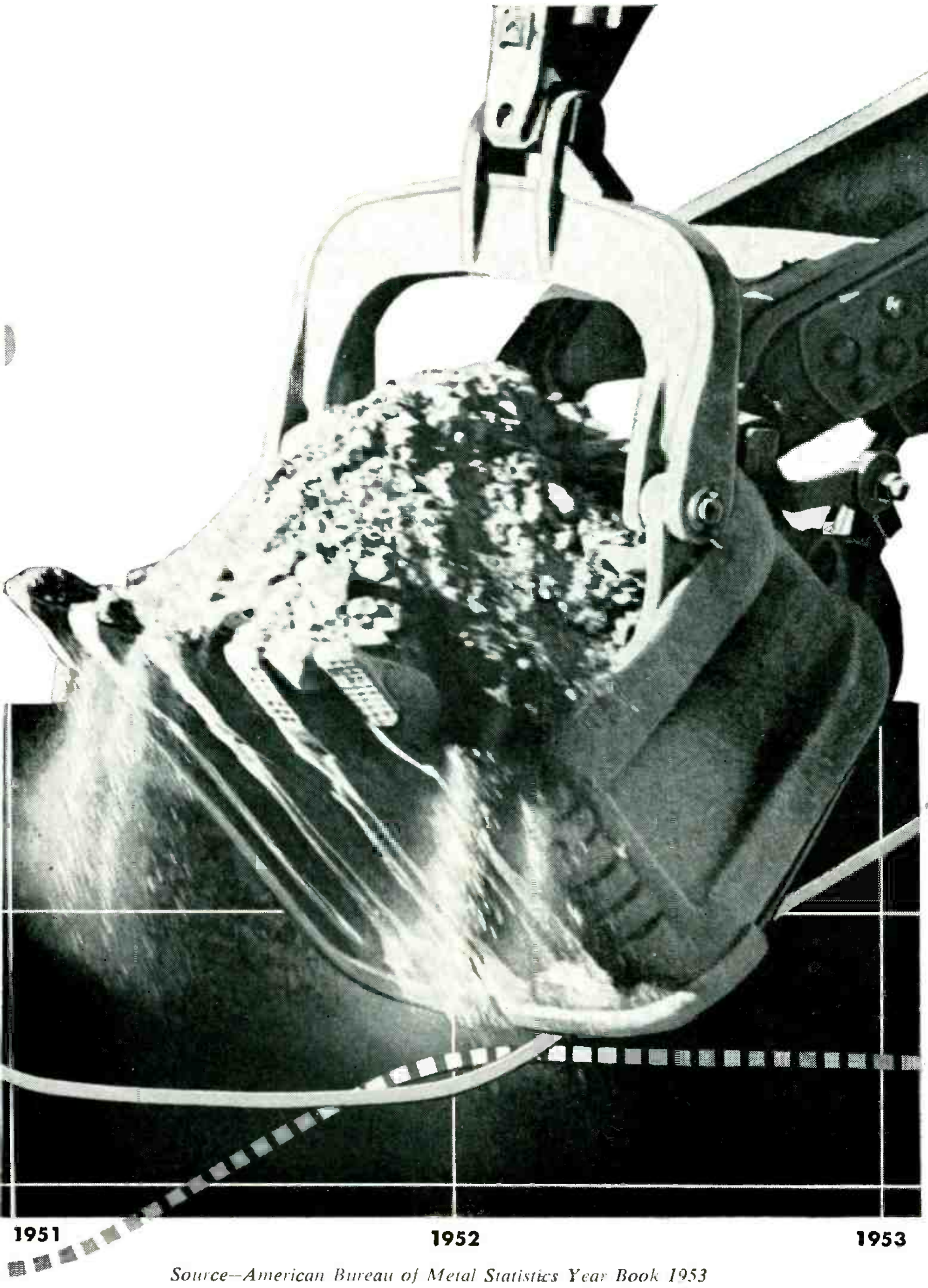


Best heat transfer agent of all commercial metals.



Easy to machine, form, draw, stamp, polish, plate, etc.

Welds readily . . . excellent for soldering and brazing.



Source—American Bureau of Metal Statistics Year Book 1953

Copper has a new ability to serve you. Many of your problems are being solved in the laboratories of the copper and brass industry. Whether it's a new alloy, a different temper or a special property . . . copper can help you develop new ideas. Copper can bring old methods up to date. Call a supplier of copper and brass and convert your thoughts to action!

COPPER & BRASS
Research Association

* ***"Copper . . . is fortunately available in ample supply to meet any foreseeable demand"***

Foreword, U. S. Dept. of Commerce
B.D.S.A. Copper Quarterly, August 1954

For information about U. S. copper supplies including free copies of this Government report and the new booklet, "Copper . . . Today and Tomorrow", send attached coupon to:

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420 Lexington Ave., New York 17, N. Y.

NAME ....

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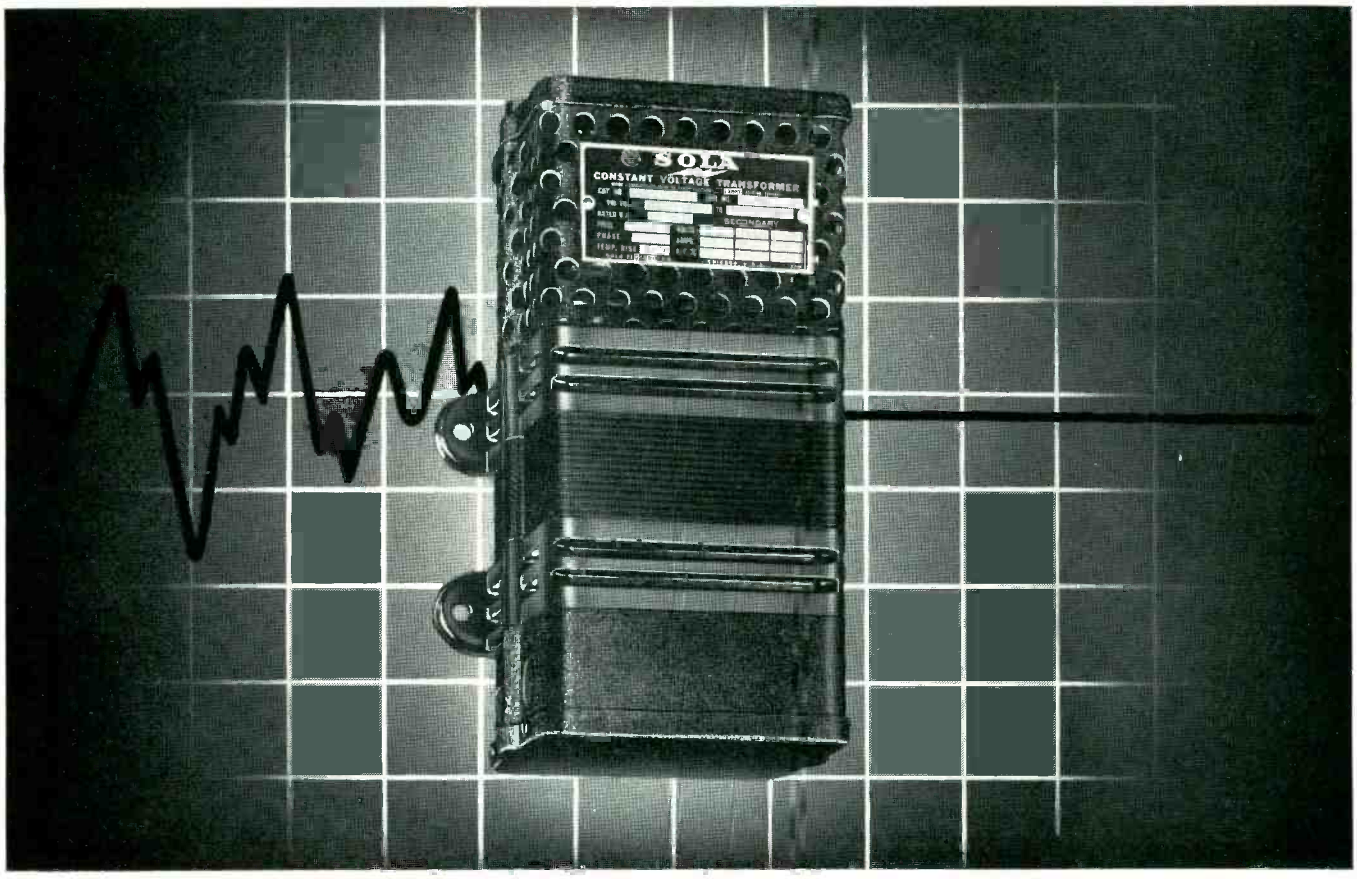

Automatic voltage stabilization for sensitive control components

You can eliminate the variable of erratic line voltage on voltage-sensitive elements of automatic control equipment. Do it simply and economically with the Sola Constant Voltage Transformer.

The Sola stabilizer is a static-magnetic regulator which differs from regulators depending solely upon saturation of core materials; or electronic types employing tubes. Their characteristics, listed below, make them ideal for controlling input voltage to voltage-sensitive electronic and electrical control components.

1. Regulation within ±1%, with primary voltage (transient or continuous) variations as great as 30%.
2. Response time less than 1½ cycles.
3. No moving or wearing mechanical parts, nor vacuum tubes; requires no manual adjustments.
4. Completely automatic, continuous regulation.
5. Self-protecting against short-circuits on output.
6. Current-limiting characteristic protects load equipment.
7. Isolates the input and output circuits.

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

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

SOLA *Constant Voltage* **TRANSFORMERS**

WRITE FOR LITERATURE. Sola Constant Voltage Transformers are completely described in a 24 page manual. Write for a copy of 7J-CV-200 on your letterhead, please.

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *BOSTON:* 272 Centre Street, Newton 58, Massachusetts • *NEW YORK 35:* 103 East 125th Street • *LOS ANGELES 26:* 2025 Sunset Boulevard • *PHILADELPHIA:* Commercial Trust Building • *CLEVELAND 15:* 1836 Euclid Avenue • *KANSAS CITY 2, MISSOURI:* 406 West 34th Street • *Representatives in Other Principal Cities*

RESULTS OF AN INTELLECTUAL REVOLUTION . . .

"The Western Miracle" Continues . . . More Automatic Controls for Industry

Within recent weeks three new monthly technical magazines devoted to automatic control systems for industrial processes and machinery have offered the public their first issues. One of these is CONTROL ENGINEERING, a McGraw-Hill publication.

What has caused this surge of interest in the design and application of automatic control systems? What does it portend for the future of American industry? More important, what does it promise for the American standard of living, of which industry is and must be the servant? And what is the role of CONTROL ENGINEERING in this development? It is to those questions that this statement is addressed.

A New Intellectual Revolution

It is frequently asserted that we are now in the throes of a new industrial revolution. The revolution is described as the eliminating of wasteful applications of human labor to repetitive tasks through new technology which makes it possible to transfer those tasks to automatically controlled machinery.

It is perhaps more accurate, however, to say that we are the beneficiaries of a new intellectual revolution in the application of science to industry. This new intellectual revolution points the way toward giant strides in the continuing process of taking dull and laborious work off the backs and minds of men and transferring it to machines operating in large batteries under automatic control.

The practical engineering work required to convert this intellectual revolution into a full-scale industrial revolution, however, in large part still remains to be done. It is to this task that CONTROL ENGINEERING will be devoted. Its role is that of bridging the gap, in engineering and economic terms, between the new conceptions of automatic control of industrial processes and their practical workaday application. These conceptions run the full gamut from systems of control for automatic factories making heavy industrial products to highly personalized systems of automatic control to warn people when they are approaching the broiling point in sunning themselves at the beach or becoming too drowsy to drive their cars safely.

Enter the "Feed-Back" System

Enough work has been done to move these conceptions out of the realm of interesting dreams and into the realm of practical possibilities, and in some cases into the realm of practical realities. Crucial parts of this work were done during World War II when weapons were successfully equipped with "feed-back" systems that automatically corrected mistakes made by the weapons in locating their targets.

The principle of the "feed-back" system is as ancient as the personal monitor that tells us not to run into each other as we walk along the street. It feeds back to our locomotion machinery the warning of a collision ahead. But the application of the principle to weapon control and then to more general machinery control required superlatively imaginative and skillful scientific development.

When a "feed-back" system that monitors an automatic process and keeps it lined up precisely is teamed up with a computing machine, capable of making lightning calculations that control both what goes into the process and what is done with the product, the horizons of automatic control become broad indeed. But in large part they still remain horizons. A vast range of practical engineering work remains to be done to realize anything like the full potential of automatic control of industrial processes and machinery.

More and Better Jobs

There are those who view the surge of interest in automatic control with alarm. They conjure up a situation in which automatic processes will at once expand the ranks of the unemployed and reduce many of those still working in industry to the status of robots or automatons.

A look at the record of the American economy — a record of amazing growth, steadily improving job opportunities and a constantly rising standard of living — demolishes the basis for such fears. The introduction of new and more efficient industrial machinery and processes obviously cannot be accomplished without creating some disturbance for some individuals and some companies. But consistently the longer range effect of such local and temporary disturbance has been more jobs and better jobs for Americans.

It is no accident that, while the proportion of industrial wage earners in our population is virtually the same as it was in 1920, the proportion of professional and salaried workers has doubled. The proportion of unskilled workers, furthermore, has dropped by half. This has been an essential part of a continuing process by which drudgery has been transferred to machines while the workers who formerly did the drudgery have been graduated to jobs calling for greater competence and providing better pay.

Higher Living Standard

A British historian, H. J. Hancock, has referred to this general process as "the Western miracle"—that of providing an ever higher and higher standard of living for more and more Americans. The key element in this miracle has been more and more reliance on power-driven machines to get the day's work done.

In the nature of the extremely complicated apparatus involved, full development of systems which have passed through the "think stage" into the status of practical possibilities will be a time-consuming process. It will also be a very exacting process, calling for a tremendous application of engineering skill and ingenuity. However, the engineers who are concentrating on this difficult, workaday phase of the development of apparatus for automatic control will be inspired by the knowledge that they are making a crucial contribution to technical progress which holds great promise of good for the American people.

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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Donald C McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

Tube life in time-proved GATES 5/10kw AM transmitters "exceeds estimates"

QUINCY
ILLINOIS
U. S. A.

GATES

Gates Radio Company

MANUFACTURING
ENGINEERS
SINCE 1922

Eitel-McCullough, Inc.
San Bruno, California

Gentlemen:

A few years ago our engineering department was requested to design several entirely new transmitters in the 5/10KW power range for both medium and short wave commercial service. One of the requirements was the establishment of a modern tube complement that would substantially reduce tube cost both initially and in greater life expectancy.

After considerable investigation and exhaustive tests in our own development section, the Eimac 3X2500F3 was decided upon. Performance-wise, the results were excellent but even successful abuse tests could not be a substitute for several years that must pass to obtain records on life expectancy.

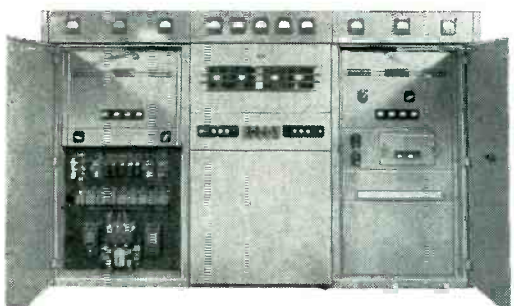
These several years have now passed. Gates transmitters employing the 3X2500F3 are all over the world in every kind of service including 24-hour a day international communications, broadcasting and many 5 KW mobile units for military service. Checks indicate, as both radio frequency amplifiers and Class B modulators, the life expectancy is not only meeting our original estimates and expectations but in many instances far exceeding them.

We congratulate you on an excellent product that has indeed saved the industry untold thousands in tube expense and again express our appreciation for the excellent cooperation of your engineering department.

Yours very truly,

GATES RADIO COMPANY

P. S. Gates
President



EIMAC 3X2500F3's
IN GATES 5/10KW AM TRANSMITTERS

GATES TRANSMITTER	MODULATOR	PA
BC-5B	2 Eimac 3X2500F3's	Eimac 3X2500F3
BC-10B	2 Eimac 3X2500F3's	2 Eimac 3X2500F3's

Eimac 3X2500F3's featured in Gates models BC-5B and BC-10B the world over.

Eimac

EITEL-McCULLOUGH, INC. SAN BRUNO, CALIFORNIA

Want more information? Use post card on last page.

Phil-trol Data

Relay Requirements Fulfilled More Easily By Greater Diversity of Phil-trol Relays

NEW FEATURES PROVIDE MORE NEARLY PERFECT RELAYS FOR THE MORE EXACTING REQUIREMENTS

One of the more recently developed relay manufacturing techniques is the method of utilizing aluminum time delay blocks in multi-contact time delay relays. These provide time delay features in a multi-contact relay, at the same time keep the unit weight as light as possible.

COMPLETE FLEXIBILITY OF ALL COMPONENTS

New methods developed at Phillips mean that relays for special or for complex control problems, which formerly have required complete engineering from "scratch", in many cases now can be produced much faster and at little or no increase in price over standard models.

Coils in a wide assortment of winding types and characteristics at Phillips are now almost completely interchangeable during relay assembly. Relay functions calling for varying marginal and timing values are easily fulfilled, as are requirements of operating values, timing sequence and release constants.

WIDE CHOICE OF SPRING AND CONTACT COMBINATIONS

The "custom" addition or omission of springs is accomplished just as easily. And variations of contact forms and of special contacts themselves are standard practice at Phillips.

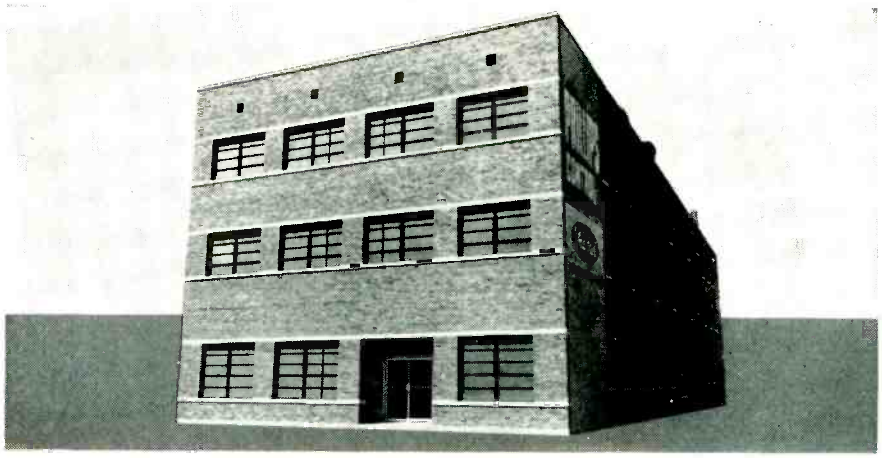
POWER RELAY SERIES COMPLETE

Requirements of aircraft and mobile equipment for relays to withstand severe shock and vibration have caused important advancements in the design and construction of Phil-trol relays. There are many types of Phil-trol power relays which exemplify the benefit of Phillip's extensive experience in this field.

The type 27QA as illustrated is unexcelled in this field. The type 27QA has been universally accepted by leading aircraft designers as the ideal relay to withstand vibration and shock. It is utilized by almost all leading commercial aircraft in use today.

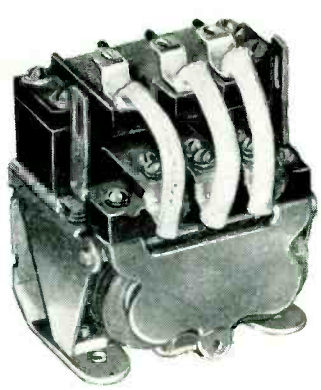
A comprehensive Phil-trol engineering service is maintained chiefly to consider and recommend, without obligation whatsoever, whether or not there is a "standard" Phil-trol relay which will precisely fulfill rigid specifications with substantial savings in cost.

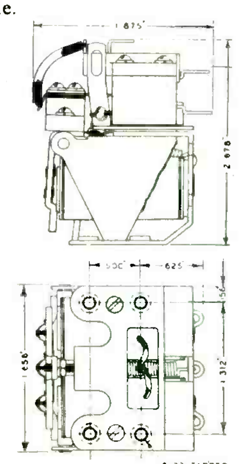
New Phillips Home Plant



PROGRESS is synonymous with Phillips. The company, beginning operations in 1946, is the leader in its field, with millions of dollars worth of Phil-trol Relays functioning in hundreds of different applications. More and more Design Engineers rely on Phillips for their relay and actuator needs, because they know that Phillips quality of product is maintained by unparalleled excellence of all Phil-trol components. They have learned, too, that the Phil-trol line provides a broader selection of relay types, and greater flexibility within each type—permitting wider latitude in product design. Phillips management, ever mindful of the company's responsibility as a leading relay supplier, has continued to develop more, improved and strategically located manufacturing facilities.

In July of this year Phillips moved into its new, modern, daylight-type home plant and offices (shown above) in Joliet, Illinois. In August, a new plant at Santa Monica, California, began operating. The modern, fully air-conditioned and air-cleaned plant at Santurce, Puerto Rico, producing high-quality aircraft Relays for more than two years, is being further expanded. Phillips future plans include additional expansions as customer needs indicate.





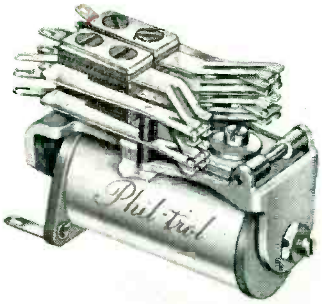
Phil-trol Type 27QA Relay

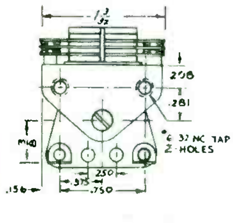
This type 27 relay is available in 1, 2, 3, 4, or 5 pole models, with single or double throw. Operating voltage up to 230 D.C., resistance up to 13,400 ohms. Minimum operating current is .001 amps. Available in dust cover, or hermetically sealed (as shown at right).

Phillips Control Corporation JOLIET, ILLINOIS
A THOR CORPORATION SUBSIDIARY

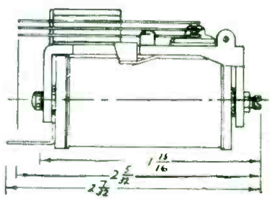
for Relay Users

Twin Contacts Give Phil-trol Type 8 Relays Exceptional Reliability





END VIEW



SIDE VIEW

Demands for reliable and fast-acting relays for applications where more rapid opening and closing of contact is required, resulted in the design of the Phil-trol Type 8 Relay.

This series of relays features high sensitivity with immediate response, excellent adaptability for marginal operation, with fast, positive and reliable closing and opening. Then, to assure that these characteristics will maintain, the Type 8 Relays are given "Y" springs, providing them with twin contacts which are operative in every circuit function. Long-life bronze bearings assure the maximum precision of operation.

These units physically are compact and light in weight. Their coils may be single or double wound and, if desired, equipped for slow release or for slow operation. They operate up to 230 volts D.C. Come in 3 different forms with maximum pile-up of 10 springs. Their dimensions are 1$\frac{3}{32}$" wide x 2$\frac{7}{32}$" long. For heavy-duty service and long life these relays are unexcelled.

Phil-trol Sales-Engineering Offices

COAST-TO-COAST

59 W. Washington St., Joliet, Ill.
Tel. Joliet 3-3431

833 Ellicott Square Bldg., Buffalo 3, N.Y.
Tel. Madison 3306.

2044 Graybar Bldg., 420 Lexington Ave., N.Y. 17, N.Y. Tel. Murray Hill 5-9103.

Western Savings Fund Bldg., Broad and Chestnut, Philadelphia, Pa.
Tel. Kingsley 6-2480.

311-315 Georgia Savings Bank Bldg., 84 Peachtree St., N.W., Atlanta 3, Ga.
Tel. Cyprus 7381.

12812 Puritan Ave., Detroit 27, Mich.
Tel. University 1-7311.

12417 Cedar Road, Cleveland 6, Ohio.
Tel. Erie View 1-0054.

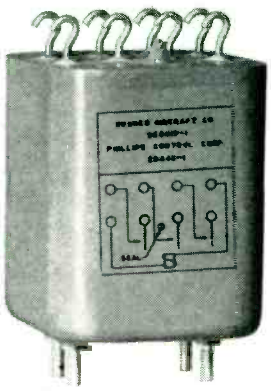
5410 Wilshire Blvd., Los Angeles 36, Calif.
Tel. Webster 3-6405.

2910 Nebraska Ave., Santa Monica, Calif.
Tel. Van Nuys, State 9-4887.

216 First Ave., N., Seattle 9, Wash.
Tel. Eliot 6981.

180 University Ave., Palo Alto, Calif.
Tel. Davenport 3-3288.

3014 So. Cherry Way, Denver 20, Colo.
Tel. Skyline 6-2555.



'Most All Phil-trol Relays Are Now Available Hermetically Sealed

Advancements in hermetic sealing pioneered at Phillips produce an utterly complete protection of proper relay function. Techniques known only at Phillips are acknowledged to deliver hermetically sealed relays superior to any other similar products in the field.

In general, Phil-trol Relays are mounted on the proper base assemblies, with INFRARED soldering used to affix the glass header. Hydraulic crimping then closes all seams of metal housings to completely enclose the relays, and seams are permanently soldered. Then each enclosure is exhausted to a few microns of pressure, removing all trace of moisture or of gas. It next is thoroughly flushed with chemically dry nitrogen. Again exhausted. Then once more pumped full of dry nitrogen to at least one atmosphere of pressure. The evacuating tube is now pinched off and solder-sealed. A coat of finishing paint over primer still further protects and "dresses" each unit. Phil-trol Relays protected by Phillips unique hermetic sealing are available for virtually every circuit purpose and requirement. The 20445 Phil-trol Sealed Relay shown here accommodates the type 27QA Relay. It has studs and individual terminals. Terminals are rated at 25 amperes.

Let **Phil-trol Progress** Help Solve Your Relay Problems

Plants at Joliet, Illinois, Santa Monica, California, and Santurce, Puerto Rico.

PHILLIPS CONTROL CORP., Dept. E. Joliet, Ill.

Gentlemen: Please send me your General Catalog ☐

I am personally interested in Phil-trol Type 27 Relays ☐

Phil-trol Type 8QA Relays ☐ Phil-trol Hermetically Sealed Relays ☐

Name ______________________

Company ______________________

Street ______________________

City ______________ Zone ________ State ________

Want more information? Use post card on last page.

660 TIMER COMBINATIONS

...So far!

PERHAPS YOUR TIMER WILL BE THE 661st

How do you know we can supply you with the timer that will do your job best? Because we have 19 years of experience in developing new timers to meet our customers widely varied requirements. If one of our standard timers won't do it–or one of the 660 combinations we have thus far developed from our 17 basic units–our engineers will develop the 661st combination, for your specific needs.

We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

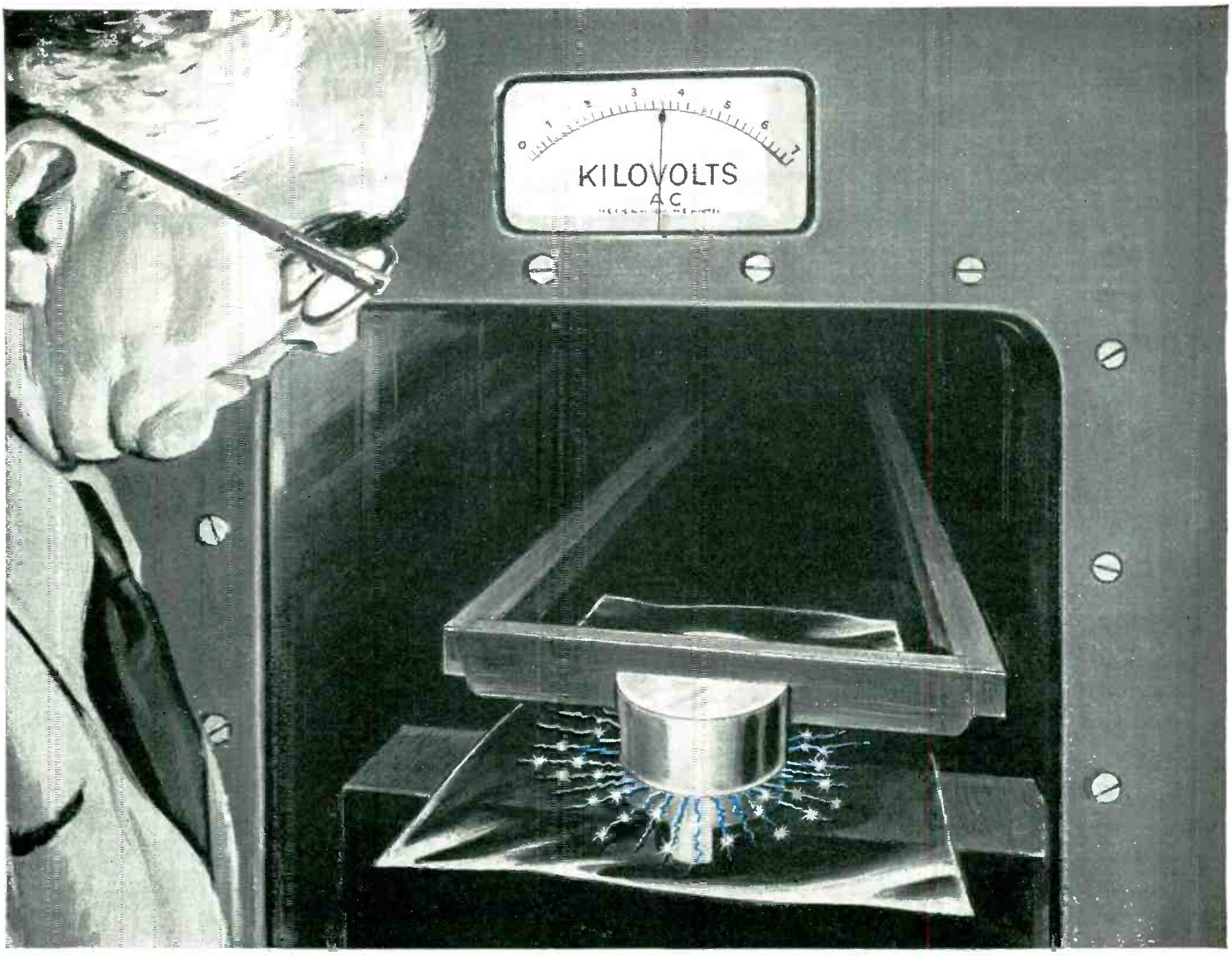
And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries–and of good deliveries even on special orders. Automation? We're in it up to our ears...just put your problem up to one of our timer specialists. Your inquiries will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

Want more information? Use post card on last page.



New design possibilities opened by outstanding dielectric strength of Du Pont MYLAR

REG. U. S. PAT. OFF.

A new product of Du Pont research—"Mylar" polyester film—offers you a balance of physical, electrical, chemical and thermal properties never before available in a plastic material.

Shown above is the testing of the unusual dielectric strength of this remarkable new film. "Mylar" resists electrical puncture at 4000 volts per mil.

Versatile "Mylar" opens new possibilities in the design of electrical equipment. It is already being used to advantage as slot, phase and wedge insulation in motors; layer insulation in capacitors; conductor insulation in transformers; under-lead insulation for coils; and as a barrier tape for wire and cable. Why not see how "Mylar" can help you improve or develop a product?

SEND FOR FREE BOOKLET:
To help you evaluate the advantages of "Mylar" for your product, this free booklet gives you the property specifications of "Mylar"... shows how this new film can be used to improve electrical products. Write E. I. du Pont de Nemours & Co. (Inc.), Film Department, Room 4-EM, Wilmington 98, Delaware.

Film Department 4E
E. I. du Pont de Nemours & Co. (Inc.)
Wilmington 98, Delaware

Please send me more information about Du Pont "Mylar."

*Name*____________________

*Title*____________________

*Firm*____________________

*Street & No.*____________________

*City*____________ *State*____________

DU PONT MYLAR®

Polyester Film

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Want more information? Use post card on last page.

MB cycling system runs vibration tests automatically

Versatile electronic "brain" for MB Vibration Exciters saves manpower and manhours—performs a variety of cycled shake-tests unattended!

A vibration test that involves a continuous cycle of changes from 10 to 500 cps along with constant displacement or constant acceleration can now be done with great simplicity, accuracy and minimum supervision. Simply set up the specimen on an MB Shaker—set the controls for the desired actions—and let the cycling system take over.

This electronic unit varies shaker frequency at any sweep speed, and between any two preset frequency limits. It controls the exciter's amplitude or acceleration within ±10% for a dead mass or resonant type of loading and for cycled tests to satisfy MIL-E-5272 and other specifications.

For maximum flexibility of operation, this cycling system also provides for automatic transfer of constant amplitude to constant "g" at any preselected frequency setting.

The system can be operated manually when desired. It's also protected against control failure or conditions of extreme load resonances through use of an automatic structural strain control.

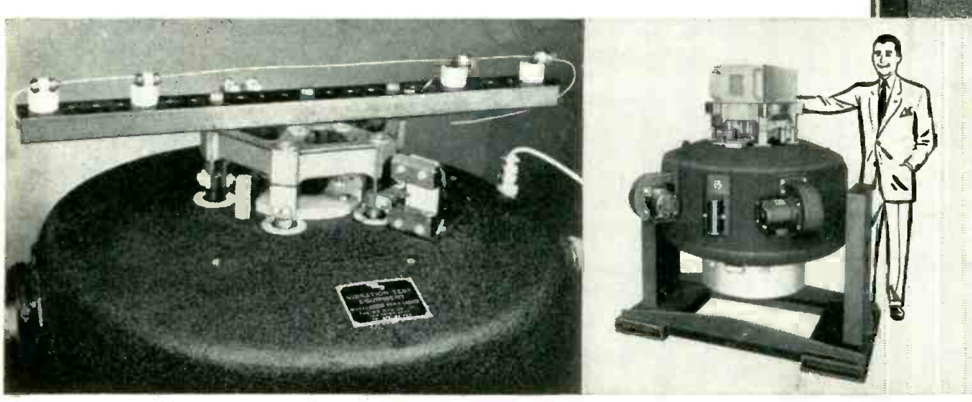
SHAKE TESTING PAYS

Vibration testing tells how well a product will bear up in service, reveals design faults, determines fatigue strength.

Designed for heavy duty service, MB vibration exciters such as the Model C-5, rated at 750 pounds force, and the Model C-25 rated at 3500 pounds force, deliver maximum performance, pure table motion and dependable operation.

Send for detailed specifications on MB cycling systems. Also for Bulletin which gives data on vibration exciters.

MB MODEL T-25 MC CONTROL CABINET with automatic cycling system developed to control the action of vibration exciters to a specified cycle of events, and with little or no supervision.



A VIBRATION TEST set up on the Model C-5 MB Vibration Exciter—and also one on Model C-25—two of the models which can be automatically controlled by MB's cycling systems.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

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

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

Want more information? Use post card on last page.

For Automatic Assembly plus Easy Inventory and Storage

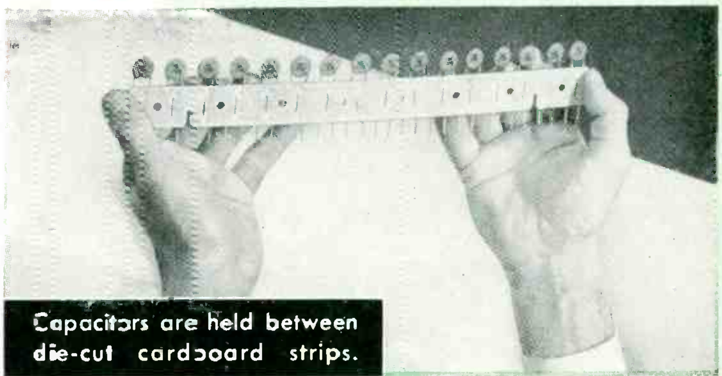
TRADE **ERIE** MARK
Pallet-Pak

NEW PACKAGING METHOD FOR DISC CERAMICONS®

Pallet-Pak, ERIE's exclusive new packaging method for Disc Ceramicons, answers the need for mechanically pre-aligned capacitors that can be fed into automatic assembly machinery. Hand assembly is also improved because of the ease of handling and the physical uniformity of the capacitor.

ERIE is constantly searching for new ways to assist manufacturers in reducing production costs. Pallet-Pak is a development by ERIE Industrial Engineers with this purpose in mind.

The many other advantages of Pallet-Pak are noted at right. Write for our Pallet-Pak Bulletin with complete illustrations and advantages of this new packaging method that is currently available on a portion of ERIE Disc Ceramicon production.

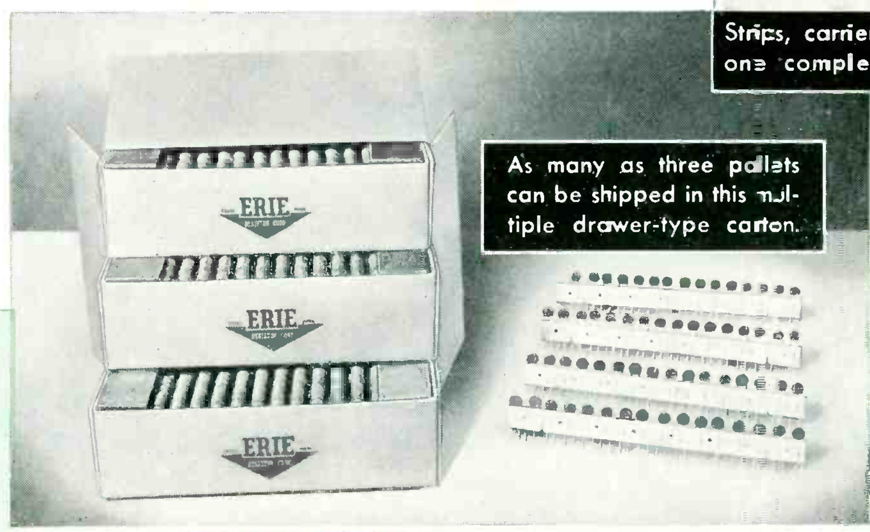

Capacitors are held between die-cut cardboard strips.


Strips are placed in carrier insert which fits in pallet.


Strips, carrier, and pallet form one complete shipping unit.

ADVANTAGES FOR INVENTORY AND STORAGE

- Known number in strip makes inventory control easier.
- Count empty strips—multiply by number for usage control.
- Markings all face one direction for easy identification.
- Drawer type disposable pallet for storage and shipping.


As many as three pallets can be shipped in this multiple drawer-type carton.

ADVANTAGES FOR YOUR PRODUCTION

- Straight lead wires—no tangling—units easily removed by pulling from strip.
- Uniform lead length.
- Carrier insert acts as tote-tray for easy handling.
- Index holes in strip 1½" center to center for use in lead forming and cutting equipment.
- Index holes are above carrier sides—rods can be inserted through holes and entire lot lifted easily in one operation.
- Assurance of uniform quality, resulting from continuous production flow.

TRADE **ERIE** MARK
RESISTOR CORP.

ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

Main Offices and Factories: **ERIE, PA.**

Sales Offices: Cliffside, N. J. • Camden, N. J. • Chicago, Ill. • Detroit, Mich. Cincinnati, Ohio • Fort Wayne, Ind. • Los Angeles, Calif. • Toronto, Ontario

Manufacturing Subsidiaries:

HOLLY SPRINGS, MISSISSIPPI • LONDON, ENGLAND • TRENTON, ONTARIO

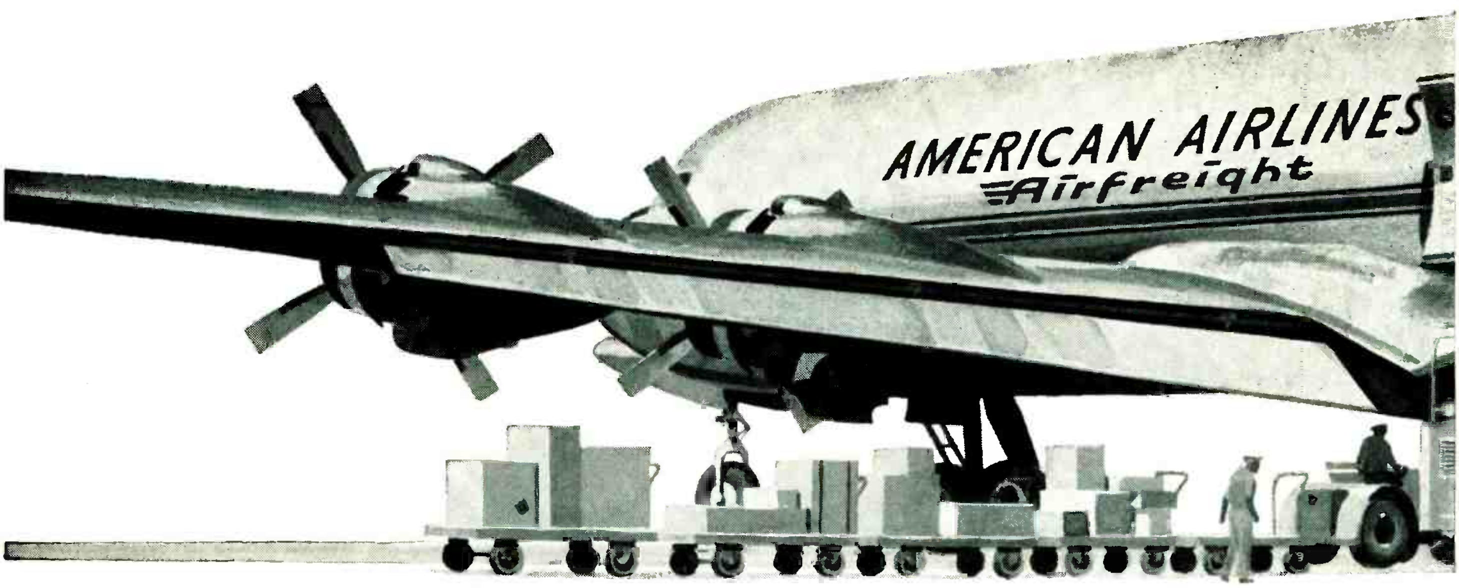
THE FLIGHT THAT MADE

10 YEARS AGO, AMERICAN AIRLINES THE WORLD'S FIRST SCHEDULED

On October 15th, 1944, businessmen found a new way to send their wares to market when an American Airlines DC-3 flew the first flight of the first scheduled airfreight service. Though the event could not compete with the war headlines of the day, it did make news—and good news—to those seeking better methods of distribution.

In the first full year of operation alone, American Airlines delivered more than 2,500,000 pounds of cargo consisting mainly of fish, flowers and pharmaceuticals. Succeeding years saw impressive gains in both volume and variety as well as American's introduction of the first all cargo aircraft to be employed in scheduled freight operations. Today—with ponderous as well as perishable products moving daily by air, the amount of freight carried by American in 1954 is expected to exceed 100,000,000 pounds—again establishing American as the leading carrier of Air Cargo.

With service to leading industrial centers throughout the United States, American Airlines Airfreight is an industry-wide offering whose full potential can only be measured by the imaginations of those who explore and employ its services. American Airlines, Cargo Sales Division, 100 Park Avenue, New York 17, New York.



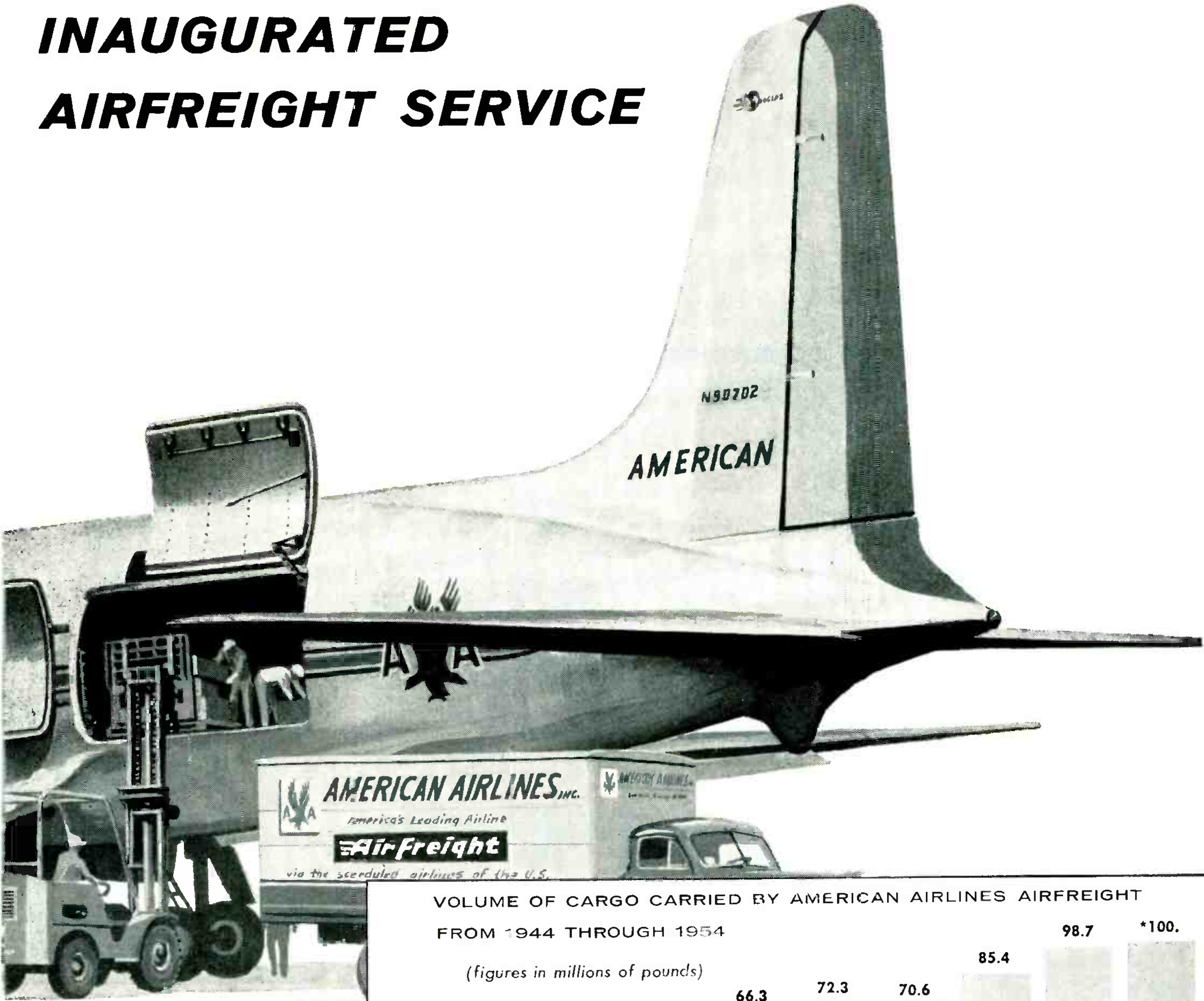
AMERICAN AIRLINES INC.

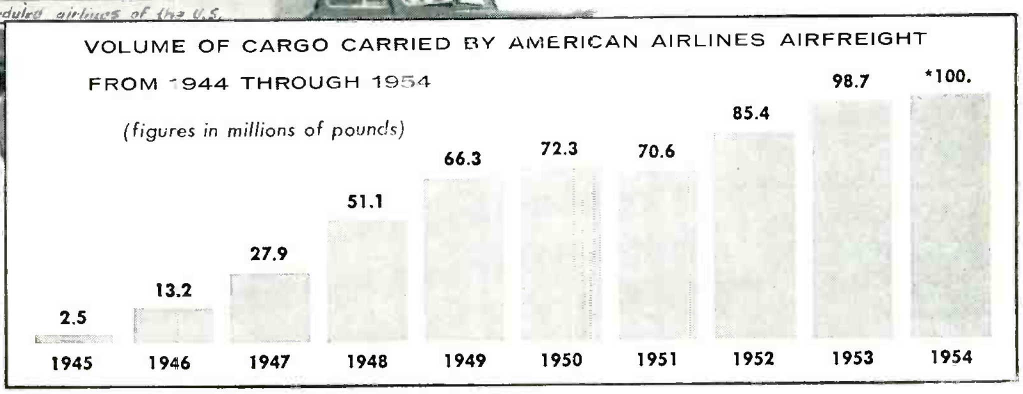
America's Leading Airline

October 15th, 1944 — An American DC•3 makes the FIRST scheduled cargo flight.

HISTORY-but not the Front Pages!

INAUGURATED AIRFREIGHT SERVICE





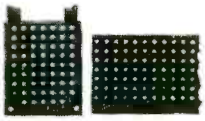
*estimate

Want more information? Use post card on last page.

3. To Provide for CIRCUITRY MOUNTING

Here is a Terminal Card Mounting System that lets you mount your circuitry in space-saving vertical planes and reduces circuitry problems to speedy sub-assembly jobs. Terminal mounting cards you can cut off any length, or order cut to your specs in volume . . . ratchet terminals that require no pliering or wrap-around . . . tube sockets not mounted in chassis, but wired right on cards. Whatever circuitry you plan, the Alden Terminal Mounting Card System is a logical step because it saves space, speeds production, leads to automation of circuitry mounting and paves the way for printed circuitry.

PREPUNCHED TERMINAL MTG. CARD



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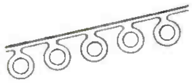
MINIATURE TERMINALS

+

JUMPER STRIP
Eliminates wiring for common circuits



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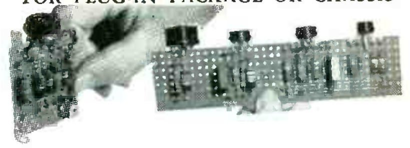
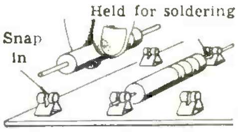
CARD-MOUNTING SOCKETS

=

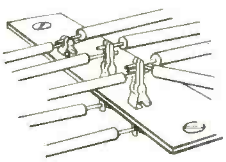
YOUR COMPLETED CIRCUITS FOR PLUG-IN PACKAGE OR CHASSIS



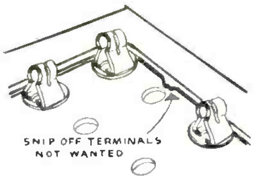


No pliers—No twisting

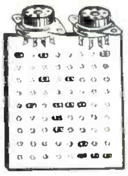
Used in printed circuitry Terminals 652T and 654T form solder eyelet.



Make speedy, flexible wiring terminals.

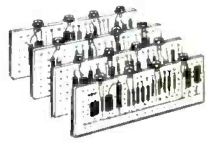


Jumper strip eliminates wiring—can be used to lay out prototype printed circuits.



Sockets can be wired on card before assembly into chassis.

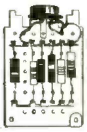
Socket with pigtail leads that drop into printed circuitry.



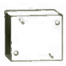
Space-saving circuitry planes mount compactly into chassis.

4. You probably want PLUG-IN CONSTRUCTION

Small circuits wired on Alden Terminal Cards become Plug-in Packages. Using only the basic components listed below, more than 117 tube and circuitry layouts can be accommodated with the Alden Plug-in Package Components.



BAILS mount through housing to Base.

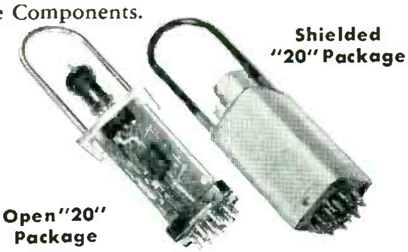


LIDS center card—mounted sockets.

HOUSINGS can be used for complete shielding.

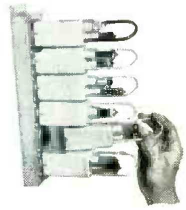
BASE provides up to 20 pins in variable layouts.

SOCKET for chassis or rack mounting.

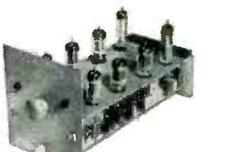


Shielded "20" Package

Open "20" Package



Complete circuits can be divided function by function mounted in planes.



ALDEN BASIC CHASSIS
2", 4", 8" and 17" widths

With complete circuitry divided function by function, the planes of circuitry can be put into Alden Basic Chasses to become plug-in units.

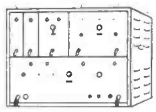
Plug into standard relay rack using Rack Adaptor

Rack Adaptor

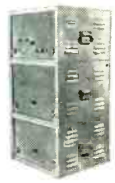
Plug into portable carrying cases

In Portable Cases

Plug into Alden Uni-racks (stacking)

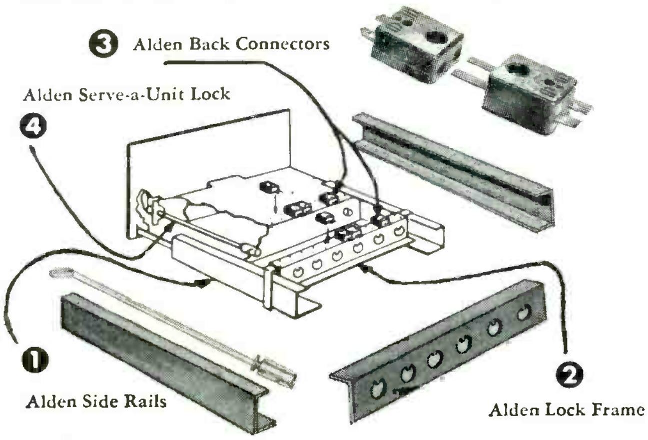


In Alden Uni-racks



5. You may wish to CONVERT DESIGNS TO PLUG-IN

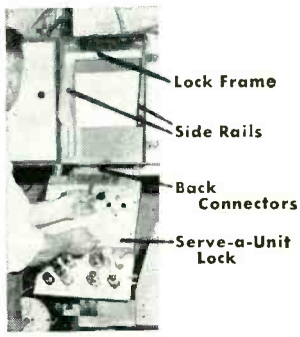
If you want plug-in advantages, it isn't necessary to completely re-design equipment already in existence. Let the Alden Serve-a-Unit Kit make your equipment into a plug-in that's easy to service and replaceable in 30 seconds. Alden standard components are ready and waiting and can be furnished to the exact dimensions you require.



It's as simple as this —

Arrange Side Rails (1) and Lock Frame (2) to accommodate your chassis. Mount Alden Back Connectors (3) on your chassis in orderly accessible row with interval between critical circuits. Mount mating back connectors on Lock Frame which is drilled and tapped to receive them. Insert Serve-a-Unit Locks (4) by drilling simple holes to fit the shank so the detachable pilot head lines up with Lock Frame holes designed to mate with its cam action.

Automatic Electronic Control converted to plug-in



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NEW

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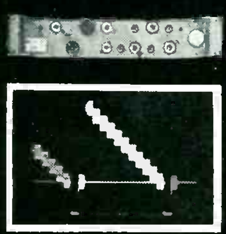
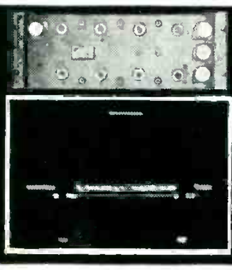
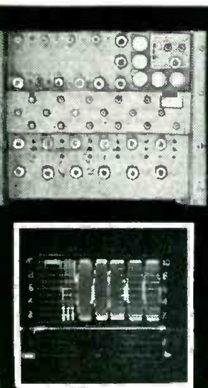
VIDEO
TRANSMISSION TEST EQUIPMENT



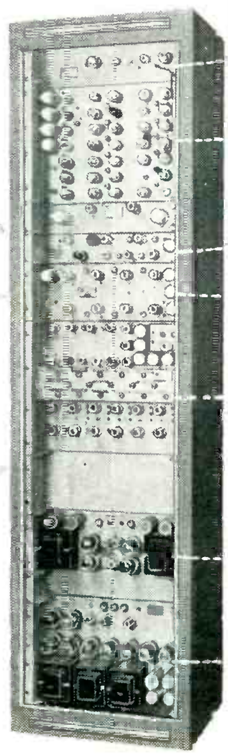
1041-BR STAIR STEP GENERATOR (Variable)
Checks lineary and grey scale output relationship in linear or non-linear system. Built-in color carrier generator may be added to steps. Back porch burst allows lock-in to 3.58 MC color equipment.



1071-AR WINDOW GENERATOR (Variable)
Determines ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.

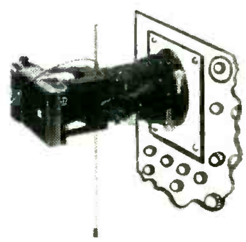


1070-BR MULTI-BURST FREQUENCY GENERATOR (13 freq. selectable from .5 to 6 MC)
Checks wide band coaxial cables, microwave links, individual units, and complete TV systems for frequency response characteristics. Produces six frequencies simultaneously plus white bar reference. Switchable color burst on back porch.



New Telechrome equipment designed to provide test signals for precise checking of video facilities.

This equipment is now in use by major networks, TV stations, and the Bell Telephone System. This type of equipment was recently described by H. Gronberg of NBC before the NARTB Engineering Conference in Chicago. These units are available individually or as an integrated system with 75 ohm or 110 ohm balanced output.



OSCILLOSCOPE CAMERA
MODEL 1521-A (Polaroid Land Type)

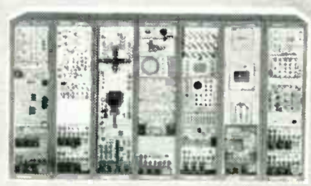
for instantaneous 1-to-1 ratio photo-recording of these or other test signals.

MODEL 608-A HI-LO CROSS FILTER
MODEL 524-D OSCILLOSCOPE

Chromalyzer

Chromascope (Signal Certification)

Phase Slope (Envelope Delay) Curve Tracer

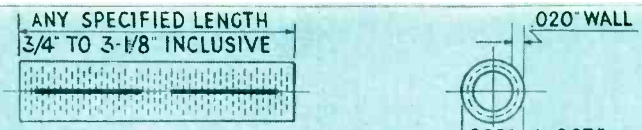


Full facilities Transmits, receives, monitors, analyzes composite color pictures

Literature on these and more than 100 additional instruments for color TV by TELECHROME are available on request.

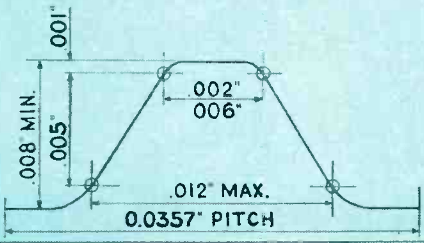
TELECHROME
INCORPORATED

The Nation's Leading Supplier of Color TV Equipment
88 Merrick Road Amityville, N. Y.
AMityville 4-4446



NOTE-:
INTERNALLY THREADED 1/4"-28 AND EMBOSSED TO PROVIDE 1" TO 6" OZ. RUNNING TORQUE WITH 1/4"-28 MPA STANDARD SHALLOW THREAD CORE AS DETAILED BELOW :

THE FOLLOWING MPA STANDARD CORE THREAD FORM DRAWING AND DIMENSION CHART IS THE RECOMMENDATION OF THE CLEVELAND CONTAINER CO. FOR USE WITH TORKRITE COIL FORMS

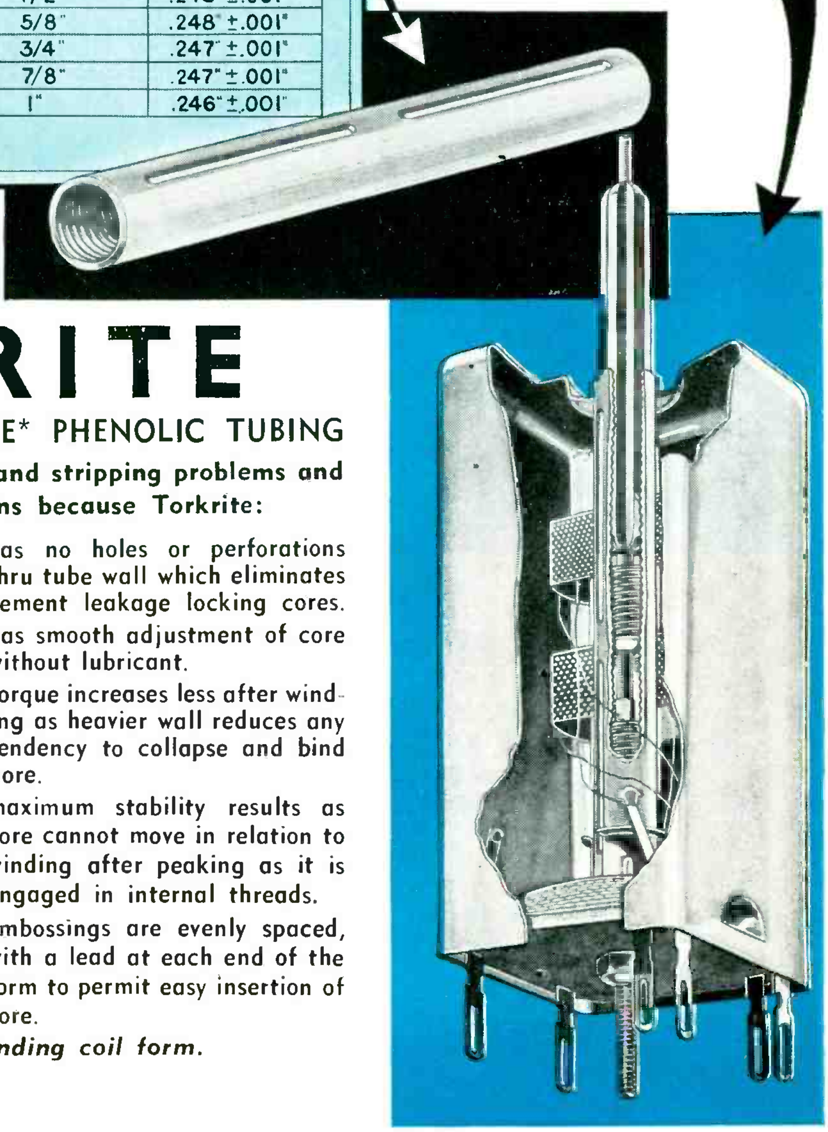


CORE LENGTH	CORE O.D.
3/8"	.249" ±.001"
1/2"	.248" ±.001"
5/8"	.248" ±.001"
3/4"	.247" ±.001"
7/8"	.247" ±.001"
1"	.246" ±.001"

DESIGN

PRODUCT

APPLICATION



TORKRITE

BY THE MAKERS OF CLEVELITE* PHENOLIC TUBING

Torkrite coil forms eliminate torque and stripping problems and are rapidly replacing other coil forms because Torkrite:

- withstands more than required stripping pressure.
- requires no revision other than reduced winding arbor diameter.
- is round and concentric; winds coils at higher speed without wire breakage or fallen turns.
- permits use of lower torque since it is completely independent of stripping pressure.
- recycling ability is unmatched.
- is stronger mechanically because of heavier wall.
- provides 1-6" oz. running torque when used with MPA standard shallow thread core.
- has no holes or perforations thru tube wall which eliminates cement leakage locking cores.
- has smooth adjustment of core without lubricant.
- torque increases less after winding as heavier wall reduces any tendency to collapse and bind core.
- maximum stability results as core cannot move in relation to winding after peaking as it is engaged in internal threads.
- embossings are evenly spaced, with a lead at each end of the form to permit easy insertion of core.

***INVESTIGATE** this outstanding coil form.*

Improved new Torkrite is now available in various diameter tubes. Lengths from 3/4" to 3-1/8" are made to fit 8-32, 10-32, 1/4-28 and 5/16-24 cores.

*Reg. U. S. Pat Off.

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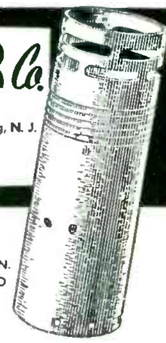
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario



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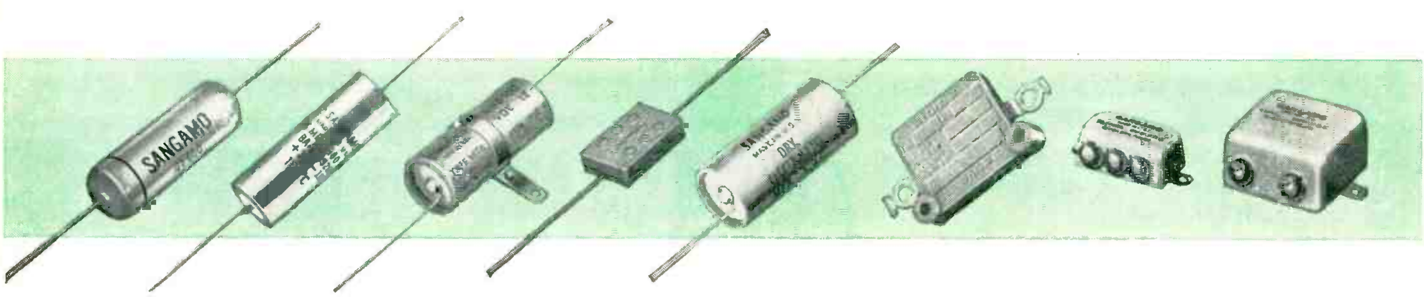
NEW ENGLAND R. S. PETTIGREW & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
CHICAGO AREA PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
WEST COAST IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES

...that's why IBM uses Sangamo

The amazingly complex IBM "702" electronic calculator is hailed as the fastest and most flexible commercial data processing system ever devised. The central Arithmetical and Logical Unit performs calculations and makes decisions at a rate of more than 10,000,000 operations in an hour. Data and instructions for processing are stored in an electrostatic memory bank of cathode ray storage tubes. Output can be in the form of punch cards at the rate of 100 per minute.

A machine like this needs components that assure maximum performance to meet its exacting demands. That's why several different types of Sangamo Capacitors are used in the 702.

If you need capacitors for demanding electronic applications, Sangamo engineers can help you. You can choose from a complete line of paper, mica, electrolytic and button type capacitors for every industrial, electronic, and radio application.



SANGAMO ELECTRIC COMPANY

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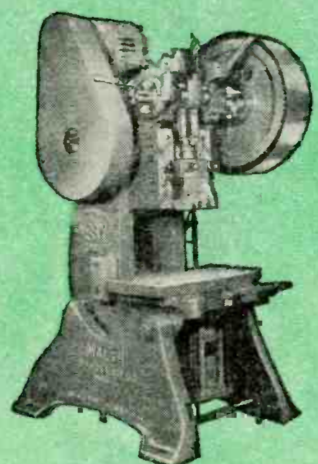

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Accuracy guaranteed ±.0003" with exact size etched on each ring. Individual accuracy one ten thousandth of an inch in roundness, straightness and taper, non-accumulative. Use to set indicating bore gages . . . inside micrometers . . . from $7.90.

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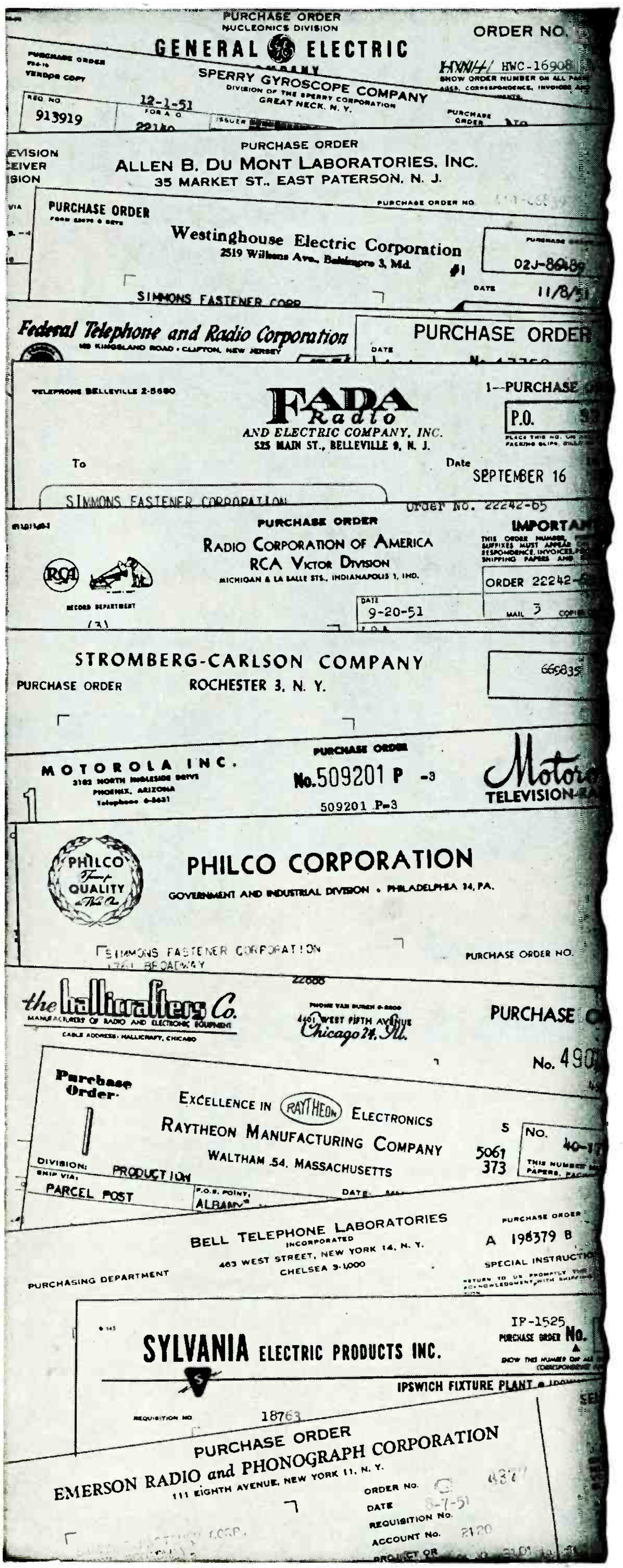

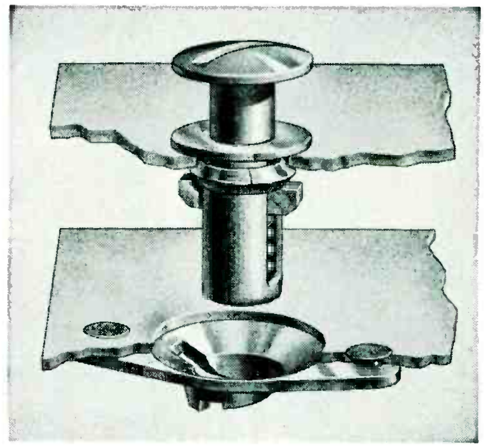

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Why do leading electronic manufacturers order and re-order Simmons' QUICK-LOCKS in quantity? For good dollar-wise reasons:

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- No special tools are needed for installation.
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- Various material thicknesses can be handled.

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- Initial loads taken by helical spring. Increased loads carried on solid supports.
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- Stud is self-ejecting when unlocked.
- Stud is self-aligning. Makes mounting and de-mounting detachable panels simple.

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

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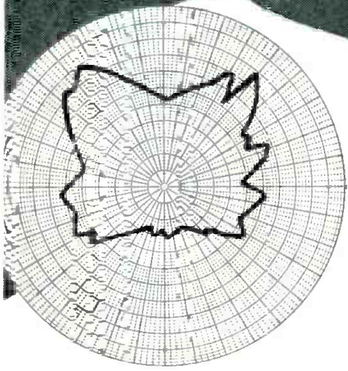

Spherical radiation patterns for antennas automatically drawn in standard polar coordinate form.

SPECIFICATIONS

Pen Positioning System

INPUT	1. Audio-frequency voltage of fixed frequency between 500 and 2000 cps. Amplifier bandwidth 35 cps. Maximum sensitivity 100 microvolts for full scale deflection.
	2. Direct voltage of either polarity. Maximum sensitivity 1 volt for full scale deflection.
PEN SPEED	15 inches per second.
PLOTTING DIAMETER	12-1/2 in.
ACCURACY	±2% of full scale.

Turntable Positioning System

INPUT	1:1 and/or 36:1 synchro signals, 115 volts 60 cps, size 5.
TURNTABLE SPEED	Maximum 7 rpm.
ACCURACY	±1/4 degree.

Primary Power

115 v, 60 cps, single phase, 350 watts.

Size and Weight

24 x 29 in. x 40 in. high, 250 pounds.

Price: **$7500** FOB Mineola

PATENT NOTICE: The polar coordinate pattern recording equipment described herein uses inventions of United States Patents 2,602,924 and 2,681,264 owned by Airborne Instruments Laboratory, Inc.

- ✓ Precision performance
- ✓ Rugged construction
- ✓ Simple maintenance
- ✓ 10 years of Proven Performance
- ✓ Adaptable to special uses

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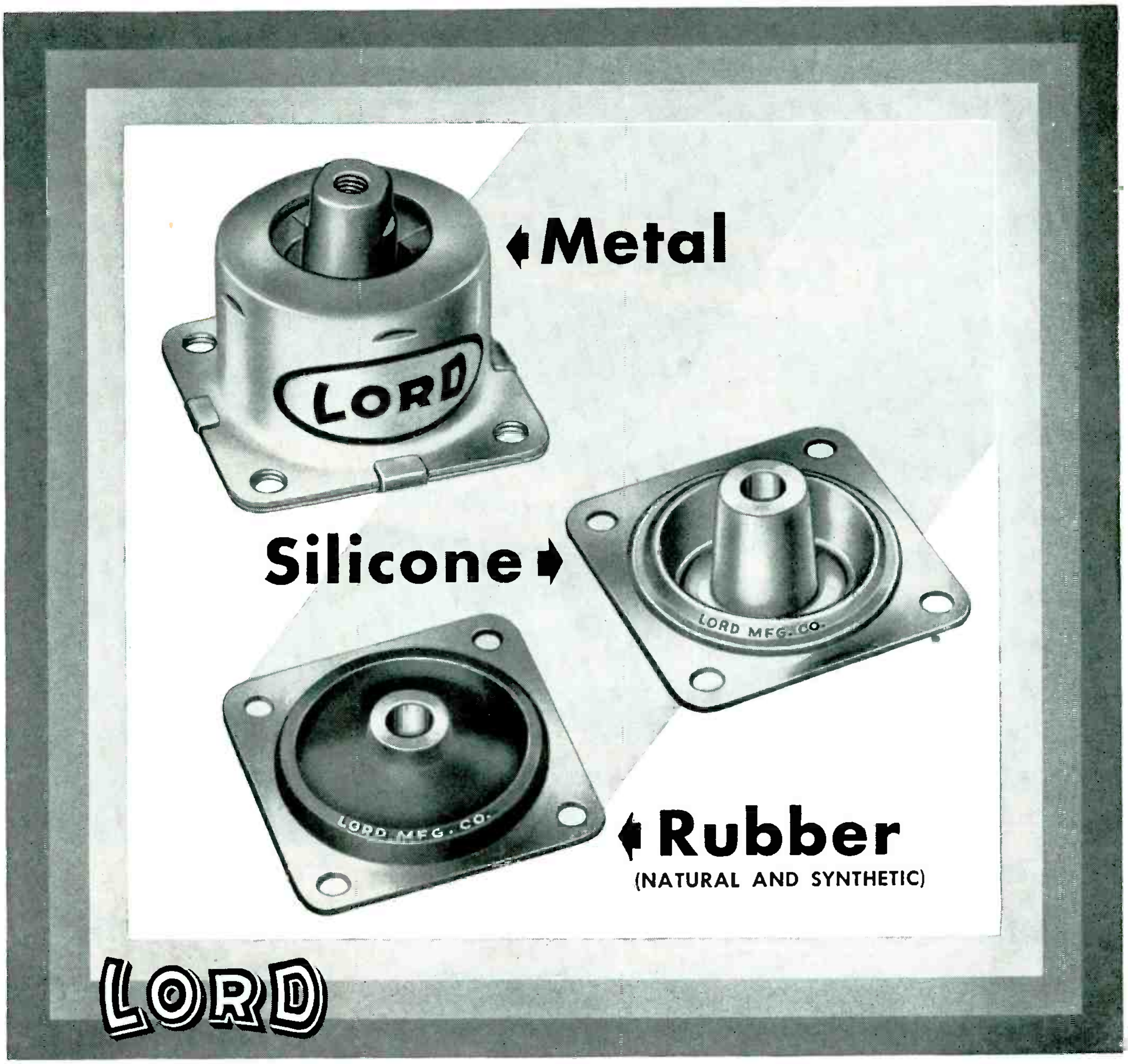
160 OLD COUNTRY ROAD, MINEOLA, L. I., N. Y.



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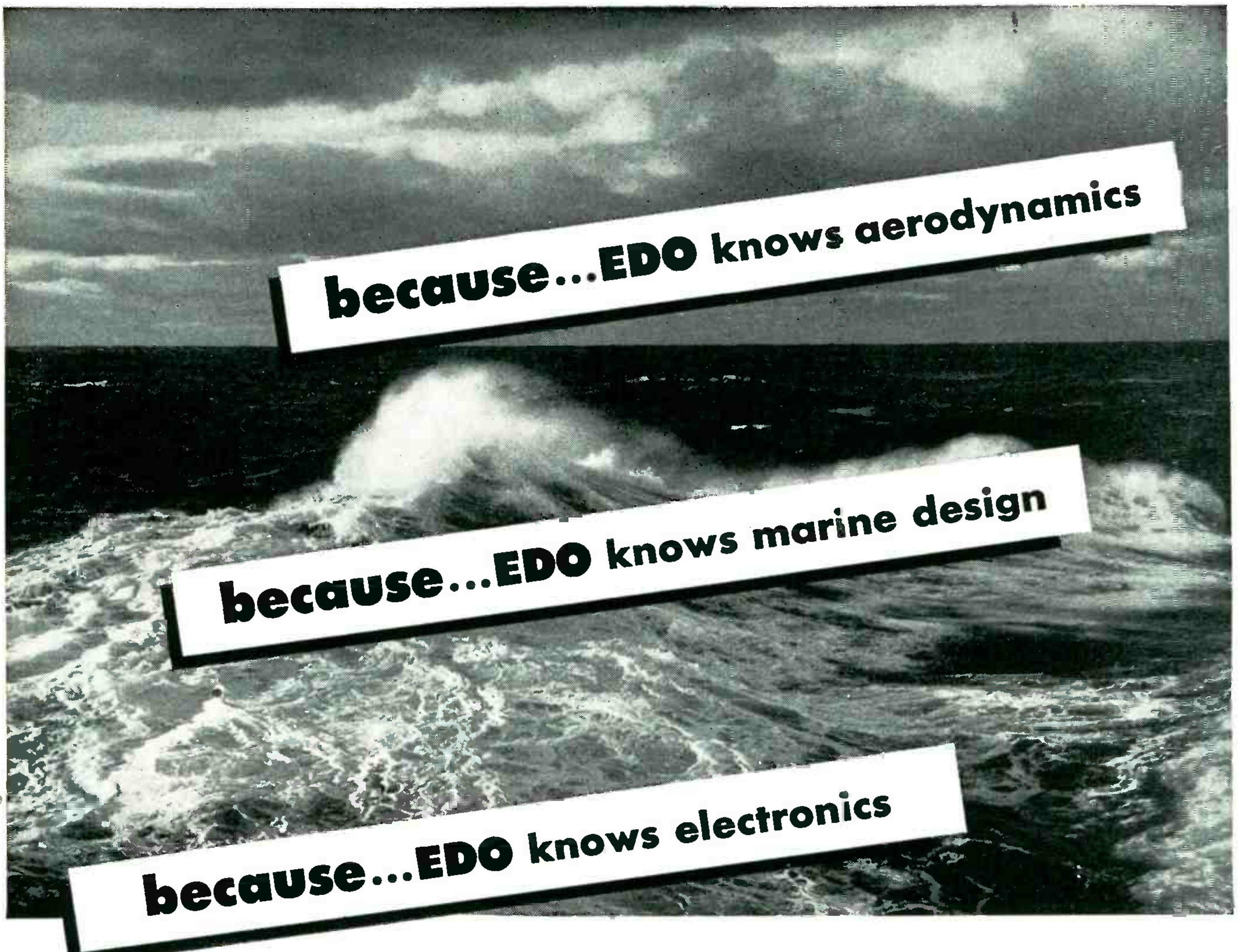

let EDO house your electronic equipment

Housing intricate electronic equipment for airborne or shipboard use to withstand shocks and forces which might cause malfunction often presents problems as difficult as the design of electronic systems themselves.

Tackling such problems for electronic manufacturers, ship and aircraft builders is a specialty of the Edo Corporation. Whether your equipment must operate properly on jet aircraft or on board ship under battle conditions, its reliability is improved if mounted in Edo-designed and built cabinets or housings.

If you have a housing problem, why not talk it over with our versatile engineering staff whose three-fold experience in the marine, aviation and electronics fields is unique *and at your disposal.*

to withstand...

SHOCK
MACH 1 SPEED
VIBRATION
CONCUSSION
SPRAY
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2. SEABORNE INSTALLATIONS. To house its own electronic equipment developed and manufactured for the Navy, Edo engineers have perfected a series of *standard* electronic cabinets admirably suited to naval electronic equipment. Capable of housing all standard electronic units, the Edo cabinets are vibration-proof and spray-proof.

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

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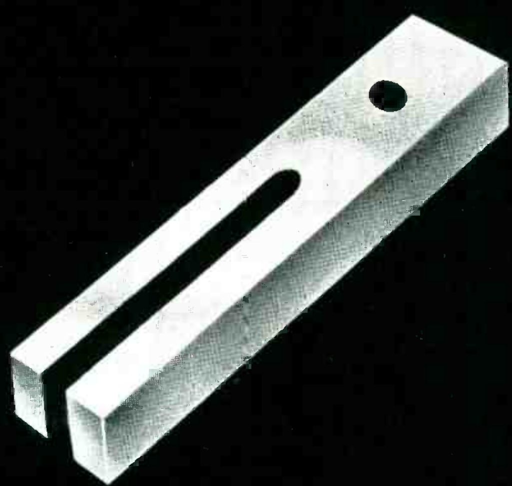
the ultimate in precision audio
frequency control . . .



. . . phone or write

for complete information regarding component type **Tuning Fork Resonators,** or variously packaged **Tuning Fork Frequency Standards.**

Philamon Laboratories Inc.

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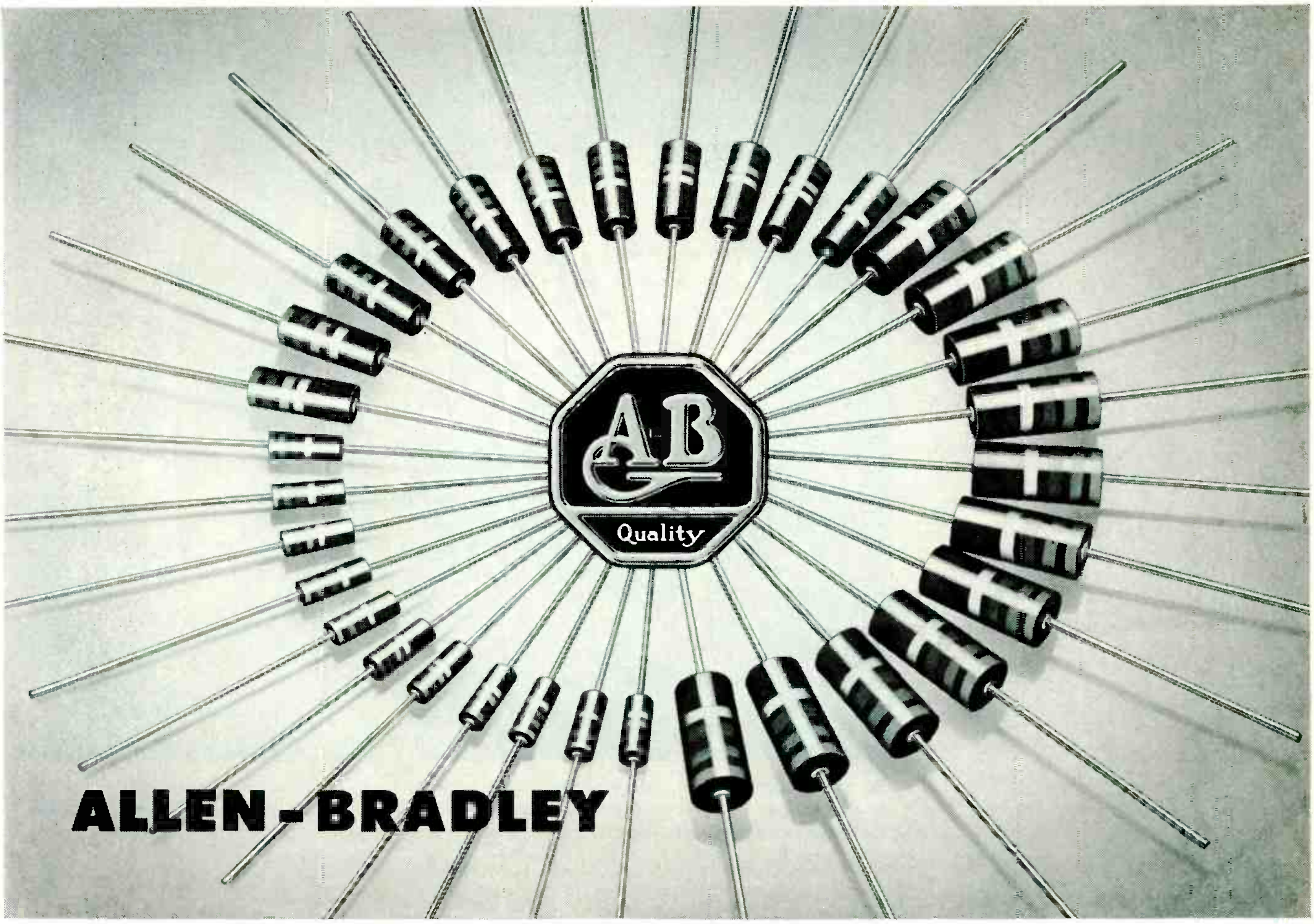

THE NAME THAT GUARANTEES *Quality* IN MOLDED RESISTORS

When you specify Bradleyunits for your radio, electronic, or television circuits you are "playing safe" with your reputation as an electronic engineer . . . because Bradleyunits are ultra-conservatively rated.

All Bradleyunits are rated at 70C ambient temperature . . . not at the usual 40C. They do not exhibit erratic resistance changes nor do they open circuit. They will operate at full rating for 1,000 hours with less than 6 per cent resistance change. Bradleyunits require no wax impregnation to pass salt water immersion tests. Their differentially tempered leads prevent sharp bends near the body of the Bradleyunit. In every way, Bradleyunits are a QUALITY product . . . trouble free, accurate, and always dependable.

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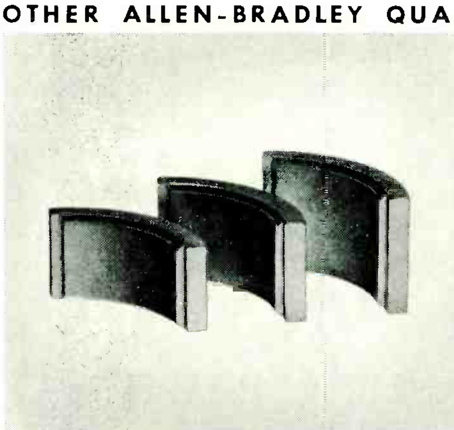
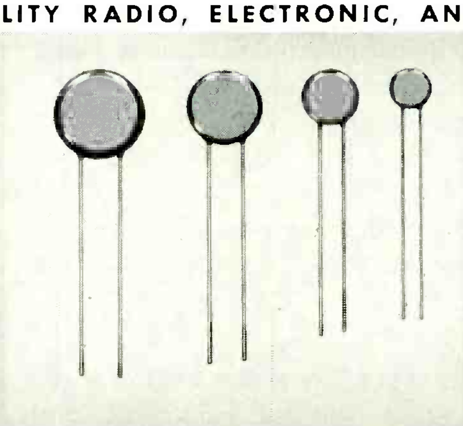
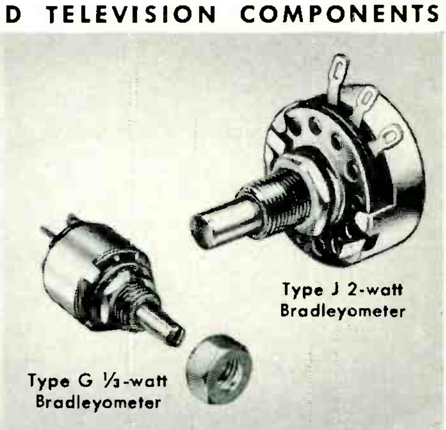


FERRITE CORES



CERAMIC CAPACITORS



ADJUSTABLE RESISTORS

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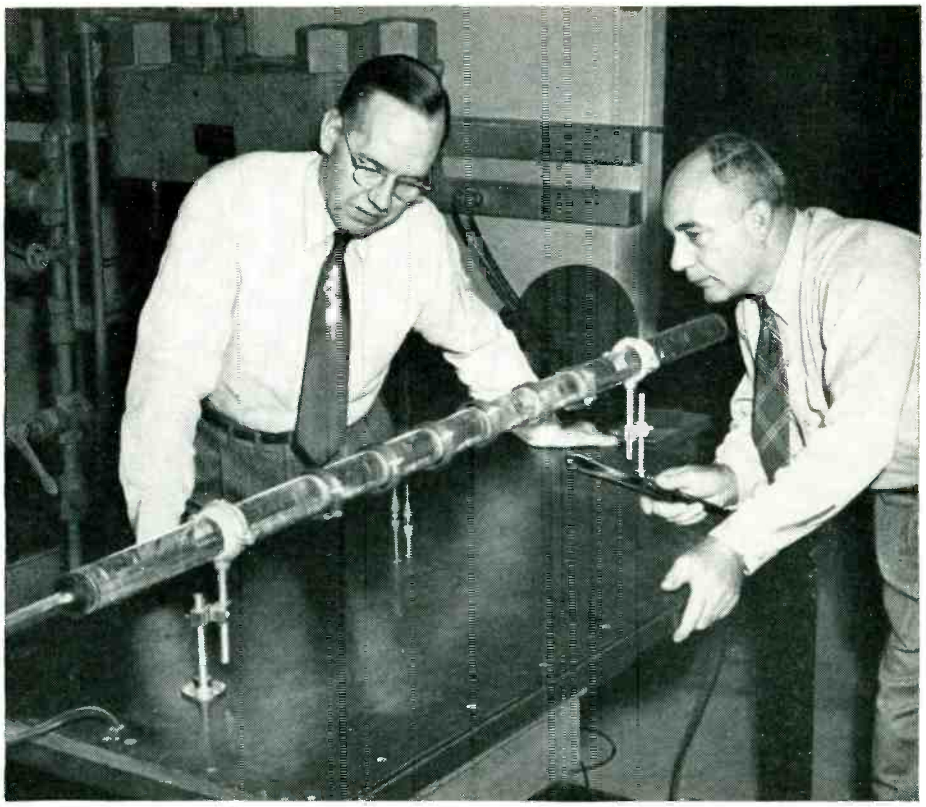

Zone Refining apparatus, showing tube and induction-heating coils. For transistors—tiny electronic amplifiers—germanium is made extremely pure. Then special impurities are added in controlled amounts for best transistor performance.

1 part in 10,000,000,000

To make the most of their revolutionary invention, the transistor, Bell Laboratories scientists needed ultrapure germanium.

The scientists solved their problem by devising a radically new refining process. The germanium it yields may well be the purest commercially produced material on earth.

It has only *one part in ten billion* of impurities harmful to transistor performance. That's about the same as a pinch of salt in 35 freight cars of sugar.

Yet the new process, Zone Refining, is simple in principle. An ingot of germanium is drawn through a series of induction-heating coils that melt narrow zones of the substance. Since impurities are more soluble in the liquid than in the solid form of a metal, the molten zones collect impurities. They are swept along by the successive melts to the end of the ingot, which is finally cut off.

Zone Refining is also being applied to the ultra-purification of other materials useful to telephony. This single achievement of research at Bell Telephone Laboratories clears the way for many advances in America's telephone system.

BELL TELEPHONE LABORATORIES

IMPROVING AMERICA'S TELEPHONE SERVICE PROVIDES CAREERS
FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS

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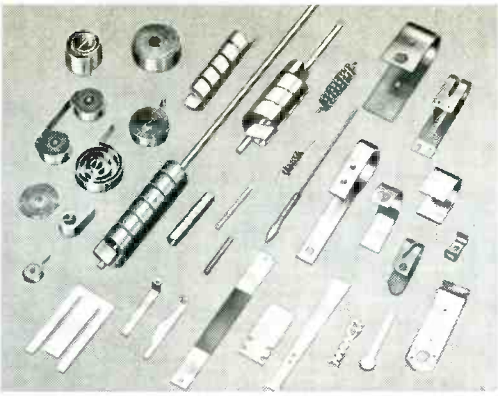
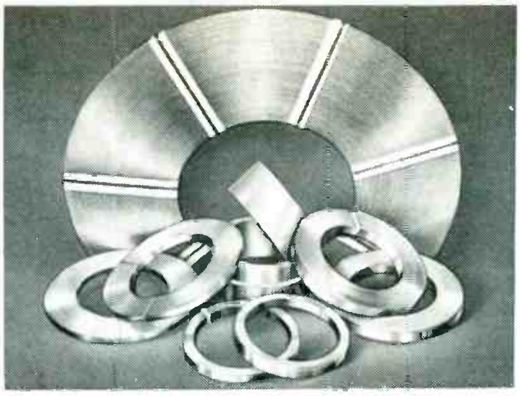


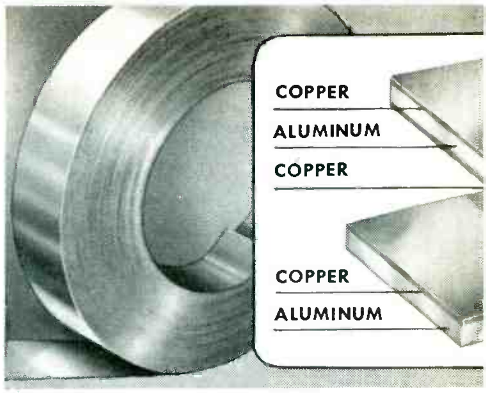
TRUFLEX THERMOSTAT METALS

TRUFLEX thermostat metals are manufactured in a wide variety of types, each with a different reaction to temperature. Uniformity of metal insures accurate and consistent performance. Precision parts fabricated to exact specifications.



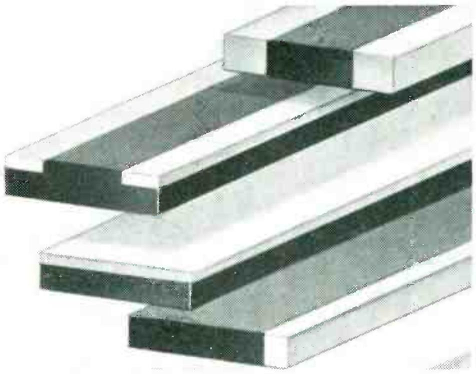
COMPOSITE METALS

Available in practically any combination of precious to precious, precious to base or base to base metals. Combinations for electronics include aluminum-clad iron, nickel-clad iron for anode materials.



ALCUPLATE

Copper-clad aluminum for component cases or cans, chassis, cooling fins, etc., light weight, excellent conductivity. Copper surface is ideal for soft soldering and electroplating.



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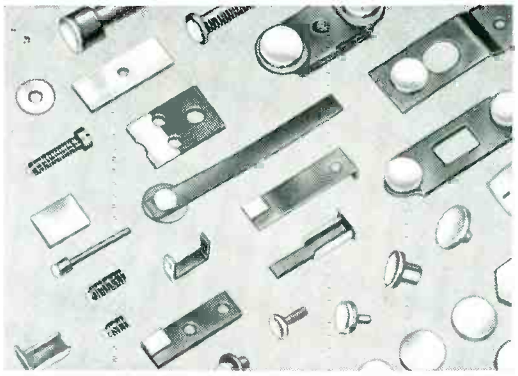
Precious metals and alloys bonded to base metals available in following types — overlay, single and double edgelay, single and double inlay, Top-lay, ready for you to fabricate into contacts.



COMPOSITE CONTACTS

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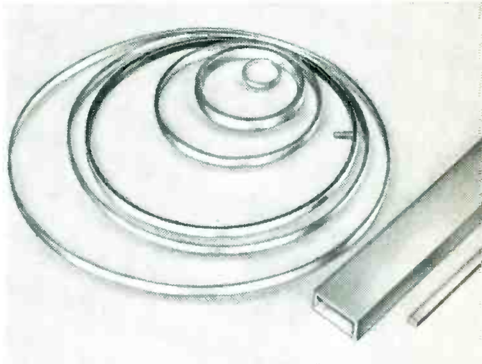

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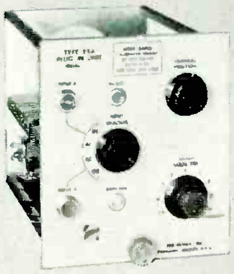
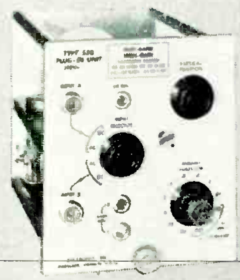
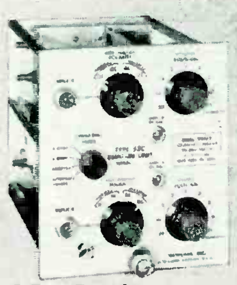


TYPE 53A—DC to 10 mc, 0.035 μsec risetime; 0.05 v/cm to 50 v/cm, calibrated $85



TYPE 53B—Same as Type 53A with additional calibrated ac-sensitivity to 5 mv/cm....$125



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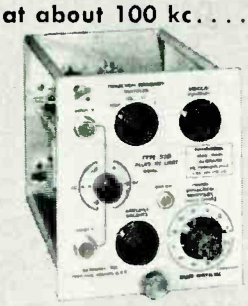

TYPE 53D—Differential input, high gain. DC to 350 kc at 1 mv/cm—pass-band increasing to 2 mc at 50 mv/cm. Full range—1 mv/cm to 125 v/cm...$145

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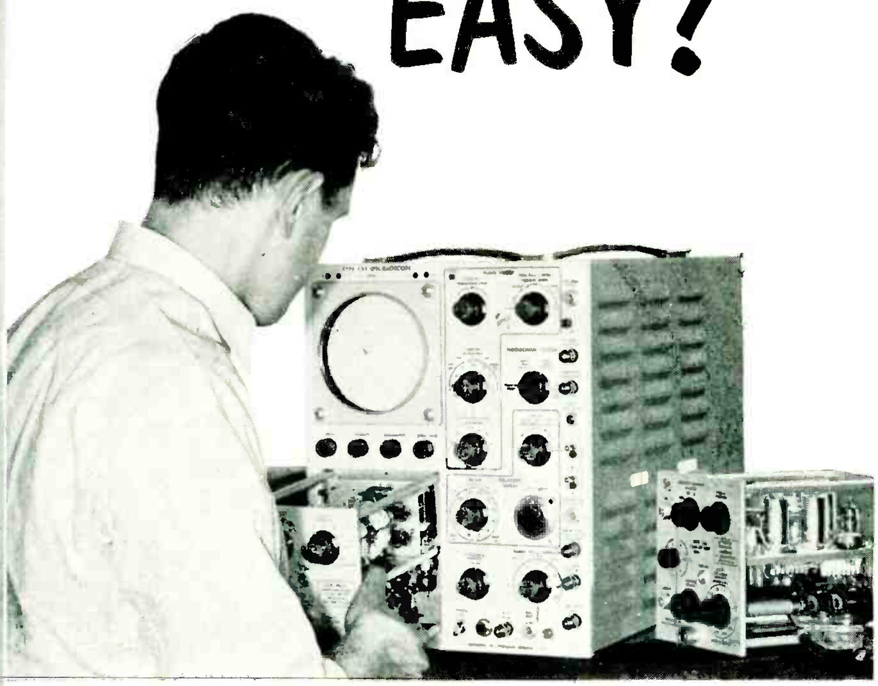

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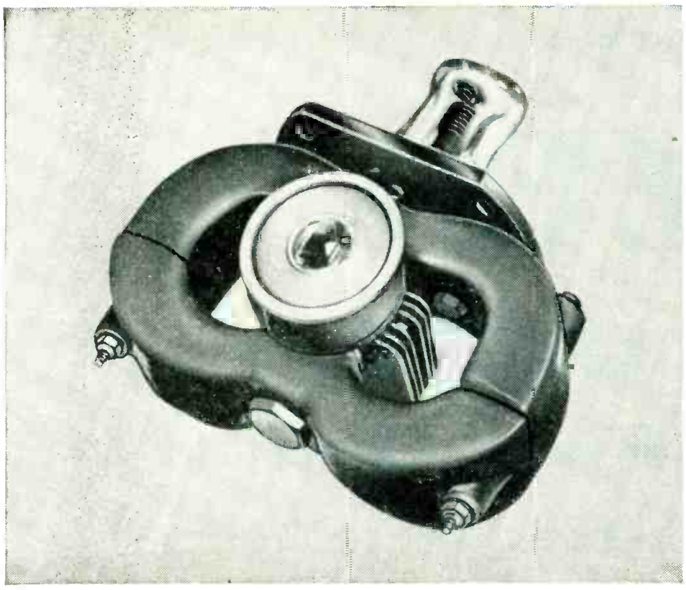

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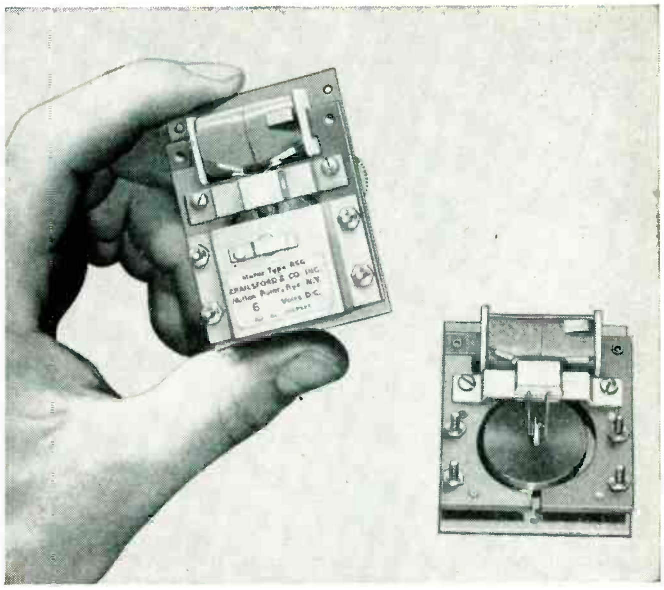

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- Motor Action
- Acoustic Action
- Electron Beam Control

2 Convert mechanical motion to electrical energy
- Generator Action
- Magneto Action
- Sound Pick-up

3 Convert mechanical energy to thermal energy
- Control of Torque

4 Mechanical Holding
- Snap Action
- Separation
- Holding and Lifting

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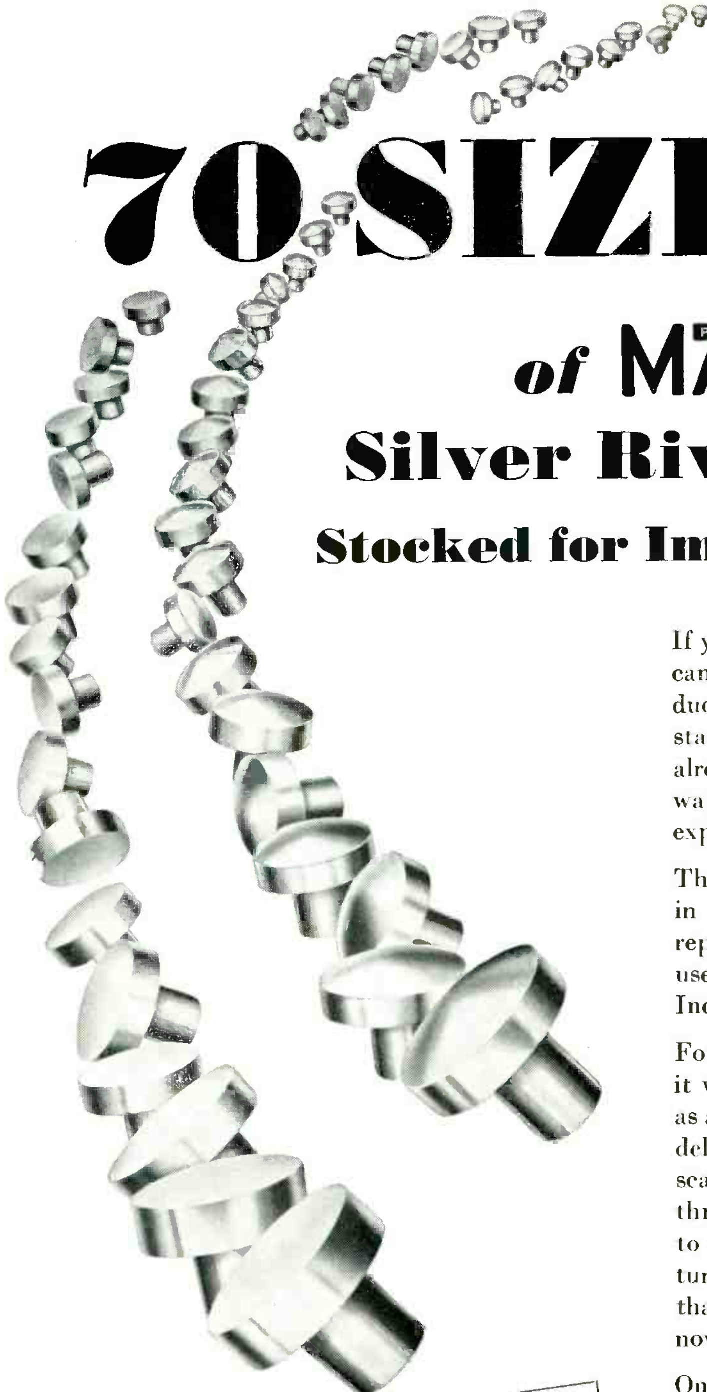

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CROSS TALK

▶ **TELEVISION TRIO** . . . Just over the horizon are three developments which can, in combination, bring about the production of large-screen color television sets at more reasonable prices—picture tubes employing a variety of new principles, mechanized wiring and assembly, and better transistors.

Tube designers are playing close to the chest, but it is known that substantial progress has been made in the direction of simplification, involving such things as printed phosphor grids, single guns and external deflection. Several radio manufacturers already using mechanized wiring and assembly methods for mass production are working hard to adapt machines to more complex tv circuitry. And military use of transistors has now swelled production to the point where reliability and price should be attractive.

▶ **TRANSISTORS** . . . Good as they are, today's transistors are by no means the last word.

Surface contamination still seems to be the primary cause of failure, even in hermetically-sealed units. Oddly enough, point-contact types appear to be least subject to it but, in any case, cleaning of surfaces in the laboratory returns many failed transistors to satisfactory performance.

One prominent engineer says the manufacture of junction types is "like whittling germanium down to a shadow and then plating electrodes on the shadow." This suggests that a method of simulating the action of a thin piece of germanium with a thicker piece operating in some other "mode", casually mentioned in the literature about a year ago, might be the next step.

▶ **LINK** . . . As industry moves closer and closer to fully automatic control of its machines and processes the timetable will be determined largely by economics—how much will it cost to install what kind of control and how soon can tangible gains in the marketplace support it.

Meanwhile, it occurs to us that two more or less packaged products can provide a link between manual and automatic control—telemetering devices and industrial television. Both have a very attractive future.

▶ **SHOPTALK** . . . Printer's errors that we caught before putting a recent issue to press included Phase *Investor* and *Sleep* Front Sawtooth Wave generator. . . . .

One of our editors points out that the industry's active Panel On Electron Tubes may be abbreviated to *POET*. . . . .

A subscriber obviously keen about clipping and filing items out of ELECTRONICS, suggests that we bind the book with "weaker staples". . . . .

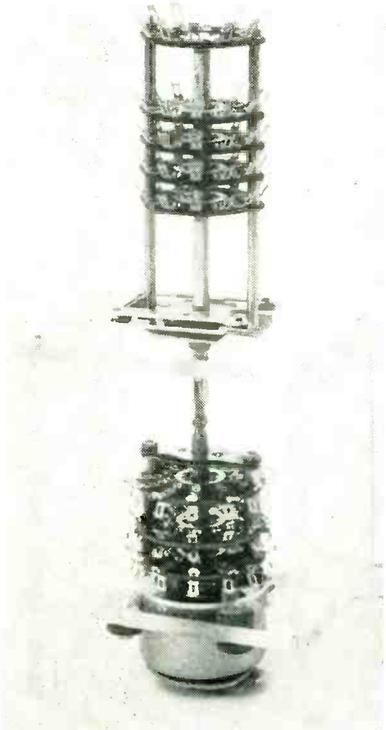
▶ **DEFINITION** . . . Military Airplane: *Electronics with wings.*

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

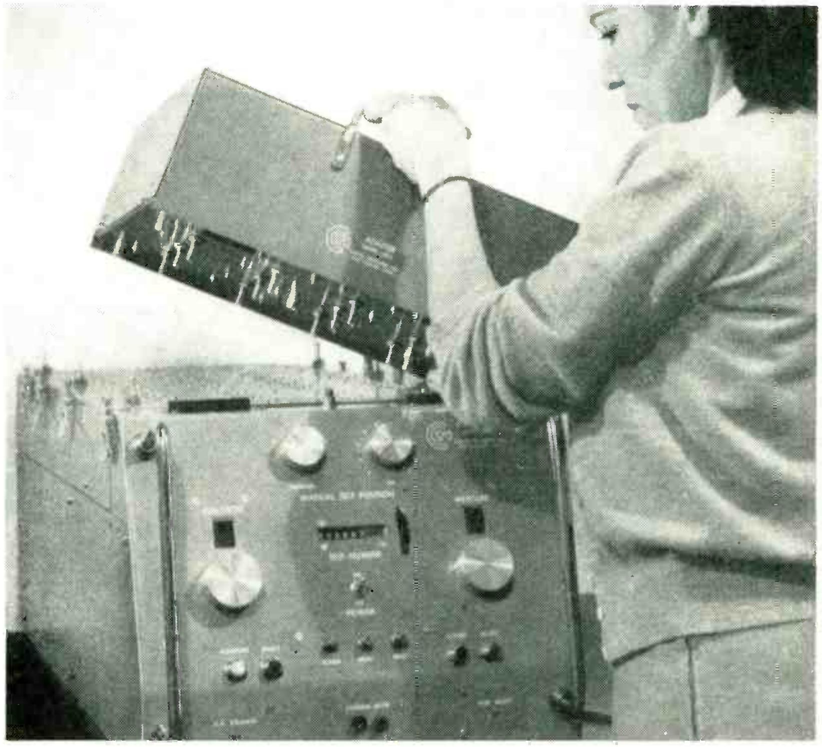
Inserted between pages *192* and *193* is a 64-page special report devoted to the mechanical design of electronic equipment, conceived nearly two years ago and in process of production for the past six months.

In July we started a series of articles spotlighting component design trends, which will continue each month for the balance of the year and well into next spring. And back in March we published a four-color spectrum chart now seen on many walls.

Extras for 1955 are currently under consideration. More about these later



Rotary solenoid with adapter switch



Adapter unit (at top) contains programming and selector switches

Automatic Circuit Tester

Final inspection costs can be cut and product reliability improved with test set that automatically checks circuit wiring and components. Plug-in adapters are tailored to particular units in production, for use with console containing universal test circuits

LIKE OTHER AUTOMATIC devices, the circuit tester described in this article is programmed in accordance with the task to be performed. Rotary switches are permanently wired with the pertinent test data. To change from one test program to another, the set of switches is quickly exchanged. These same switches also select the circuit to be tested, as they are mechanically coupled to drives in the circuit tester.

All portions of the tester not subject to change are contained in a standard universal unit; programming devices and test circuits peculiar to the job are permanently assembled into a special plug-in unit. Thus, the universal unit contains all basic measuring circuits, power supplies and automatic controls. The special adapter unit contains all circuits and components needed to adapt the universal unit to the work, including portions to select the circuit to be tested, designate the type of test, establish test conditions, set required values and tolerances and perform auxiliary operations.

Since unattended operation necessitates automatic control, the drive causes the selector switch to advance one step upon satisfactory completion of each test, in accordance with information supplied by the measurement element. The rate of stepping is adjusted to the inherent speed of a given test. A delay period before rejection is provided, to allow for transient conditions that may simulate defects.

The selector switch position is known at all times and this information is available to the printing device which records the test number of any reject.

Basic Test Circuits

The first of the basic test circuits is the continuity test diagrammed in Fig. 1A. This test is designed to detect small discrepancies in wiring resistance and to spot wiring errors and defective connections. The resistance of the circuit continuity to be measured is R_c; R_d, R_a and R_b are conventional bridge arms set to accept values of R_c less than 0.25 ohm and causing a reject on all connections having higher resistance. If a limit other

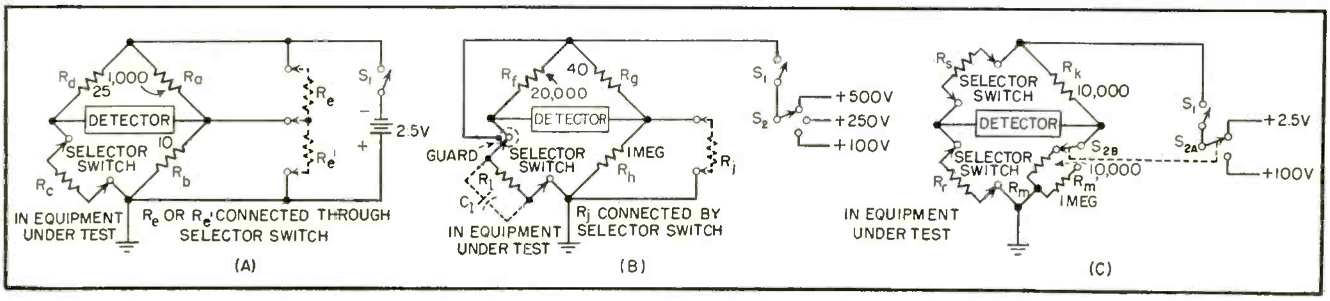


FIG. 1—Simplified schematic diagrams of continuity-test circuit (A), leakage-test circuit (B) and resistance-test circuit (C)

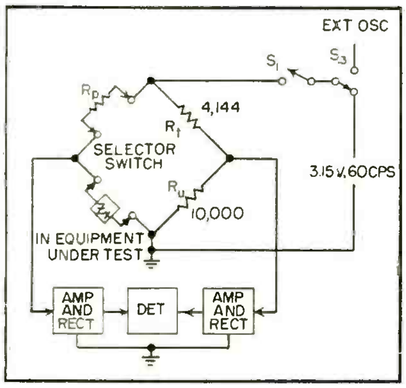


FIG. 2—Impedance-test circuit

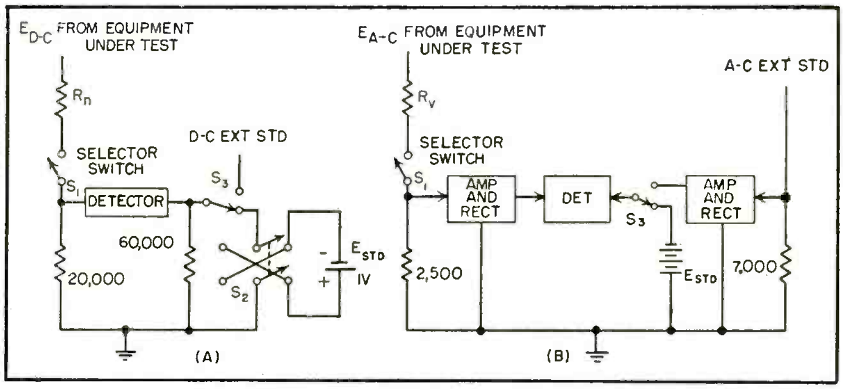


FIG. 3—Circuit of d-c voltage-test circuit (A) and a-c voltage-test circuit (B)

Speeds Production

By ROBERT J. STAHL* and GEORGE R. WEST

Color Television Incorporated
San Carlos, California

than this generally suitable value is desired, the bridge ratio is altered by shunt R_e or R_e' depending upon whether the limit is to be raised or lowered.

A range of 0.1 to 5 ohms can be covered in this fashion with an accuracy of ±0.025 ohm through use of a 1-millivolt detector sensitivity. Switch S_1 removes excitation during selector-switch operation to avoid interruption of the up to 100-ma test current.

The leakage test is made with high voltage in order to uncover incipient breakdowns in addition to wiring and component defects. The circuit in Fig. 1B shows the leakage between the conductor under test and all other circuits (which are grounded during this test by a special selector-switch section) as R_l. Resistors R_f, R_g and R_h form the rest of the bridge.

The test voltage is determined by S_2, and is normally 500 v as in Megger practice, but reducible to 250 or 100 v where component ratings limit. Switch S_1 removes the test voltage during selector operation.

The leakage limit can be lowered from the normal 500 meg to as low as 10 meg by R_j, with all values accurate to about ±5,000 meg shunt. Transients introduced by C_l are made as short as possible by keeping R_f at a minimum.

The resistance test is designed to measure components accurately over a wide range; in conjunction with the continuity and leakage tests all values from 0.1 ohm to 500 megohms can be covered. The resistance being tested is designated as R_r in Fig. 1C, while R_s is the standard, selected in accordance with the limit value of R_r. The other side of the bridge is formed by R_k and R_m, with R_m selectable by S_{2B} to change from the 1 to 10,000-ohm range to 0.01 to 10-megohm range (the excitation voltage being simultaneously raised by S_{2A} to retain maximum accuracy). Through use of 0.1-percent resistors in the bridge, an overall accuracy of better than ±0.5 percent can be maintained.

The impedance test is arranged so that a vector balance is not needed, permitting the use of a

* Now with Dalmo Victor Company

simple resistor, R_p in Fig. 2, as the standard. Inconvenient reactive components are thus avoided in most situations. The separate amplifiers and rectifiers supplying the d-c detector inputs remove all phase response from the system, giving a null whenever the scalar values of the two a-c bridge outputs are equal. The division by the permanent arms is $R_u/(R_t + R_u) = 1/\sqrt{2}$ so that balance is produced when $R_p = |Z_x|$, provided Z_x is a pure reactance such as a capacitor.

Either the internal 60-cycle supply or an external oscillator of selected audio frequency may be chosen by S_3. Impedances from 10 ohms to 1 megohm may be thus measured with an accuracy of ± 1 percent.

Voltage Tests

The d-c voltage test circuit shown in Fig. 3A is used to evaluate circuit operating conditions. The unknown voltage E_{d-c} is supplied through a multiplier R_n having a 20,000-ohms-per-volt drop so that loading will be similar to that imposed by multimeters used by technicians. Resistor R_n is set to include the tolerance limit.

The selector is protected by S_1, while S_2 designates the polarity required of E_{d-c}. An external comparison voltage can be chosen by S_3 for ratio or differential measurements (a limit system can be used to determine either). The range of 1 to 1,000 v may be handled with normal circuits, while higher voltages require special dividers. Lower voltages (down to 10 millivolts) can be accommodated at decreasing accuracy by connecting the external-standard terminal to a known low voltage of similar magnitude. Through use of 0.1-percent resistors in the voltage dividers, an overall accuracy better than 0.5 percent can be held.

The a-c voltage test measures performance. The circuit shown in Fig. 3B permits both absolute and ratio determinations throughout the audio range. The previously mentioned amplifiers and rectifiers convert the signal to the d-c required for the measurement element. A basic sensitivity of 2.5 volts peak at the conventional 1,000 ohms per volt sensitivity avoids most effects of stray capacitance in the wiring.

Switch S_3 selects either the absolute reference E_{STD} or a rectified external standard for measuring relative to line voltage or oscillator level. Transformer turns ratio is easily checked at this latter position. A voltage range from 2.5 to 1,000 volts can be covered with an accurary of ± 1 percent.

Detector

The detector used in the test circuits of Fig. 1, 2 and 3 closes a pair of relay contacts upon receiving a 1-mv limit signal of selected polarity. The simplified circuit in Fig. 4 shows both input terminals floating with respect to ground because of basic test requirements.

The 6AL5 limits the input signal to 3.5 v while not affecting normal levels, due to bias furnished by the two bias batteries. Current through V_1 passes through the coil of overload relay K_1, opening contacts S_1 in the basic test circuits if the overload is of sufficient magnitude and duration and thus protecting the work and the entire tester from damage.

Capacitor C_1 reduces transients, hum and noise, while the parallel-T filter attenuates any 60-cycle pickup. The chopper converts the 1-mv d-c to 60-cycle a-c so that it can be conveniently amplified by V_2, V_3 and V_4. This floating amplifier is coupled to grounded equipment by T_1.

Phase detector V_5 develops a positive d-c output when the plate signal is in phase with the 60-cycle grid reference supplied by T_2. Phase reversal by S_2 reverses the required input polarity and hence reverses the sign of the tolerance. The output of V_5 is filtered by C_2, R_1 and C_3 and applied to V_6. Cathode bias for V_6 is set by R_2 so that relay K_2 is just closed by a 1-mv input, establishing optimum adjustment between sensitivity and stability.

An input polarity from an acceptable test develops a signal through the chopper which is in phase with the V_5 grid reference, producing a positive voltage which overcomes bias on V_6 and thereby energizes K_2. The output contacts initiate a complete stepping cycle of the automatic equipment. Input polarity from a reject test develops an opposite phase signal which can produce no output from the phase detector.

Automatic Control

Figure 5 outlines the basic circuit used to achieve automatic control. Rotary solenoids K_3 and K_4 are each coupled to respective selector switches in the adapter.

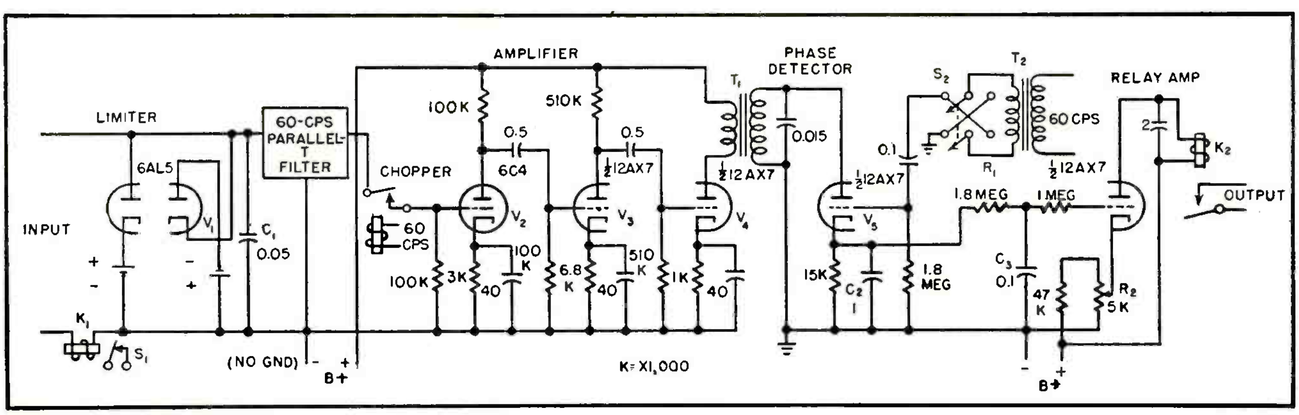


FIG. 4—Detector used in bridge circuits of Fig. 1, 2 and 3. Note that both input terminals are floating with respect to ground

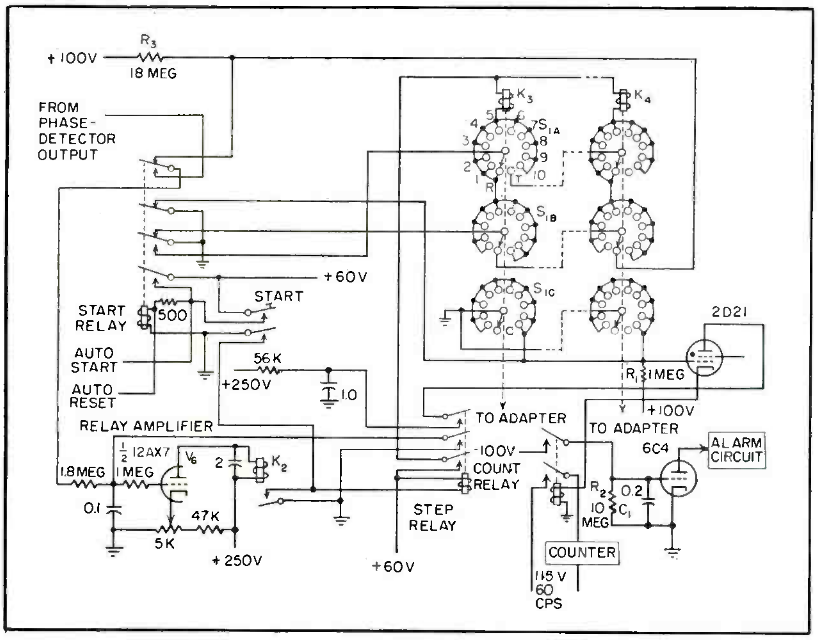


FIG. 5—Basic circuit used to achieve automatic control. Details such as range-changing circuitry, safety provisions and manual provisions are not included

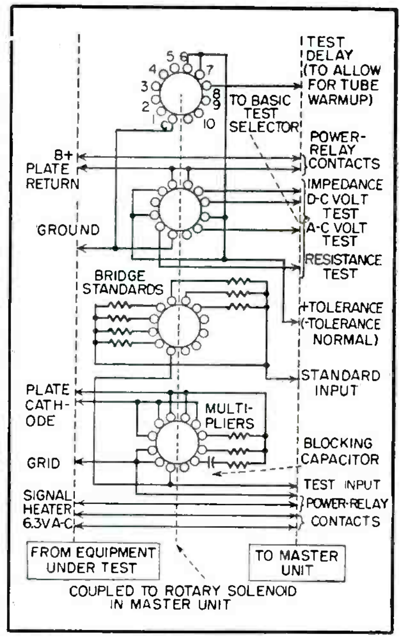


FIG. 6—Typical wiring form to test a resistance-coupled amplifier

Depressing the start button locks in the start relay through the holding circuit and causes K_3 to step to the first test position. The start relay simultaneously connects the ground return to K_3 through S_{1A} and connects the phase detector output to relay amplifier V_6 so that measurement can commence.

A positive (acceptable) signal causes operation of the step relay through relay K_2. Energizing voltage is thus applied to the first rotary solenoid, causing it to step the switch to the next position. Under usual conditions, stepping occurs at a rate of about three per second.

As coupled switch S_{1C} turns, its circuit is momentarily broken, permitting a positive voltage through R_1 to fire the thyratron and thereby energize the count relay, causing the counter to register the next step number. This roundabout method for obtaining the step number is used so that the counter reading will always correspond to the rotary-switch position, even if the latter should lose a step for any reason.

On the other hand, the grounding contact on the step relay, which connects to the relay amplifier input, causes the step impulsing to repeat until the cycle is completed. This combination makes for high reliability of stepping and indicating. If a test is unacceptable, so that no positive voltage appears at the relay amplifier input, all stepping ceases. However, if the count relay does not operate at least once every 5 seconds, replacing the negative charge on C_1 leaking off through R_2, the 6C4 conducts and causes energizing of the alarm system.

At the completion of the tenth test, rotary switch S_{1A} steps to position T, causing the pulse to be transferred to the next switch, stepping it from the original reset position R to the first test position. This avoids the necessity of employing separate stepping switches or transfer relays and permits the addition of an indefinite number of selector switches.

Through the series circuit shown, it is not possible for more than one rotary switch to be stepped to a numbered (or test) position at one time.

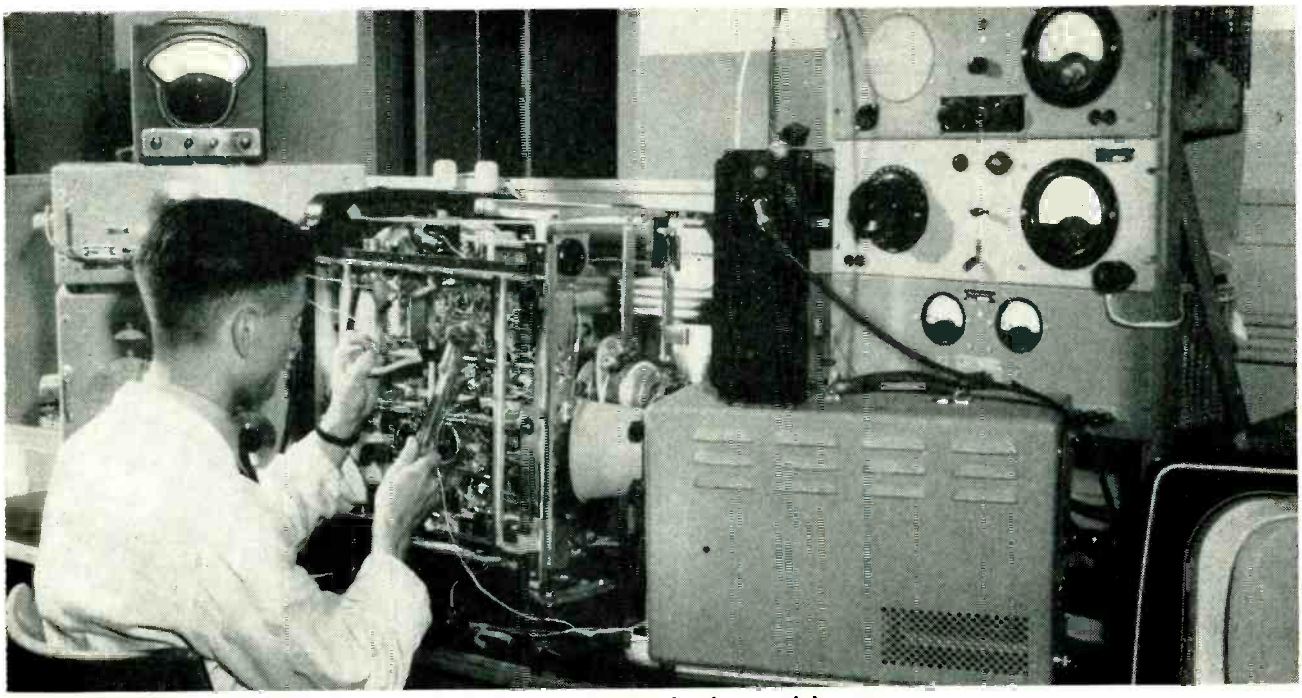
Reset

At the end of the test series, the adapter has the next test position of the selector switch wired to the auto reset terminal, dropping out the start relay. This relay applies a high positive input to the relay amplifier so that the step relay impulses rapidly and continuously. However, the return path from the rotary solenoids is now through switch S_{1B}, instead of S_{1A}. Since the former is shifted one step further than the latter, each switch left on position T (or any other position) is advanced in sequence to R (reset). When all switches reach R, within 2 seconds after the completion of testing, a ground connection is completed to R_3, removing the positive input signal and stopping the operation until the start button is again depressed.

Adapter Design

A form similar to that shown in Fig. 6 printed with the switch symbols, is used in adapter design to provide a combination of worksheet, schematic and wiring diagram. A separate sheet is used for each selector switch.

In the example shown, the first six tests check minus and plus tolerances of the grid, cathode and plate resistors of a standard resistance-coupled amplifier stage. Position 7 checks the upper impedance limit on the cathode bypass capacitor. The plate voltage operating limits are checked at positions 8 and 9, power being applied to the circuit under test through the relay connections indicated. Finally, the a-c signal at the plate is checked at position 10.



Receiver undergoing test at Philips' plant at the Eindhoven television development laboratory

TV Receiver Operates On

By W. WERNER

*N. V. Philips' Gloeilampenfabrieken
Eindhoven, The Netherlands*

BELGIUM, a country with two languages, French and Dutch, has adopted a bistandard television system: one using 819 lines and the other 625 lines. Thus it is possible to rebroadcast tv programs from France on 819 lines and from other neighboring countries on 625 lines without using a line-converter[1]. However, there are also locations in Belgium where direct reception of foreign television broadcasts is possible; Dutch programs in the North, German programs in the East and French programs in the South. The same holds for other regions along the French and Belgian borders. A receiver was therefore developed which would be capable of receiving four different tv systems: the Gerber (named for chairman of CCIR committee) the French and the two Belgian.

Because f-m as well as a-m sound has to be received, an intercarrier-sound system was out of the question without resorting to complicated switching. In the French system the separation between picture and sound carriers differs from that for the other three systems. It would have been possible to use a separate i-f amplifier with greater bandwidth in the case where the receiver was used for the reception of a French channel. Because the video bandwidth for the Belgian 819-line system is limited by the separation of 5.5 mc between the two carriers, it was decided to use the same i-f picture amplifier

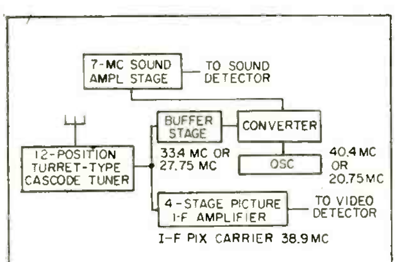


FIG. 1—Diagram shows buffer sound stage between tuner and converter. Small trimmer capacitor switches resonant frequency of tuned circuits in buffer intermediate frequency sound stage from 33.4 to 27.75 mc

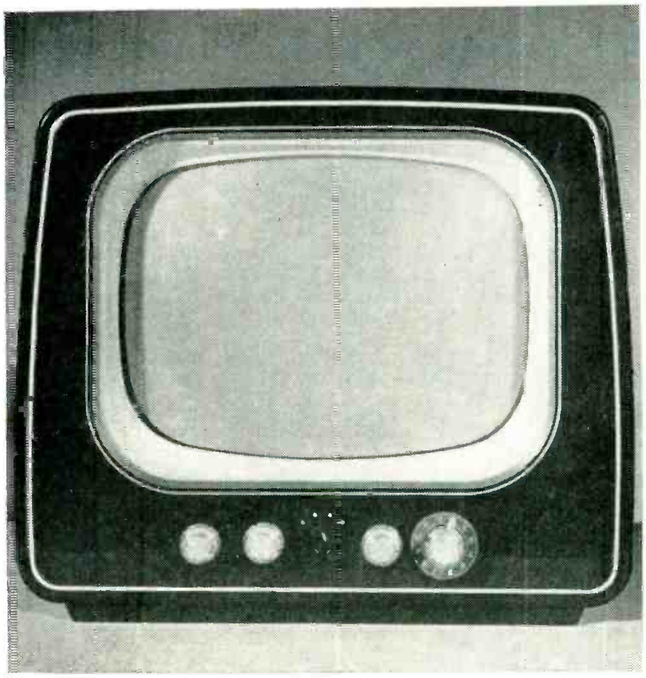
	Gerber[a]	Belgian I	Belgian II	French
Channel width	7	7	7	[b]13.15 mc
Carrier separation	5.5	5.5	5.5	11.15 mc
Picture modulation	neg	pos	pos	pos
Sound modulation	f-m	a-m	a-m	a-m
Number of lines	625	625	819	819
Sync signal	substantially as RETMA			signal field sync pulse of 40 percent line duration

In all four systems the number of frames is 25 per sec and a 2:1 interlace is used. Aspect ratio = 4:3

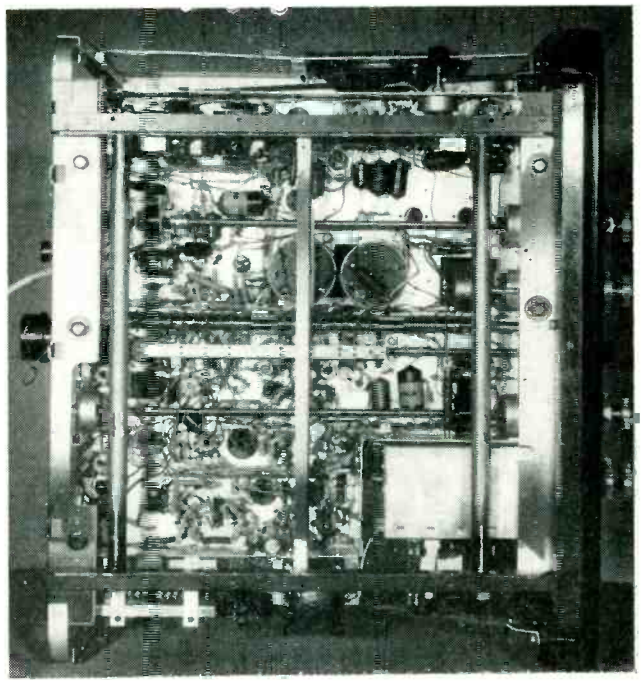
[a]—System adopted by: Norway, Sweden, Finland, Denmark, Western Germany, The Netherlands, Luxembourg, Switzerland, Austria, Italy, Yugoslavia, Turkey and Spain.

[b]—Exception: Paris and Lille transmitters have 14-mc channel width.

Table I—Specifications of Four TV Systems



All four-system receiver controls located on front of chassis



Detail of chassis construction in four-system receiver

Four System Standards

Twenty-two tube receiver operates on Gerber, French and both Belgian television systems. Same i-f picture amplifier is used for all four systems. Sound rejection is necessarily better than 50 db since three of the systems employ a-m sound

for all four systems. Several tests proved that the resulting degradation of the picture was far less than would be expected from the reduction of the video bandwidth.

Because three of the four systems use a-m sound modulation, the rejection of the accompanying sound had to be at least 50 db. The available video bandwidth thus became 4.25 mc. A separate i-f sound amplifier had to be used; the sound i-f being taken off directly after the tuner.

Suitable i-f carrier frequencies for an E-channel were found to be 38.9 mc for picture i-f and 33.4 mc for sound i-f. Keeping the i-f picture carrier at 38.9 mc for the reception of a French channel would mean that the i-f sound-carrier frequency would become 38.9 − 11.15 = 27.75 mc.

It is not easy to design an f-m

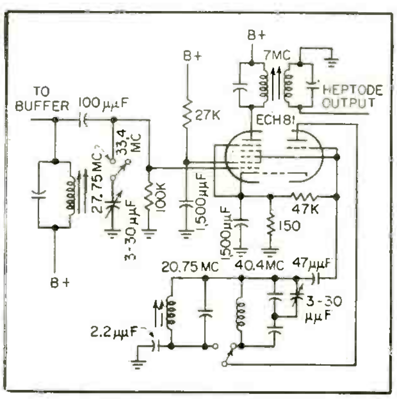


FIG. 2—Converter stage uses triode-heptode ECH 81

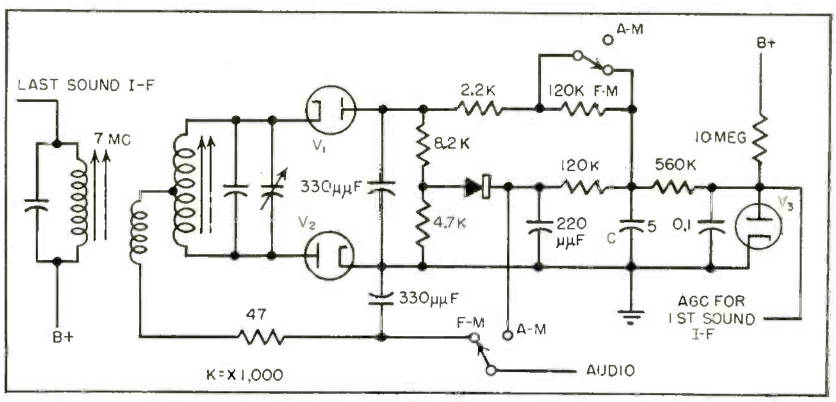


FIG. 3—Sound-detector stage uses diodes V_1 and V_2 in a radio-detector circuit tuned to the 7-mc sound i-f

Table II—Channel Allocation in Gerber TV System

Channel	Mc	Picture carrier	Sound carrier
E 2.	47– 54	48.25	53.75
E 3.	54– 61	55.25	60.75
E 4.	61– 68	62.25	67.75
E 5.	174–181	175.25	180.75
E 6.	181–188	182.25	187.75
E 7.	188–195	189.25	194.75
E 8.	195–202	196.25	201.75
E 9.	202–209	203.25	208.75
E10.	209–216	210.25	215.75
E11.	216–223	217.25	222.75
Italian channels: E4, E4A, E5, E7A, E8A, E10			
E4A.	81– 88	82.25	87.75
E7A.	191–198	192.25	197.75
E8A.	200–207	201.25	206.75

Table III—French TV System Channel Allocation

Channel	Mc	Picture carrier	Sound carrier
F 2.	41.00– 54.15	52.40	41.25
F 3.	54.40– 67.55	56.15	67.30
F 4.	54.15– 67.30	65.55	54.40
F 5.	162.25–175.40	164.00	175.15
F 6.	162.00–175.15	173.40	162.25
F 7.	175.40–188.55	177.15	188.30
F 8.	175.15–188.30	186.55	175.40
F 8A.	173.85–187.85	185.25	174.10
F 9.	188.55–201.70	190.30	201.45
F10.	188.30–201.45	199.70	188.55
F11.	201.70–214.85	203.45	214.60
F12.	201.45–214.60	212.85	201.70

F8A used for Paris and Lille only; F2 not likely to be used.

Any twelve of the channels (Table II, III) can be accommodated in the 12-position turret-type channel selector of the 4-system receiver by inserting appropriate coil strips.

detector for a frequency of 33.4 mc. It was therefore decided to convert the sound i-f to a frequency of 7 mc by using a second oscillator with a frequency of 40.4 mc for reception of an E— channel and a frequency of 20.75 mc for reception of a French channel. This frequency of 7 mc was chosen because the second oscillator frequency of 40.4 mc then fell in the adjacent-

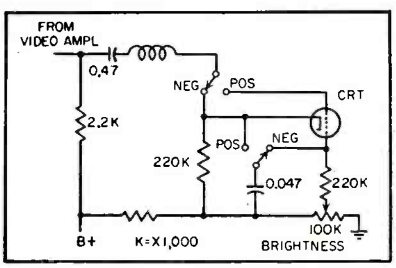


FIG. 4—Positive and negative modulation of the picture information in the four-system receiver requires switching arrangement shown

sound trap provided in the i-f picture amplifier.

Nevertheless, it was not feasible to put this converter directly after the tuner, because too much oscillator voltage was still coupled into the i-f picture amplifier resulting in a 1.5 mc interference pattern in the picture. Therefore, a buffer i-f sound stage was used between the tuner and the converter. The resonance frequency of the tuned circuits in this stage is switched from 33.4 to 27.75 mc by adding a small trimmer capacitor. Figure 1 shows a block diagram of this part of the receiver.

Figure 2 shows the schematic diagram of the converter. The tube is a triode-heptode with the third grid of the heptode-converter connected to the first grid of the triode-oscillator.

Sound Switching

Switching from f-m to a-m sound takes place in the sound-detector stage shown in Fig. 3. The triode of a triple-diode triode PABC 80 (6T8) is used as an audio-frequency amplifier. Two of the diodes, V_1 and V_2, are used in a ratio-detector circuit tuned to the 7-mc sound i-f. The third diode, V_3, serves as a delay for the sound agc voltage applied to the first sound i-f buffer stage.

In the a-m position of the switches, the resistance in series with the anode of diode V_1 and capacitor C is increased. The detected a-m sound is taken off through the germanium diode, which then functions as an interference limiter for pulses above 100-percent modulation level.

Three of the four tv systems under consideration have positive modulation for the picture information. In the anode of the video-output tube the sync pulses are positive when the receiver is switched for reception of the Gerber system. Therefore, the video signal is applied to the cathode of the picture tube. In the reception of a tv signal with positive modulation the

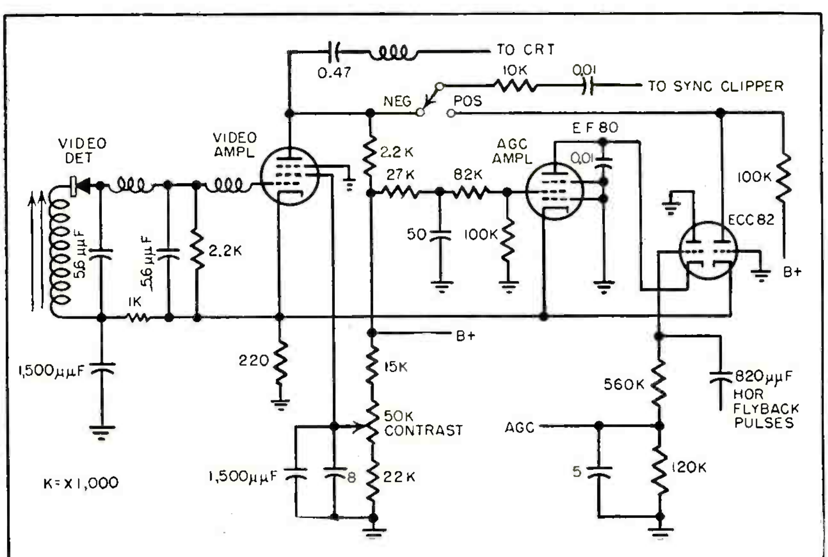


FIG. 5—The agc voltage, with negative modulation, is determined by the sync-tip level of the video signal across the cathode resistor of the video-output tube

video-output signal is switched to the grid of the picture tube. In both cases no d-c component is present in the signal on the picture tube. Figure 4 shows the switching arrangement and Fig. 5 the switching arrangement for sync take-off.

The first sync clipper, Fig. 6, is of conventional design for positive-going sync pulses. For signals with negative modulation the signal applied to the sync clipper is taken off the anode of the video-output stage, whereas in the case of signals with positive modulation the sync clipper obtains its signal from the cathode of the video-output stage through a grounded-grid triode amplifier. This triode is one half of a double-triode ECC 82 (12AU7); the other triode is used as diode in amplified agc circuit.

AGC Circuit

The receiver is equipped with amplified picture agc. With negative modulation, the sync-tip level of the video signal across the cathode resistor of the video-output tube determines the agc voltage. With positive modulation, agc voltage is determined by the peak-white level. Figure 5 shows the circuit diagram. The EF 80 (6CB6) agc amplifier is used as a grounded grid amplifier with its cathode connected to the cathode of the video amplifier tube. It has a short grid base (sharp-cutoff), due to the low voltage on its screen-grid. The video-detector is direct coupled to the video-output tube. With negative modulation its anode current at the sync tips decreases with increasing signal strength. The corresponding voltage level at the cathode of the agc amplifier also decreases until the agc amplifier starts drawing anode current during the sync pulses.

The anode voltage of the agc amplifier is obtained by rectifying horizontal flyback pulses by a diode formed by the grid and cathode of one half of a double-triode. When the anode current of the agc amplifier increases with increasing signal strength the negative agc voltage also increases. In case of signals with positive modulations, the agc amplifier starts to draw current on those parts of the signal corresponding to peak-white in the picture. Contrast control is obtained by changing the screen-grid potential of the video-output tube.

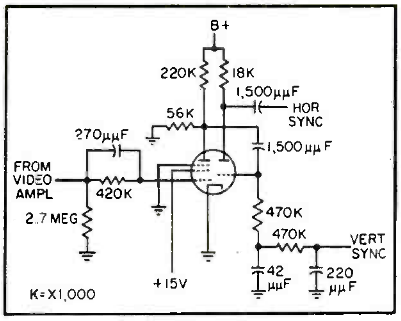


FIG. 6—Sync clipper circuit details

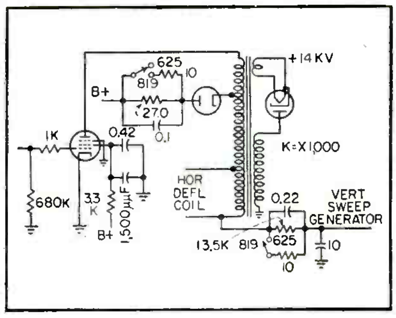


FIG. 8—Horizontal output stage

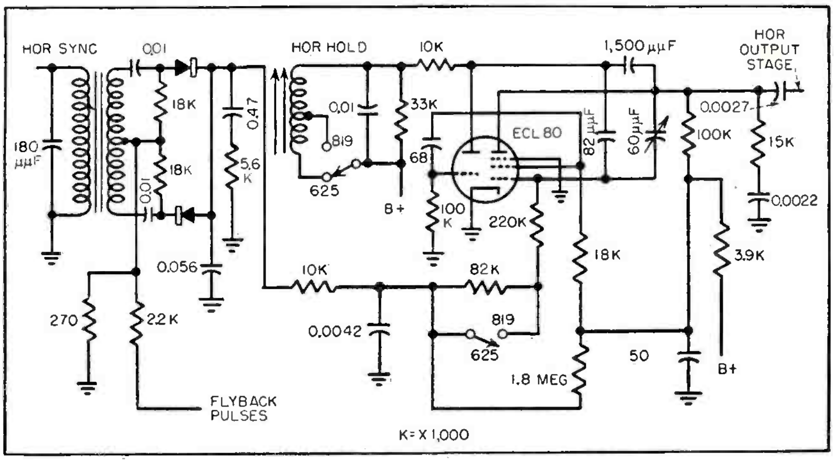


FIG. 7—Horizontal-sweep generator employs triode-pentode in multivibrator circuit

Horizontal Sweeps

The horizontal-sweep generator, Fig. 7, is of conventional design. A triode-pentode is used in a multivibrator circuit with a stabilizing resonance circuit in the anode. The frequency is controlled by a voltage obtained from a balanced discriminator with two germanium diodes by comparing the phase of the horizontal-sync pulses with respect to a sawtooth voltage from the horizontal-output transformer. When switching from 625 to 819 lines the inductance in the stabilizing circuit is reduced and the time constant in the grid circuit of one of the triodes is altered.

The horizontal-output stage, Fig. 8, is changed from 625 to 819 line operation by shorting out a series dropping resistor in its B+ supply. For 819 lines, the anode-supply voltage is the full B+ voltage of 240 volts. For 625 lines, this anode supply is reduced to 180 volts by the series dropping resistor. When switching from 625 to 819 lines the boosted voltage increases from 500 to 650 volts. As this voltage is also used for feeding the vertical-sweep oscillator and the vertical-output stage, a series dropping resistor is switched in when the receiver is operated on 819 lines.

The high voltage for the picture tube is obtained in the conventional way by rectifying the flyback pulses. No switching is necessary in this part of the circuit. For 625 as well as 819 lines the high voltage is 14 kv at a load of 50 μamp. The internal resistance is 10 megohms.

The receiver contains 21 tubes, four germanium diodes, one picture tube and a selenium rectifier for the B+ supply. The photographs show the seven ganged switch wafers and the four-position control knob.

Many engineers have been actively engaged in the development of this receiver, in particular: Messrs. Kerkhof, Berkhout, Janssen and Kollenburg of the television development laboratory.

REFERENCE

(1) J. Haantjes and T. G. Schut, A line converter for the International Exchange of TV Programs, *Philips' Technical Review*, May 1954.

COMPONENT DESIGN TRENDS

Precision Potentiometers

Resistance elements made from deposited metallic films, conductive plastics or lossy liquid dielectrics give infinite resolution, greatly increasing the scope of applications. Other new design and construction techniques give increased life and reliability

PRECISION potentiometers differ from conventional radio volume controls by their inherent features of higher accuracy, freedom from overt electrical noise, longer life (usually 1 million cycles at 60 rpm or less), lower torque and more rigid tolerances on both electrical and mechanical parameters.

Precision potentiometers are generally used to convert mechanical activity—usually rotation but also translation—into an electrical voltage. Whereas volume controls, variable resistors and rheostats, as used in electronic circuits, are made to loose tolerances either because they need not be calibrated or because they operate under such varying conditions as to make calibration meaningless, precision potentiometers are so incorporated in the circuit as to serve a calibrated purpose and to operate under sufficiently stable conditions so that calibration is feasible.

Examples of Applications

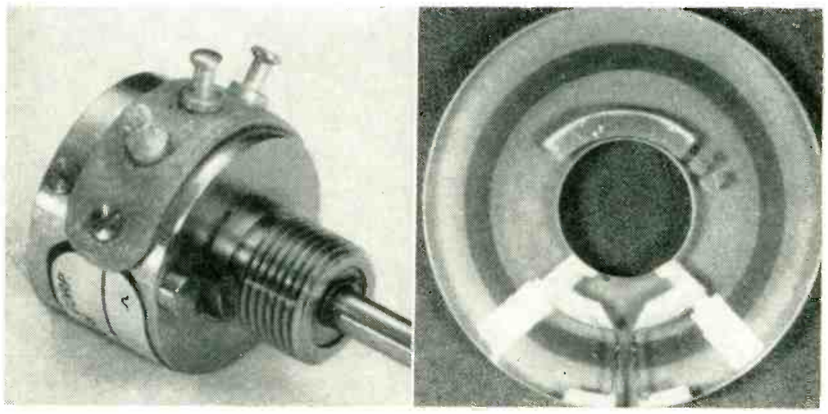
Potentiometers can be used in circuits to add, subtract, multiply and divide. Wire-wound units made by Helipot and others have long been available with nonlinear windings which produce logarithmic, hyperbolic, square root and trigonometric functions.

Previous Articles in Series

Part I: Fixed Capacitors Undergo Miniaturization, p 120, July 1954

Part II: New Variable Capacitors Extend Tuning Range, p 130, Aug. 1954

Part III: Fixed Resistors Show Stability Improvements, p 132, Sept. 1954



Miniature Fairchild potentiometer with metallic-film element provides essentially infinite resolution, is stable to 225 C and can be produced in a wide range of resistances for applications requiring high accuracy

Precision potentiometers are frequently used as mechanical amplitude modulators. For some applications it is desirable that the wiper rotate continuously through 360 degrees in which case the winding may itself be continuous or have an interruption making the electrical contact angle something less than the 360-degree mechanical rotation.

Specialized uses of potentiometers as in analog computers have led to the development of differential computing potentiometers. In such a unit a linear winding is arranged to rotate as well as the wiper, both through 360 degrees. For example, instead of using terminal lugs, the Fairchild D-C-P differential computing potentiometer provides external connections to the winding ends and wiper by means of three silver slip rings molded on the body. This arrangement makes possible the measurement of two variables directly in a single instrument. The voltage output is proportional to the sum or difference of the two input variables—the angular movements of the body and of the shaft.

As the reliability of potentiometers increases, they are finding use as information transmitters in place of variable transformers, variable capacitors and photoelectric devices. In such applications,

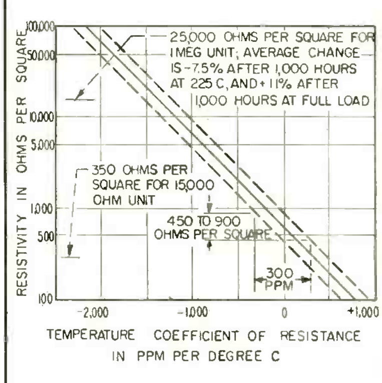


FIG. 1—Typical relation between temperature coefficient of resistance and resistivity of Fairchild film unit

Use New Materials

By FRANK ROCKETT
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Airborne Instruments Laboratory, Inc.
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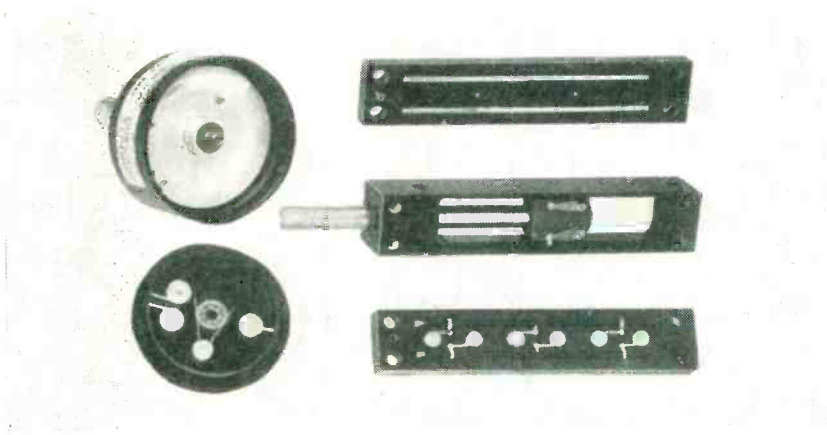


Markite conductive plastic rotational and strip-type translational potentiometers provide long life and infinite resolution. For strip-type unit, taps molded into back of resistive element (bottom) leave conductive track (top) clear for slider in center

potentiometers are frequently more compact and weigh less than similar information transmitters. Circuits can be arranged to make full use of their inherent accuracy and to avoid cumbersome mechanical lears, cams and linkages.

New resistance materials and new construction techniques have been developed in the past few years to broaden greatly the scope of applications for precision potentiometers. Some of these new designs will be discussed with a representative example in each case, to give a quick picture of what is now available to engineers for incorporation in electronic products.

In a wire-wound potentiometer the resistance to the slider varies in small steps as the slider moves from one turn to the next of the resistive element. The amount of this step change in resistance is the resolution of the potentiometer, and is inherently related to the size of resistance wire used.

Metallic Film Units

Newly introduced film potentiometers employ a construction giving what is commonly referred to as an infinite resolution. The film units have therefore served to broaden considerably the scope of applications for potentiometers as transducers for servomechanisms and for telemetering.

With a resistive film there are an infinite number of positions of contact by the slider on the resistance element, with a corresponding infinite number of outputs of electrical voltage. This assures freedom from hunting or oscillation of a servo due to the inability of the

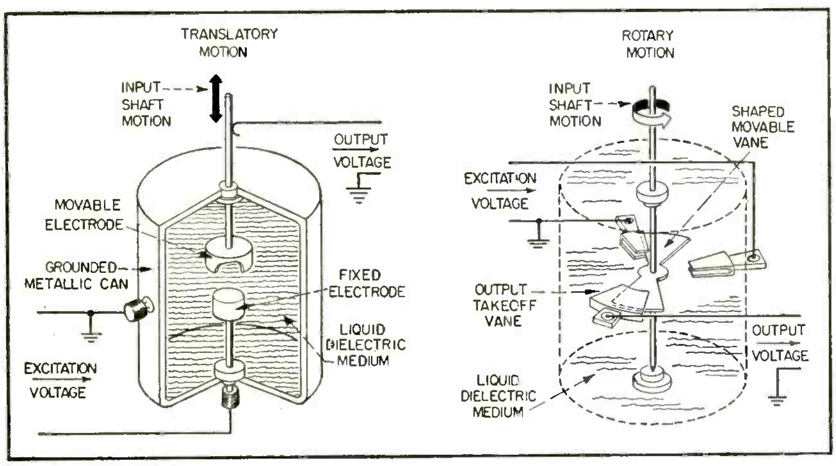


FIG. 2—Liquid dielectric potentiometer provides infinite resolution. Capacitance to output electrode varies in same ratio as does resistance, hence time constant is substantially unchanged by rotation

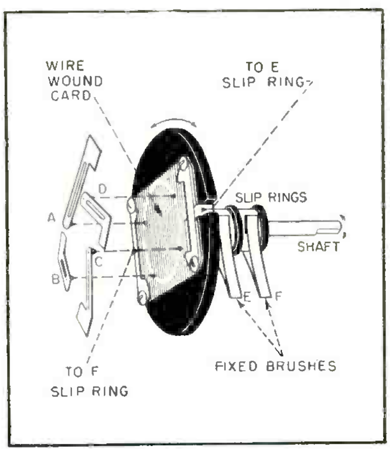


FIG. 3—Sine-cosine potentiometer made by Rawson Electrical Instrument Co. uses linear resistance card

COMPONENT DESIGN TRENDS

- Metal films thermally evaporated onto glass withstand up to 225C
- Long-wear conductive plastic elements have integrally molded taps
- Straight-line resistance elements translate linear motion into voltage changes
- Liquid resistance elements approach infinite resolution and have flat response from 50 cps to 1 mc

balancing potentiometer to find a null.

Illustrative of the properties that can be built into a film potentiometer is the recently announced FilmPot of Fairchild Camera and Instrument Corp. This potentiometer is built in an unusually small size, being only 0.75 inch in diameter and 0.5 inch long. Within this case a wide range of resistance is possible. Currently available units include resistances from 100 ohms to 1 megohm ±10 percent. Independent linearity can usually be maintained to 0.5 percent, can probably be improved to half this value by further control, and reduced to 0.1 percent by selection. Noise is rated at 400 mv or less; units can be furnished with torques as low as 0.1 oz-in.

Another outstanding feature of the metallic film potentiometer deposited on glass is its ability to withstand high temperatures. The unit is electrically and thermally stable to hot spot temperatures of 225C; units with resistances to 500,000 ohms are capable of dissipating 3 watts at 100C and are derated linearly to 0 watts at 225C. Due to voltage breakdown limitations, rated dissipation decreases linearly for higher-resistance units to 1 watt at 1 megohm. The potentiometer resists corrosion even at these high temperatures. Materials used in the unit are precious metal alloys, glass and high-temperature plastics and lubricants.

Thermal and electrical stability of a metallic film are better at lower resistivities. The relationship of resistivity to temperature coefficient of resistivity differs for film materials; the curve presented in Fig. 1 is for the material used in one commercial potentiometer. There is an intercept at which films of 600 ohms per square have an average temperature coefficient of zero. Marked on the curve is the range over which temperature coefficient of resistivity is within 0.03 percent of zero.

The state of the film potentiometer art indicates that quantity production of such units is in the foreseeable future. Prices are likely to be within the ratio of their performance compared to the price and performance of wire-wound units.

Using artificial or natural graphite depending on desired characteristics, manufacturers are developing precision adaptations of carbon film potentiometers. Units from Elektro-Serv Co. display a temperature coefficient of resistance of ±0.01 percent per degree C at normal ambients, are rated for 2 watts to 50C and are derated to zero at 65C. Terminal resistances range from 1,000 ohms to 2 megohms, with tolerance of ±1 percent if required; independent linearity is normally ±1 percent. Sufficient pressure (25 to 50 grams) of the gold wire wiper is used to keep noise comparable to the inherently low thermal noise of the controlled composition resistance track, yet the pressure is light enough to achieve a rated life of a million cycles at 100 rpm. Dual takeoff from the buffed silver slip ring of the rotor also contributes to low noise, low inductance and low torque (0.5 oz-in. per section with ball bearings).

Conductive Plastic Units

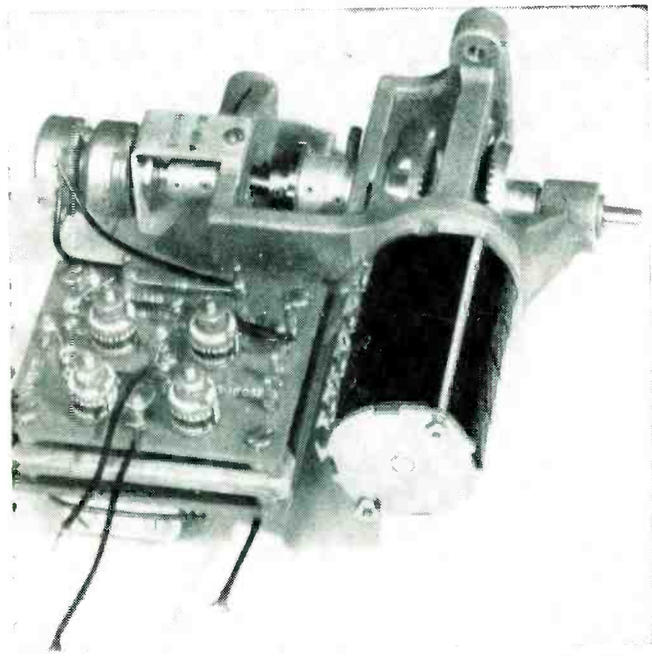
For applications requiring long wear and high resolution, potentiometers whose resistive tracks are of solid conductive plastic are integrally comolded by Markite Corp. with terminals and taps to a rigid mineral-filled phenolic insulator support. The low coefficient of friction combines with extreme wear resistance of the smooth track to permit use of relatively high brush contact pressure without incurring excessive torque or short life. As a consequence such units provide quiet operation even in the presence of substantial vibration and acceleration.

Manufacturer's tests at 600 rpm showed an increase in resistance of 25 to 30 percent after 236-million revolutions; noise and linearity remained substantially unchanged. As a consequence of these and of customer tests, units are guaranteed for 5-million revolutions at up to 600 rpm with a resistance change less than 3 percent and a linearity change less than 0.1 percent. Resolution is better than 0.00004 inch. Because taps are molded into the resistive track below the surface contacted by the slider, they introduce negligible tap dead space. Units are rated at 0.75 watt per linear inch of resistive track at 20C and half this at 80C. Standard independent linearity is ±0.5 percent to 20,000 ohms, or ±1.0 percent to 100,000 ohms; overall resistances go up 100,000 ohms ±10 percent; torque with ball bearings is below 0.5 oz-in. The plastic resists corrosion even in a moist chlorine atmosphere. Temperature coefficient of resistance from 0C to 100C is about −0.00035 ohm per ohm per deg C.

An unusual application of such conductive plastics is in function generators for analog computers. The extreme resolution and long life of the potentiometer element are desirable characteristics. In addition, the unit is not subject to abrupt failure during computation and, if worn excessively in one region because of the nature of a generated function, can be resurfaced with but slight change in overall resistance.

Another approach to infinite resolution is to use a liquid as the resistive element, as in a water rheostat. Depending on the mechancial arrangement, the unit can respond to translatory or rotary

Typical assembly of ganged potentiometers, as made by George Rattray & Co. Inc. All wipers mount on single shaft to avoid backlash. Clamp rings enable units to be phased individually



Typical Fairchild servo application uses ganged precision potentiometers at right for accuracy and general-purpose potentiometers at left for gross control

motion. As being developed by Technology Instrument Corp., such a potentiometer employs a lossy liquid dielectric as the resistive element in which are mounted fixed and movable electrodes as shown in Fig. 2.

Liquid Potentiometers

Because capacitance to a movable electrode in liquid varies in the same manner as the resistance to it from the fixed electrode, the time constant of the potentiometer remains constant as it is varied, thus providing broad bandwidth. The voltage divider so formed is rated for flat amplitude response and zero phase shift from 50 cps to 1 mc.

In the unit responding to linear motion, one or more electrodes translate. The total excitation voltage is placed between the grounded metallic can and insulated fixed electrode. By shaping the electrodes and the can, linear or nonlinear functions can be produced.

In the rotary type, the excitation is applied across two fixed vanes; a third fixed vane acts as the take-off electrode. The rotating vane thus requires no sliding metallic contact. By shaping the vanes the resistance function of shaft rotation angle can be varied.

A number of liquid dielectrics have been tested successfully. Methyl alcohol is commonly used for its stable impedance level. It produces no corrosion or electrolysis when used with aluminum electrodes at frequencies above 10 cps. By selection of electrolytes, resistances from a few hundred ohms to several megohms have been achieved in units operable to 100 volts.

Sine-Cosine Potentiometers

Several types of potentiometers are available whose resistances vary sinusoidally with the angle of shaft rotation. One such precision wire-wound potentiometer provides two output voltages accurately proportional to the sine and to the cosine of the shaft rotation angle. The design in Fig. 3 is based on a wire-wound linear flat card mounted on a rotating platform. The ends of the winding are connected to the excitation voltage through slip rings. Four output brushes are arranged in quadrature on a circle of rotation on the winding. As the card rotates, each pair of brushes traces the circle on the wire, picking up a sinusoidal output voltage or resistance. This construction results in the desired output function from a simple linear winding that can be wound very accurately.

When the winding is excited by direct voltage, the brushes give output voltages that vary sinusoidally as the shaft is turned. The peak value of the output is about 12 percent less than the exciting voltage. The output voltages oscillate plus and minus in polarity and are balanced about the potential at the center of the winding. The potentiometer is thus a mechanical generator of low-frequency sine waves suitable for a variety of research problems.

If excited by alternating voltages up to 155 volts at frequencies up to 1 mc, the excitation signal can be modulated by shaft rotation. The expected life of this potentiometer is 350,000 revolutions; maximum recommended speed of rotation is 1 cycle per second; amplitude accuracy is ± 1 percent maximum; the output wave form is within 1 percent of the peak value at any point of a pure sine or cosine wave; resistance within the brush circle is 14,000 ohms ± 10 percent; the winding is rated at 1.5 watts at 65C.

If, by analogy with the linear potentiometer, resolution is considered as the change in resistance from a reference point on the winding (center of the brush circle in this case) to any single brush, for each equal increment of brush rota-

COMPONENT DESIGN TRENDS

- **Flat-card windings give sinusoidal output**
- **Carbon-film sine-cosine units operate at high speed with low noise**
- **Starting torques can be under 0.5 ounce-inch**
- **New phasing adjustments improve performance of ganged units**

tion the number of wires crossed will vary from a maximum when the brush is moving perpendicular to the direction of the winding to a minimum when it is moving parallel. However, the resolution which is ultimately of interest is the angular magnitude of the finite steps by which the resultant vector rotates. The poorest resolution occurs when the brushes are moving at an angle of 45 degrees with the winding.

A miniature precision sine-cosine potentiometer recently announced by Computer Instruments Co. is a carbon film unit. The track is laid down by an evaporation technique which, because of the control afforded, is used to produce both linear and nonlinear functions. The infinite resolution and comparatively low noise characteristics of the film enable the potentiometer to be operated at high speeds. As a consequence the potentiometer is guaranteed for a life of a million cycles at 100 rpm. Some engineers have used it to 3,600 rpm. Lowest noise is achieved with these units when operating as pure voltage dividers into relatively high-impedance loads. The potentiometer, $1\frac{3}{32}$ inches in diameter by $\frac{11}{16}$ inch in length and weighing only 1 ounce, can be excited with either direct or alternating voltages.

Factors Affecting Torque

Because of the manner in which precision potentiometers cooperate with mechanical movements, their mechanical characteristics are quite as important as their electrical characteristics. The torque necessary to rotate the shaft of a potentiometer is of particular importance. Except in cases where a torque resistor is used to add stiffness in the presence of vibration, low torque is generally desirable. Usual starting torques are less than 1 oz-in. per section. Half of this is obtainable; it rarely exceeds 2 oz-in., but with special seals or locks may be 8 oz-in.

In achieving the inherent precision of a potentiometer, it is desirable that the torque also be free from variations such as binding or extreme differences between starting and running torque. The lower the torque, the less the power required to drive a potentiometer and, in general, the more compact the equipment.

Torque is developed in several ways—by the inertia of the rotating parts of the potentiometer, by the friction of the shaft in its bearings (usually slip rings, although in special applications ball bearings may be used) and by the action of the wiper or sliding contact. The wiper must necessarily bear on the resistance element with sufficient force to assure positive electrical contact, and thus a friction component at the end of an arm of substantial length is developed.

To maintain low torque, parts are precision machined and assembled; materials are used that are congenial in their friction relationship and in their temperature, humidity and other environmental behaviors. The mounting position of the potentiometer may influence its torque; the wear of parts due to operation can either increase or decrease torque. The assembly and alignment of a potentiometer in its mounting and in relation to its drive can vary the torque especially if there is radial shaft play. To obtain low torque a combination of small diameter resistance element, small short shaft and a light contact wiper are used. Lubricants on the winding may reduce torque at some temperatures but usually increase it at others. With stainless steel ball bearings, a starting torque of 0.1 oz-in. is possible.

The requirements of mounting squareness, low radial shaft play and the like are also important in reducing torque. However, unless the conditions under which the potentiometer is to be installed and operated will preserve these refinements, the additional cost of extreme efforts to reduce torque may be unjustified. For example, the mounting squareness of the potentiometer cup on the mounting surface or base plate depends as much on the care with which the potentiometer is mounted in the equipment as upon the construction of the potentiometer itself. If the shaft is not square with the mounting surface, there will be an increased torque. In addition, the wiper arm attached to the shaft will be out of alignment, thereby causing a change or deviation in linearity which may disrupt the electrical function of the potentiometer.

Concentricity of the shaft of a potentiometer in relation to the mounting place and specifically with relation to the winding is essential so that the winding and pilot bushings have a common center. Even small eccentricities may offset the precision of the potentiometer. Eccentricity causes the indicated rotation to differ from the true rotation by an angle the size of which is a function of the eccentricity. For example, a precision potentiometer with a 2-inch radius and an eccentricity of but 0.02 inch has a percentage error due to eccentricity alone of ± 0.18 percent. Thus the eccentricity error can nullify the accuracy inherent in the precision winding of a potentiometer.

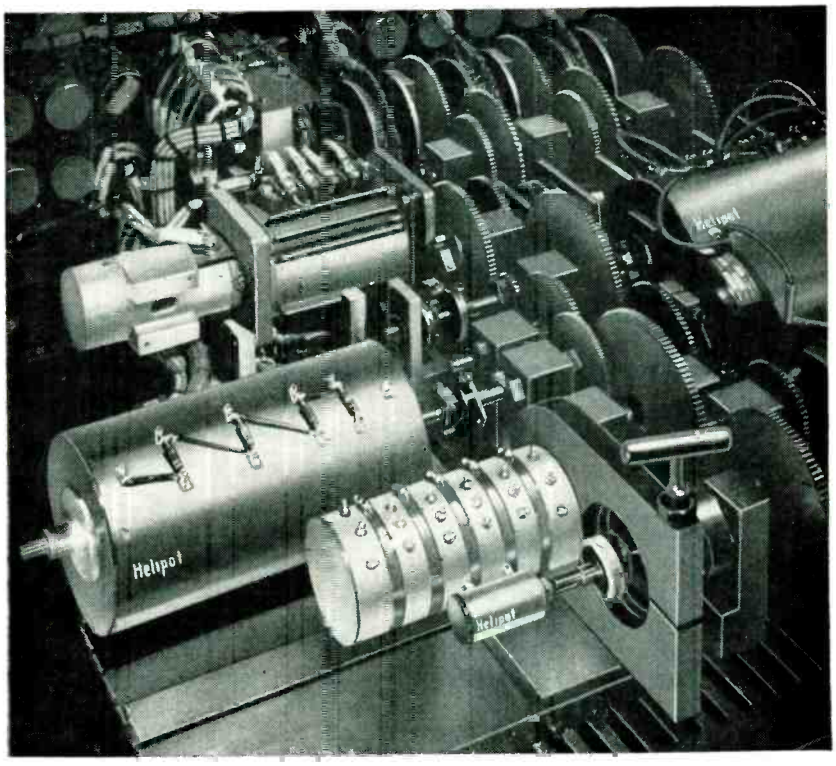
Radial shaft play has somewhat the effect of a fluctuating eccentricity. It not only causes a change in linearity but a change in torque and, in extreme cases, may vary the electrical contact resistance at the wiper arm. Hunting and backlash in servomechanisms are frequently traced to radial play.

Where more than one output is desired from a single shaft, several potentiometers can be ganged. For this purpose a variety of units are available, including specially cupped units that can be ganged in any combination and are easily changed or replaced. As many as twenty separate functions are obtained from a ganged unit having a single shaft.

Ganged Potentiometers

Ganged units must be phased relative to one another. This can usually be accomplished by loosening the retaining bands on the ganged unit and rotating each cup. In this way each unit of a gang is set so that its zero electrical position corresponds with the zero electrical position of other units in the gang.

Some styles of potentiometers can be ganged by removing one cover plate. The adjacent cup then completes the case so that there is no waste space between cups; the gang approaches a solid structure with its consequent rigidity yet any one cup can be replaced during development or maintenance without dismounting the others. Where the rotation of subsequent units in a gang is produced by a drive through a coupling such as an eccentric pin, backlash between units can be held below 0.05 degree per section.



Setup used at Helipot for recording linearity of single unit, ganged unit and large tapped unit under test at left, by automatic comparison with master precision potentiometer at right center. At top can be seen some of the trim potentiometers that have been pre-set to insert voltage in series with master pot at 360 points to give tester accuracy within 0.003 percent. Gear train gives correct drive for models having from 1 to 40 turns, in phase with 40-turn master

In use, potentiometers may be rotated at a variety of speeds. At excessive speeds increased wiper wear may produce arcing or loss of contact, along with increased noise. The life of the unit may be shortened as measured in cycles of operation; radial shaft play may increase rapidly due to the higher accelerations, with resultant misalignment. High temperature rise may increase the overall resistance of the winding. (Temperature coefficients of resistance wire are in the vicinity of 0.002 percent per degree C.) The wire of the resistance unit may fail due to the pounding effect of the wiper arm. If it is anticipated that a potentiometer will operate at high speeds, special wiper assemblies and ball bearings for the shaft are desirable.

Electrical Characteristics

The most important electrical characteristic of precision potentiometers is the deviation or difference between the actual electrical output and the output specified by the electrical function of shaft angle. Deviation is expressed as the electrical output minus the reference electrical output.

Resolution has been mentioned as a measure of the accuracy to which a potentiometer can be set. The maximum incremental change in resistance or voltage output observed anywhere in the total mechanical motion or rotation of the potentiometer shaft (or a specified portion of it), when multiplied by 100 and divided by the total resistance or voltage (or specified portion of it), is the percentage resolution of a potentiometer.

Linearity is the deviation of the curve of actual resistance of a potentiometer versus shaft angle from a straight line for a linear resistance unit. Various types of linearity are used and are defined and named slightly differently by different manufacturers.

Noise is also an important characteristic of potentiometers, especially in applications that necessitate achieving the ultimate performance from the units. Noise is measured quantitatively in terms of an equivalent, parasitic and transient contact resistance expressed in ohms that appears between wiper and the resistance element when the shaft is rotated. Equivalent noise resistance is considered independently of the total winding resistance; in wire-wound potentiometers it is in the vicinity of 150 ohms maximum.

Factors Influencing Noise

In specific instances where noise may be defined as any electrical disturbance or signal which tends to interfere with the generation or indicating characteristics of the potentiometer, noise should be more specifically related to such operating conditions as applied voltage, load resistance, speed of rotation and load current. In such instances noise may be measured in millivolts.

Among the contributions to the noise of a precision potentiometer is contact resistance noise appearing at both wiper contacts and at slipring contacts; this noise is generated through the constriction resistance set up when current flows through two separate pieces of

COMPONENT DESIGN TRENDS

- Independent linearity can be as low as 0.1 percent for single-turn units and better than 0.025 percent for multiturn units
- Paliney alloy contacts withstand over 2,000,000 cycles of operation without affecting linearity
- Small load currents help maintain low contact resistance
- Servo-controlled winding machines give greatly improved linearity
- Bellows-driven unit withstands shocks up to 30 g without permanent damage

metal joined only at a point. The load current flowing through a fluctuating contact resistance produces a loading noise, expressed in ohms as a peak variation in that contact resistance.

Shorting noise is the noise due to winding current as the wiper shorts turns in its passage along the winding. It is proportional to winding current, the resistance per turn of wire and the resistance of the contact. Variations in contact resistance also cause noise. Thus, shorting noise is closely connected with resolution.

Resolution noise is the sawtooth voltage superimposed on the functional output of the potentiometer caused by resistance to flow of load current by the winding. Resolution noise is proportional to the resistance per turn of the resistance wire and to the load current; it, too, is expressed in ohms.

Transient noise is that due to foreign material coming between the wiper and winding. Foreign material may be dirt or an oxide film which develops on the winding.

Generated noise is caused by heat or friction of two metals rubbing against each other, such as the wiper contact and the winding. Accompanying this noise is thermocouple noise consisting of the potential developed in a circuit composed of dissimilar metals with junction points at different temperatures.

Noise associated with excessive rotational speed is caused by the sliding contact rising clear of the winding momentarily.

Circuit design influences some of these noises. Wiping action combined with a small load current (about 1 ma) may help to maintain low contact resistance.

Multiturn Potentiometers

To increase resolution beyond that obtainable in a single-turn potentiometer, the multiturn design has long been used by Helipot and others. As one example, in the ten-turn precision Micropot (Borg Equipment Division), the total resistance ranges from 10,000 to 40,000 ohms and linearity from 0.25 percent through 0.025 percent, depending on total resistance and the type of linearity specified. The three-turn unit, with total resistance about a third of that for the ten-turn unit, has a percent linearity about 3 times that for the ten-turn potentiometer. Power dissipation in the ten-turn unit is 5 watts at 40 C; for the three-turn unit it is 3 watts at 40 C. In the ten-turn unit the helix is about 49 inches long and consists of a Kohlrausch winding (spiral winding on a spiral mandrel) of resistance wire molded and locked in place on a plastic mandrel. Potentiometer units wound on insulated copper mandrels give considerably improved heat dissipation but inherently higher capacitance to ground. The Paliney alloy contact is reported to provide a life of over two million cycles without affecting linearity. Equal life with a phosphor-bronze contact would increase the percent deviation from linearity to twice its initial value.

Constructional features of another multiturn potentiometer are shown in Fig. 4. This unit is based on a design developed by IBM under an Air Force project. The winding is sometimes described as a violin-string type.

Automatic Winders

Automatic servo-controlled machines are being used by a number of firms to achieve greater accuracy in winding precision wire-wound potentiometers, although details may differ. The basic principle of one of the machines is essentially as shown in Fig. 5. This machine is used by TIC to produce the IBM design. A self-supporting tightly coiled resistance element is formed by winding uncoated resistance wire about a mandrel which is immediately removed. The result is a flexible spring coil which is mounted on a potentiometer base by a servo correction technique that automatically insures good linearity.

Before the coiled resistance element is mounted, it is placed on an intermediate spool under slight tension. A multiturn potentiometer base is next mounted on a base plate having slip-ring take-off contacts. This potentiometer structure is mechanically complete and its actual slider contact is clamped at a fixed position. One end of the resistance element is attached to this potentiometer structure. An excitation voltage is placed across the resistance element and the voltage of the clamped slider contact is taken off by means of one of the slip rings.

By rotating the potentiometer base and the supporting spool, the potentiometer winding is transferred from the spool to the base. The potentiometer base is coupled to a high-precision multiturn master potentiometer. The voltage from the fixed slider contact is compared with that from the precision master potentiometer. Any difference voltage drives the servo correction motor and causes the payoff spool to speed up or to slow down with respect to the potentiometer being wound. This alters the tension and thus the spacing of the turns of the coiled potentiometer winding.

By this continuous method of servo correction, multiturn potentiometers are wound with linearities consistently better than 0.025 percent. Because the final potenti-

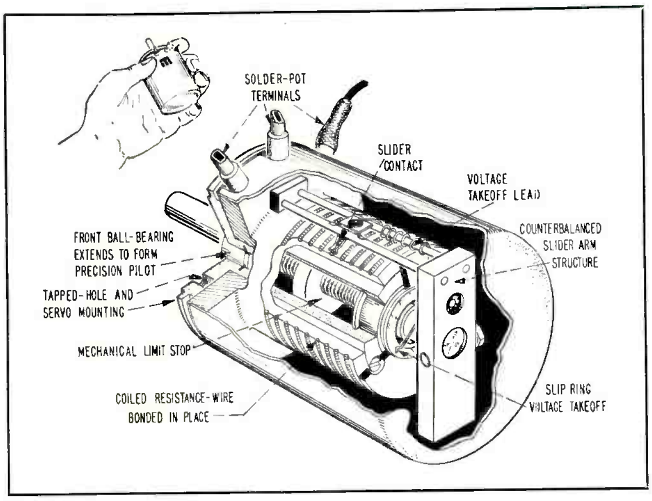


FIG. 4—Multiturn potentiometer construction as used by TIC provides high resolution along with low noise and long life

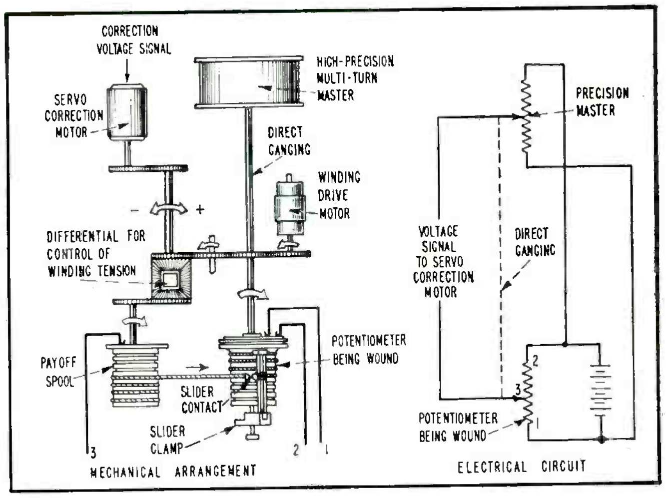


FIG. 5—Servo control system used by TIC to correct winding tension in accordance with error compared to master potentiometer

ometer structure is used in the process of correcting the winding, compensation can be made for changes in resistivity of the resistance wire and minor eccentricities in the potentiometer mechanical structure. If a prescribed loading resistor is placed across the potentiometer before it is wound, compensation can be made automatically by the servo correction control so that the loaded potentiometer will be highly linear.

Mechanical features of this multiturn design include two ball bearing supports near the extremities of the shaft which result in a starting torque less than 1.3 oz-in. and a running torque less than 1 oz-in. An internal lead-screw type of limit stop withstands torques exceeding 100 pound-inches without loading the precision slider or assembly.

Precision potentiometers find numerous and varied applications, one example of which is shown in Fig. 6. Here a Baroresistor employs hydraulic bellows to actuate a precision wire-bound potentiometer. The unit withstands shocks up to 30 g; the only observable change in resistance ratio occurs along the axis of the potentiometer winding, the change being in resistance ratio of 2 to 3 percent but without permanent damage.

The instrument operates over a temperature range from −50C to +80C over its full-scale pressure range, which is from 0 to 14.7 psi. The unit has been tested by the manufacturer up to 200,000 cycles with no evidence of wear or other incipient failure. Measured temperature sensitivity is 0.01 percent per degree C. From 0 to 14.7 psi absolute the accuracy is ±2 percent of full scale. There is hysteresis due to the bellows of less than 2 percent of full scale. Acceleration sensitivity is less than 0.1 percent of full scale per g. The total resistance of the winding is 7,500 ohms ±2 percent rated for 75 volts. Maximum winding current in any part of the winding is 10 ma continuous.

In summary, it can be expected that the development of precision potentiometers will continue under the impetus of entry of an appreciable number of manufacturers into the field. This concerted effort appears to be bringing safe operating temperatures to 150 C, possibly to 200 C. Units are more sturdy today than heretofore; in the future they may operate satisfactorily during shocks up to 100 g and vibration between 1,000 and 2,000 cps.

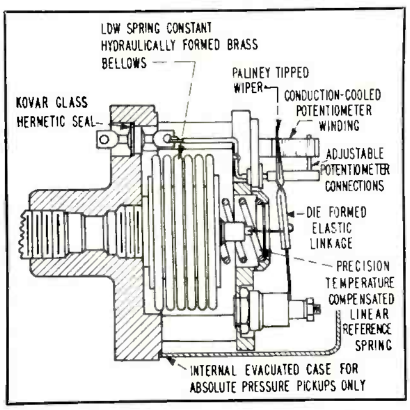
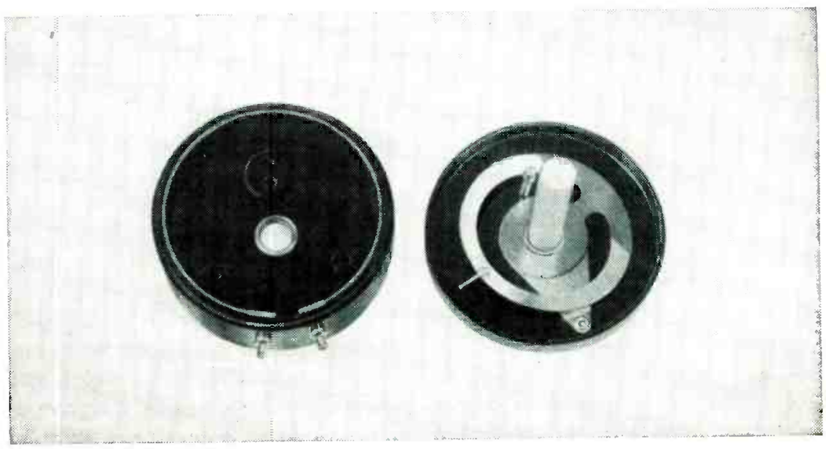


FIG. 6—Hermetically sealed potentiometer made by Trans-Sonics, Inc. is actuated by gas or liquid pressure through bellows and bearing-free linkage; resolution is 0.33 percent of full scale



Typical of new wire-wound potentiometers designed to hold capacitances to minimum is this General Radio unit using phenolic winding form, cup and cover along with glass polyester shaft, for a-c linear-resistance applications. Tolerance is 2 percent for 1.25-inch diameter units and 0.2 percent for 4.25-inch units

The MICROWAVE Market Picture

Point-to-point communications systems, exclusive of military, near 100 and extend almost 30,000 miles. Common carriers dominate field and have grown most rapidly. Pipelines still lead private users, with power companies gaining rapidly

By JOHN M. CARROLL

Associate Editor, ELECTRONICS

A MAJOR development in post-war electronics has been the application of microwave equipment in point-to-point communications. Successful transmissions across the English Channel were made in 1931, but installations by the Bell System immediately after World War II put microwave on a commercial basis. Today there are nearly 100 civilian microwave systems in the U. S., with over 1,300 individual stations. Total route mileage is nearly 30,000 miles. Table I gives a breakdown of the figures according to FCC records.

It is difficult to compare sizes of different microwave systems. Best common denominator is dollar value but this is not always available and is complicated by the changing value of the dollar, varying land prices and construction costs. Communicators talk about circuit miles—the number of available communications circuits multiplied by the miles over which they extend. This is a good measure of traffic capacity but can be misleading as to the amount of equipment used.

Another measure is the number of stations. This, however, tells little about the traffic capacity of the system. Throughout this report, systems are compared in route miles—the actual distance over which the microwave beam travels. Two guides for further approximation are that the average distance between towers is about 20 miles and that the average cost of a microwave system used by private companies is roughly $1,500 a route mile. Common-carrier systems generally run higher.

There is no general agreement on a definition of microwaves. Design engineers restrict the term to superhigh frequencies and above—3,000 mc and up. In communications, any frequency above 890 mc is loosely termed microwave. The bands allocated to the various services are listed in Table II.

Microwave Frequencies

The short wavelength of microwaves (30 cm and less) provides two important properties. First, the transmissions follow a line-of-sight path and can be focused much like a beam of light by high-gain antennas. This enables nearby systems to operate in the same frequency band without harmful interference. Secondly, a circuit's physical dimensions determine its electrical parameters, and for such short wavelengths a small change in circuit dimensions can produce a wide frequency variation. Thus, microwave equipment can readily have an extremely wide frequency bandwidth compared to lower-frequency communications equipment. Systems providing 24 voice channels are widely used; common-carrier systems sometimes have several hundred voice channels.

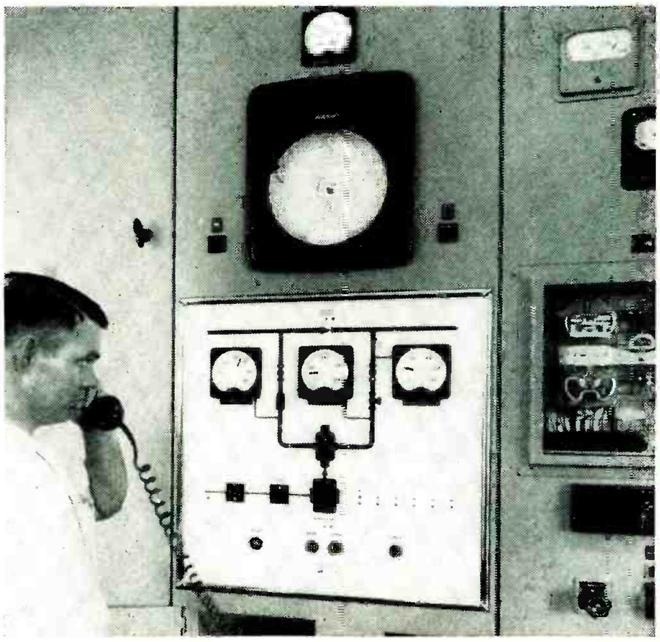
Commercial exploitation of microwave has proceeded in three general directions: common-carrier, private and military. By far the greatest expansion has been in the common-carrier field.

Common-Carrier Systems

As may be seen from Fig. 1 telephone and telegraph companies have more than doubled route mileage in the past two years. Major impetus has been the need to connect television stations for intercity network service. Some television stations are connected by coaxial cable but the current trend is toward greater use of microwave radio relay, which will pass without difficulty the complete 6-mc band required.

Another kind of common-carrier recently appeared when a group in Poplar Bluffs, Mo. sought and received authorization to build a microwave system to distribute tv signals captured from the air to remote community antenna cable systems. Other common carriers include Western Union, one of the oldest. Plans are on paper to extend its system from its present terminal at Pittsburgh to St. Louis when the necessary $42 million is available.

Microwave systems operated by independent telephone companies are usually small—two or three stations. But, there are more than 5,000 independent telephone companies. Figure 2 is a map of common-carrier microwave facilities in the U. S.



Supervisory control panel illustrates how microwave operates an unattended remote pipeline booster station. Passive reflector mounted on steel tower is becoming symbolic of a new communications age

Commercially, the keenest competition by far has been in the private, or more properly, the non-common-carrier market. Users include gas and oil pipelines, industrial firms, power utilities, railroads and forest products companies. Also local and state government services such as police, fire, highway maintenance and forest conservation.

Private Systems

Microwave systems operated by gas and oil pipelines constitute about two thirds of the total route mileage of all private systems. One manufacturer of microwave equipment believes that 85 percent of the potential market is here. Pipeliners need microwave for telephone communications between pumping and metering stations along their right of way and to tie in with radio-equipped service vehicles. They also need it for telemetering and supervisory control of unattended booster stations, teleprinter and facsimile.

Newest of the right-of-way companies, the pipelines, unlike power companies and railroads, could not rely on existing wire lines. Microwave avoided the problems of securing rights to string pole lines and offered more dependable service—no pole lines to come down in bad weather. Microwave compares favorably in cost with either privately owned or leased wire lines. Figure 3 is a map showing routes of pipeline microwave systems.

Power utilities operate about one quarter of all private microwave. Microwave has steadily gained favor with power men along with wire-line carrier. Microwave's most attractive feature is the safety angle. During storms, if power lines come down, so do telephone lines, in many cases disrupting both wire-line carrier and leased-line service. Microwave offers a means for maintaining essential communications, telemetering, supervisory control and line-fault locating when most needed. Power-company

Type of Service	*Systems*	*Stations*	*Route Miles*
Common carrier			
Amer Tel & Tel	1	450	12,348
other carriers	4	43	1,177
Gas & oil pipelines	26	516	10,679
Power utilities			
privately owned	33	159	2,763
U. S. Gov't	2	83	1,467
Police	9	48	712
Highway maintenance	5	20	226
Special industrial	2	10	184
Railroads	2	11	175
Forest products	4	8	58
Forest conservation	2	9	44
Fire	3	10	16
Total	93	1,367	29,853

Table I—Microwave Communications Systems in the U. S.

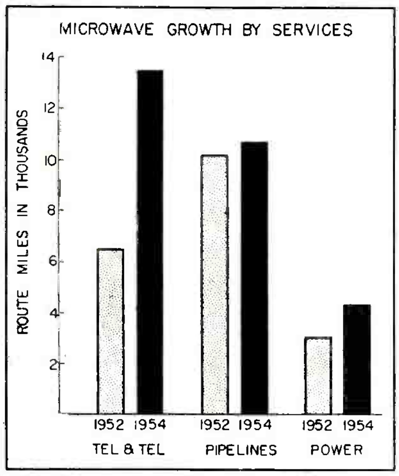


FIG. 1—Common carrier (tel & tel) has enjoyed greatest growth and leads all other microwave services

Type of Service	*Frequency in MC*
Common-carrier	3,700- 4,200
	5,925- 6,425
	10,700-11,700
Private users	952- 960
	1,850- 1,990
	2,110- 2,200
	2,500- 2,700
	6,575- 6,875
	12,200-12,700
U. S. Gov't	1,700- 1,850
	2,200- 2,300
	4,400- 5,000
	7,125- 8,500
Television pickup & STL	1,990- 2,110
	6,875- 7,125
	12,700-13,200

Table II—Frequency Bands for Microwave Development

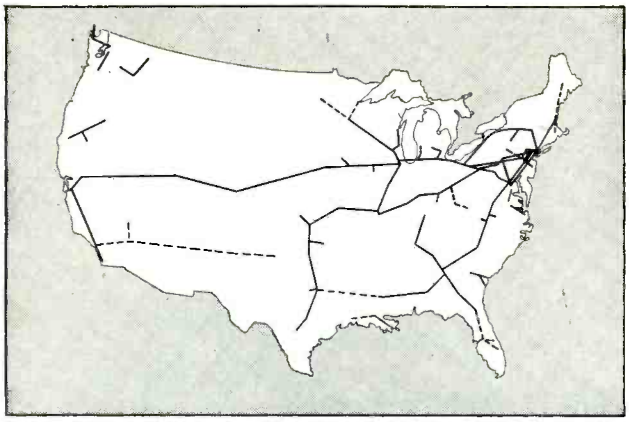


FIG. 2—Map shows extent of common carrier (public telephone & telegraph) microwave service in U. S.

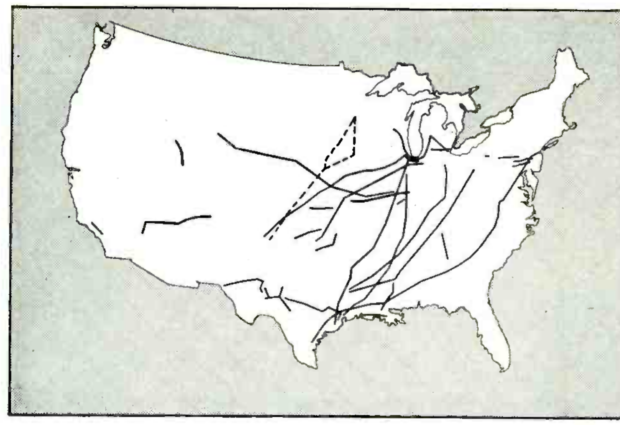


FIG. 3—Pipeline microwave follows main arteries bringing gas and oil from fields to industrial areas

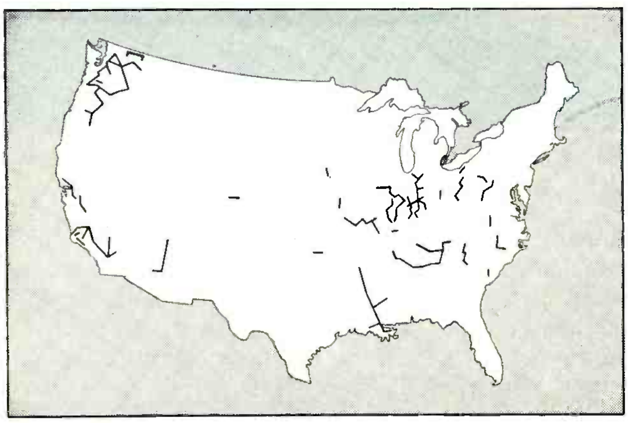


FIG. 4—Major power utilities are developing extensive microwave networks within their areas of operation

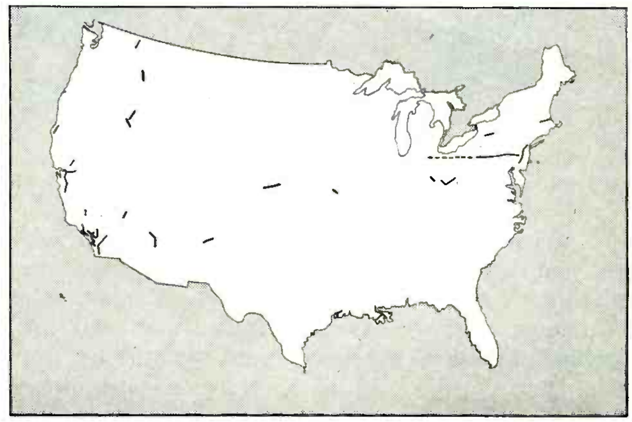


FIG. 5—Other users of microwave are few and widely separated but police systems are expanding

microwave systems are shown in Fig. 4.

Other Systems

Other microwave users account for less than one tenth of the non-common-carrier business. Some services, however, offer great possibilities. For example, rumors are current from time to time that this or that railroad will go microwave for so many thousand route miles. Railroaders' interest in microwave frequently ties back to a telephone company's attitude on interconnection. Railroads will invest more heavily in microwave when they are assured that their new systems will be accorded the same interconnection privileges as existing wire lines.

One mining firm has installed an extensive microwave system to help coordinate its widespread operations but, in general, the major industrial microwave market is still in the future. Microwave for police communications, on the other hand, is going hand in hand with the building of new super turnpikes. First the Pennsylvania Turnpike was equipped for microwave communication along the right of way, then the New Jersey Turnpike and, most recently, the Ohio Turnpike as the turnpike network spread across the country.

Strong interest has been evidenced by state governments in microwave networks to handle police, highway maintenance, conservation, civilian defense and general administrative matters throughout a state. This potential market is intimately bound up in the intricacies of politics.

A map of miscellaneous users of microwave is shown in Fig. 5.

Broadcasting

Use of microwave equipment by television stations is increasing. There are 194 microwave studio-transmitter links and 43 stations used for intercity transmission of television signals. The latter are usually private systems set up to provide network programming for a station in cases where common-carrier service is not available.

Security prevents obtaining figures on the use of microwave communications equipment by the armed services. Many installations have, however, been made both here and abroad linking major headquarters and other installations to pass operational and administrative traffic and in some cases radar signals. Truck-carried equipment has been developed to provide the mobility essential to a military communications network operating in what may become a forward area.

The actual amount of military microwave equipment in use has not been revealed but a manufacturer who does a lot of military business claims to have shipped around 1,000 complete equipments —only a fraction of which are accounted for in the civilian market. It seems probable that military microwave is at least as big as private and common-carrier combined.

Germanium Modulator for Infrared Communication

Transparency of germanium to infrared radiation is controlled by injection of charge carriers to provide direct modulation of light beam. Typical design example is given for a-f modulator having response 3 db down at 10 kc

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NUMEROUS INFRARED communication systems have been devised in the past with limited success.

The systems differed primarily in the transmitter and in particular in the method of modulation of the infrared carrier. A tungsten-filament lamp may be modulated directly by applying the audio signal directly to the filament. Due to the long thermal time constant of the filament, the response time and hence the bandwidth of such a system is limited.

Alternatively a gas-discharge tube, giving emission lines in the infrared region, may be used as the source of transmitter power. Very high modulation frequencies can then be obtained but the available power is seriously limited. Using a tungsten lamp source (a very efficient source of infrared radiation) and a mechanical shutter arrangement, some excellent shutters have been devised, but the high speed of operation required usually implies large size and high cost of construction.

This article describes an electronic replacement for the mechanical shutter making use of the transparency of germanium to infrared radiation. Infrared modulators made with germanium crystals are small, simple to make and reasonably efficient.

A germanium crystal is completely opaque to visible light but at a wavelength of 1.8 microns in the infrared region becomes almost completely transparent. There

Design Example For A-F Modulator

Infrared carrier wavelength = 2 microns

Therefore $\alpha = 1.6 \times 10^{-16}$ cm^2

Resistivity of germanium crystal = 1 ohm-cm

Carrier lifetime in germanium crystal = 25 μsec

Length of modulator, x = 1.2 cm (Eq. 1)

Thickness of modulator, y = 0.2 cm

Width of modulator, z = 0.2 mm

Mean transit time = 50 μsec

Therefore bias current is 50 ma (Eq. 2)

Therefore response is down 3 db at approximately 9.5 kc (Eq. 3)

As Eq. 1 is fulfilled it can be shown that the peak modulation depth obtainable is 50 percent.[4]

Reduction in transmitter power due to background absorption in the germanium is about 1½ db and reduction due to reflection, scattering and other uncontrolled factors is about 4 db. Losses of this magnitude are not usually important is a small amount of optical absorption left and this has been ascribed to the free electrons or other charge carriers in the germanium.[2] It is known from the theory of germanium transistors that a rectifying contact on germanium, biased in the forward direction, injects charge carriers into the crystal.[3] It follows, therefore, that the transparency of germanium to infrared radiation can be varied by injecting carriers which will give rise to additional optical absorption.[4]

Effect of Absorption

In theory the injected carriers give rise to increased absorption at all wavelengths, but in practice the absorption in the visible wavelengths and out to 1.8 microns is so large that the contribution of the injected carriers is quite negligible. Hence germanium modulators can only be used at wavelengths greater than 1.8 microns. No upper limit of wavelength can yet be specified. Modulators have been used up to 12 microns and theoretically the effect should still exist at millimeter wavelengths.

Modulator Design

Consider a simple rectangular block of crystalline germanium, as illustrated in Fig. 1. Focused light from a tungsten lamp source enters at one end. The visible and short wavelength components are completely absorbed and the infrared radiation is transmitted through the material. Due to the high refractive index of germanium (about 4) the crystal behaves as a light pipe and the beam is kept in the crystal by total internal reflection off the walls. The carriers injected into the crystal vary its transparency to infrared and hence modulate the amplitude of the transmitted beam.

When a germanium modulator is to be designed for an infrared communication system there are a number of factors affecting the shape, size and construction of the modulator which must be considered.

The increase in charge-carrier density in the crystal that can be obtained by injection is not very large. If, however, the infrared radiation has to pass through a sufficiently long crystal even a low density of injected carriers will give rise to an appreciable amount of absorption. Hence the depth of modulation increases with the length of the modulator. The absorption in the germanium without injection is, however, not zero because of the charge carriers (electrons in n-type germanium) already present. Increasing the length of the optical path in the crystal therefore increases the background absorption, with a consequent loss of transmitted power. It follows, then, that there must be an optimum length for a modulator. This is given approximately, for n-type germanium, by

$$x_o = 1.9 \times 10^{-16}\, R/\alpha \text{ cm} \qquad (1)$$

where R is the resistivity of the germanium in ohm-cm and α is the absorption coefficient per unity

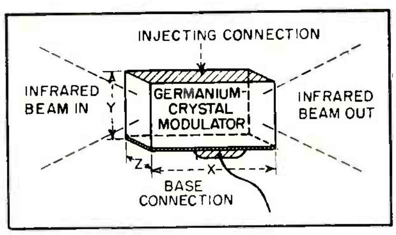

FIG. 1—Modulator uses transistor-type connections. Signal across modulator varies charge density in crystal

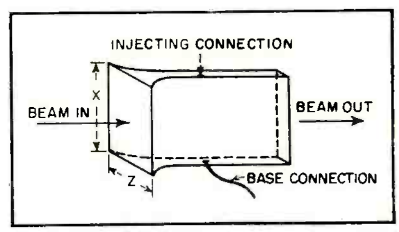

FIG. 2—Modified design of modulator providing larger acceptance area yz for improved performance

density of carriers.[4] The value of α in germanium is largely independent of wavelength between 1.8 and 5 microns and is about 1.6×10^{-16} cm^2. At wavelengths greater than 5 microns, α increases as the square of the wavelength and reaches about 25×10^{-16} at 12 microns. Optimum length of a modulator is a function of the wavelength at which it is to operate and it should be designed accordingly.

Resistivity of the germanium, R, is also at the disposal of the designer and it is desirable to keep this low, about 1 ohm-cm, so that the length of the modulator is kept to manageable proportions. Modulators having only about a tenth the optimum length have been used successfully; the small modulation depth then obtained (about 5 percent) being sufficient in many cases.

In Fig. 1 the area yz is called the acceptance area, as all the energy from the infrared source must be focused on it. In principle the image of the source can be made indefinitely small, but in practice aberrations and other defects in the optical system, not to mention convenience, require the area to be kept reasonably large. Electrical considerations require the area yz to be kept small and hence the final choice is a matter of compromise.

Charge Carriers

Charge carriers injected into germanium tend to recombine; their average expectance of life being referred to as the carrier lifetime τ. The value of τ is determined primarily by the purity of the germanium crystal and is usually between a few microseconds and a few milliseconds.

The time taken for the injected carriers to cross the crystal is determined by the voltage across, and hence the current through, the modulator and is given approximately by

$$t = x\,y\,z/I\,\mu\,R \text{ seconds} \qquad (2)$$

where I is the current in amperes and μ, the carrier mobility, equals 1,700 sq cm per volt-second in n-type germanium. If the transit time t, of the carriers is much less than their lifetime, so that none of them recombine, they will be swept out of the crystal as fast as they are injected. In this condition the number of carriers in the crystal no longer increases with current and the modulator saturates. The condition for saturation can be taken as a measure of the efficiency of the device. The lower the current required for saturation the more sensitive is the modulator. For this reason it is desirable to keep the area yz as small as possible.

Another feature of the modulator which may influence the choice of the area yz is frequency response. When sinusoidal modulation is desired the modulator is normally operated with a steady bias current. This current determines a mean transit time (Eq. 2) and response of the modulator is flat up to a frequency given approximately by

$$f = \tau + t/2\pi \tau t \qquad (3)$$

If pulse modulation is used, turn-off time ($I = 0$) is equal to τ and the turn-on time ($I = I_{max}$) is $\tau t/(\tau + t)$.

Carrier lifetime in the germanium is also at the disposal of the designer within certain limits and considerations of frequency response, efficiency and maximum rated current will clearly influence the choice made.

The data given refers to simple rectangular modulators, as shown in Fig. 1. Since germanium acts

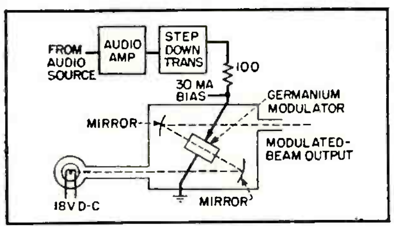

FIG. 3—Demonstration infrared transmitter uses parabolic mirrors to focus light beam of modulator crystal

as a light pipe in the infrared region, structures of the type shown in Fig. 2 may be used, coupling the advantages of a large acceptance area with a small value of z for use in Eq. 2.

Finally it may be noted that Eq. 2 only determines the product yz and not the shape of the acceptance area. The latter can be chosen to suit the shape of the image from the infrared source.

Electrical Connections

As in a germanium diode, a low-resistance base connection is soldered along the bottom of the crystal. The injecting contact on the opposite surface may be made with pointed wire contacts, wires laid flat on the crystal and held in place with a rubber pad, evaporated metal contacts or by fabricating a p-n junction on the germanium surface by indium diffusion.[5] The efficiency of injection of all these contacts is sufficiently near 100 percent for practical purposes. Junction or large-area contacts have a lower resistance and will materially reduce heat dissipation and power necessary to drive the modulator but otherwise the choice is one of convenience.

Modulator Operation

Carriers are injected into the germanium only when the modulator, considered as a diode, is biased in the low-resistance direction. The modulation impressed on the infrared beam will therefore be half-wave rectified. To avoid this the modulator must be biased in the forward direction and the signal drive current kept within this limit.

At high currents, saturation occurs, therefore the bias current is chosen so that t (Eq. 2) equals about 2τ. This implies that, on the average, the injected carriers die off when they are about halfway across the crystal. If operation at higher frequencies is desired, at the cost of reduced sensitivity and increased distortion, the value of the bias current may be increased.

The rate of carrier injection is determined by driving current rather than voltage. Since the forward characteristic of a diode is nonlinear a voltage drive will cause distortion. This difficulty is overcome by feeding the modulator from a high-impedance current source. Distortion also arises from the fact that carrier injection reduces the resistivity of the crystal by a significant fraction. This is also overcome by using a current drive.

By way of example, an infrared communication set will be described. This set was demonstrated at the April 1953 exhibition of the Physical Society in London. The system was by no means ideal since the use of an off-axis optical system is undesirable, but was quite adequate for demonstration purposes.

Transmitter

The arrangement of the source, modulator and spherical mirrors is shown in Fig. 3. The transmitter power source was a 24-volt, 36-watt tungsten filament lamp operating at 18 volts. The effective emitting area of the filament was about 1 cm × 1 mm. The spherical mirrors had a focal length of 5 cm and an aperture of f:1. The spacings between the tungsten lamp, first mirror and modulator were arranged so that the image on the modulator was about 0.2 cm × 0.2 mm. This was about the largest optical reduction that could be achieved with the arrangement used. The position of the second mirror was then adjusted to give a near-parallel output beam. No filter was necessary to remove visible light.

For the demonstration the signal for the modulator was obtained from a phonograph record. The output from the pickup was amplified in a conventional two-stage audio amplifier and fed to the modulator through a stepdown transformer and 100-ohm series resistance. The 30-ma bias current for the modulator was obtained from a battery.

Receiver

The receiver consisted of a 5-cm focal-length spherical mirror which focused the incoming infrared beam on a commercial lead-sulfide cell. These cells decrease in resistance when illuminated by infrared radiation of any wavelength less than about 2.8 microns. The effective carrier wavelength band was therefore about 1.8 microns to 2.8 microns, set by the transmission of the germanium and the sensitivity of the lead-sulfide cell respectively. The frequency response of the lead-sulfide cell and the modulator were about the same, flat from about 25 to about 6,000 cps. The output from the cell was fed to a conventional audio amplifier and loudspeaker. The quality of the transmission under these conditions was determined by the surface noise of the recording.

The author is indebted to the Chief Scientist, British Ministry of Supply for permission to publish this article.

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Radio Receiver Counts Lightning Strokes

Lightning strokes are recorded automatically on direct-readout counter at output of radio receiver that is adjusted to pick up discharges within predetermined radius. Full-wave semiconductor detector is used for strokes of either polarity in 8 to 20-kc range

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TECHNIQUES FOR LOCATING and mapping thunderstorm centers have been devised that vary from complex direction-finding networks for long-range charting of thunderstorms to aural observation of thunder by the meteorologist.

There remains the need for an additional method of detecting and evaluating the thunderstorm activity at various points on the earth. International scientific organizations have recommended development of simple apparatus suitable for wide distribution among meteorological stations and intended to replace the human ear for aural observations of electric discharge.

Such an instrument should supply statistical information on the frequency of thunderstorms, detecting discharges over the range of aural detection, or not farther than fifteen miles from the point of observation. It must be inexpensive to produce, maintain and operate. Simple operation and self-calibration must be possible without the use of expensive signal generators or trained personnel.

Stroke Counter

The Atmospheric Noise Research Laboratory of the University of Florida has developed such an instrument described below.

Basically, the counter comprises functional blocks shown in Fig. 1. Output of an antenna is fed into a low-gain amplifier stage, full-wave detector, amplifier and a relay that actuates a mechanical counter. Detailed operation of the counter is described in terms of the circuit diagram shown in Fig 2.

Input Circuit

Since the preponderance of power in a lightning stroke is found in the frequency range from 8 to 20 kc, it was decided to operate the counter in this range. This requires that the input impedance be high, since vertical and horizontal antennas of practical dimensions exhibit high output impedances in this frequency range. Therefore, values of C_1 and R_1 are chosen such that power-line voltages and their major harmonics will not operate the counter. At the same time, the input impedance is in the order of 1 megohm for the frequency range of interest.

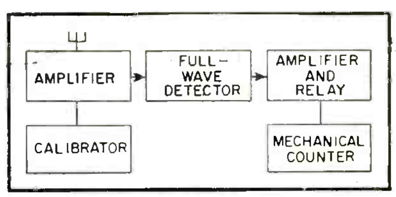


FIG. 1—Block representation of low-frequency lightning receiver

Amplifier and Rectifier

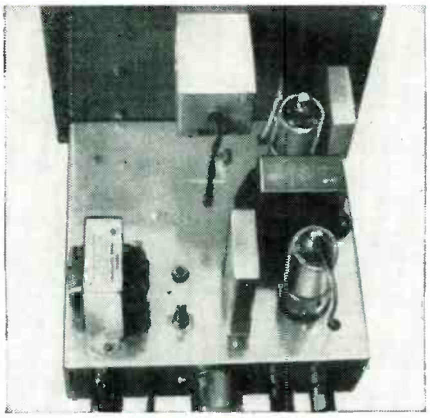
Two amplifier stages employing type 1N5 tubes are used to permit satisfactory operation from either a battery pack or conventional a-c supply. The input tube is operated as a class A voltage amplifier that is transformer-coupled to a bridge rectifier. The necessity for a bridge circuit is understood from consideration of the nature of the lightning stroke. There are conditions under which the polarity of the major portion of the stroke may be either positive or negative. To count most of the strokes, it is necessary to utilize both the positive and negative portions of the stroke.

Duration of a lightning stroke is relatively short. For operating a slow-acting mechanical counter it is necessary to include a short-charge long-discharge circuit that will hold the relay closed long enough for the counter to operate. The charge time of the network is determined by the forward resistance of the diodes of the bridge rectifier, the impedance looking back into T_1 and the value of C_2. The discharge path through R_2 is comparatively long with an actual value of 1 second.

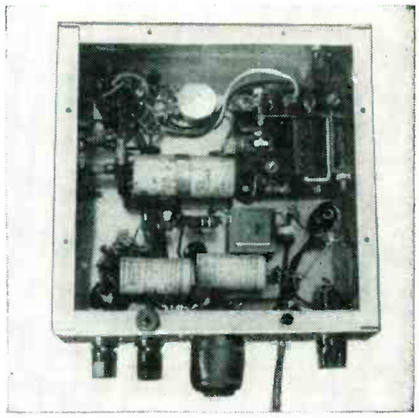
Relay and Counter

Second stage V_2 is normally biased to approximately cutoff potential, so that when a pulse of positive voltage appears on its grid relay K_1 is closed. This places 90 v d-c across the counter causing a

Counter is initially calibrated against aural and visual observations



Top view of counter chassis shows electromechanical counter on panel



Underside of chassis shows simplicity of wiring and relay at upper right

count to be registered. Adjustment of the control-grid bias on V_2 determines the level at which the relay operates and consequently the overall sensitivity of the counter.

Calibration

Calibration of the counter is accomplished by momentarily closing S_1, which places a d-c voltage of predetermined value on the control grid of V_1. The actual value of the calibrating voltage is determined by the desired sensitivity of the counter which is, in turn, a function of the antenna used and the average intensity of strokes in a given locality.

Adjustment should be determined through a study made at or near the locality at which the counter is to be operated. A sensitivity of approximately 0.1 v rms has been found to be satisfactory in Florida when a 100-ft horizontal antenna elevated 30 ft is used. Once the calibration voltage has been set, closing the test switch determines if the counter is functioning properly.

Counting rate is 2 cycles a second maximum using the electromechanical counter shown, which has a total capacity of 99,999 counts. Frequency response is ±3 db from 10 to 28 kc. Line-voltage changes from 100 to 120 volts result in only ±3 db change in sensitivity.

Performance Tests

It is difficult to assess accurately the number of lightning strokes occurring within a given thunderstorm and the range from the receiving antenna to the point of discharge. However, since the device is designed to operate within the aural range of thunder, the method used to calibrate the instrument consists of measuring the elapsed time between the occurrence of the stroke and the time that thunder is heard. From this time measurement the range to the stroke is computed.

Results obtained in Florida indicate that the maximum range at which thunder can be heard is approximately 8 to 10 miles with approximately 90 percent of all local strokes being counted. In several cases strokes were counted when no thunder was heard. The range in these cases is indeterminate, but during one nighttime storm when the flashes were visible, counts were made when the range was estimated to be between 15 and 25 miles.

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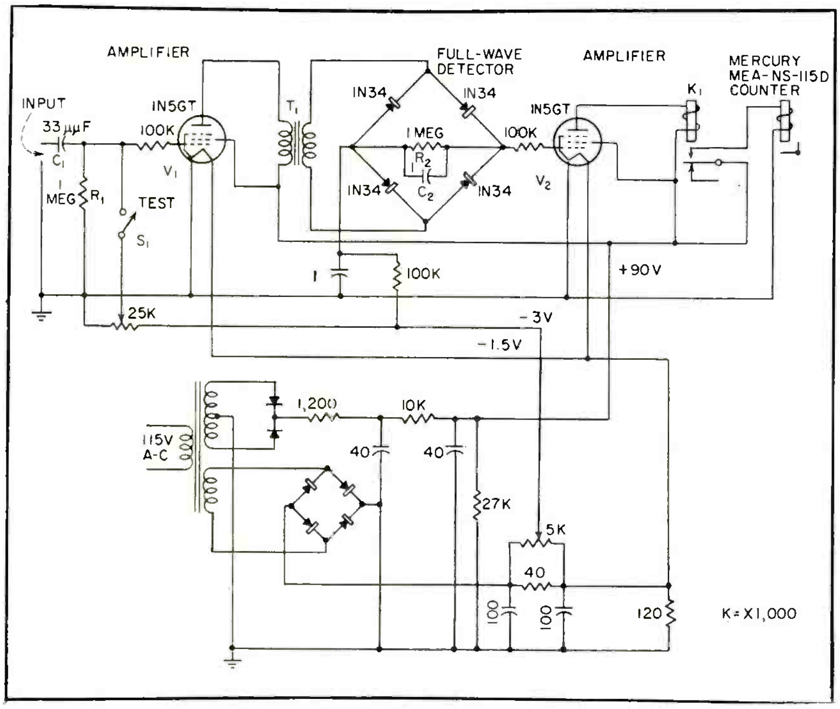

FIG. 2—Counter unit can be operated from batteries or power line as shown. Input is connected to suitable antenna. Bridge rectifier insures counting every lightning stroke since polarity may be either positive or negative

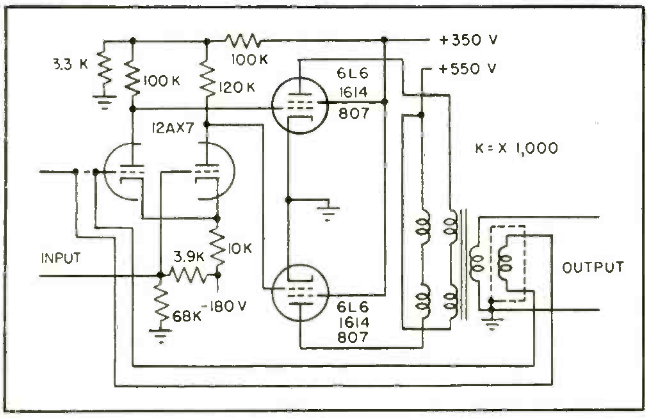

FIG. 1—Basic power amplifier has large amount of inverse feedback without trace of instability

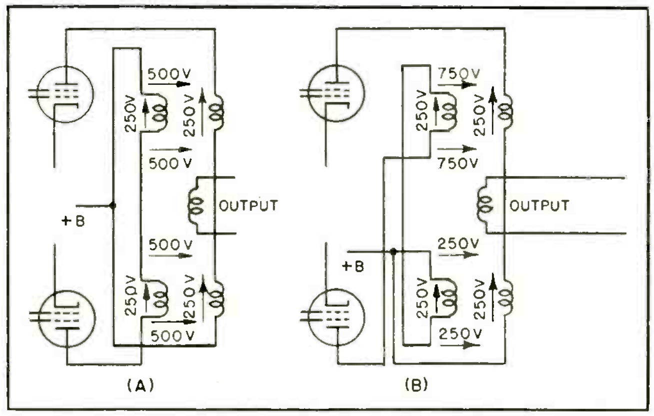

FIG. 2—Voltage relations in bifilar output transformer with different primary connections

Fifty-Watt Amplifier

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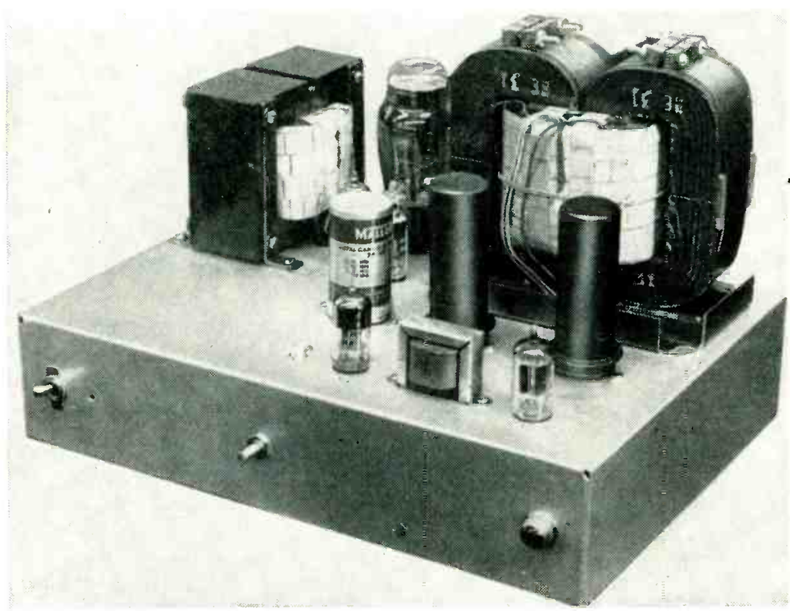

Fifty-watt amplifier uses 1614 output tubes. Output transformer is shown mounted on chassis in its normal position, but not potted

SIZE OF AN AMPLIFIER package and its cost are dependent largely on the efficiency of operation and the power sensitivity of the output stage. Beam power tubes satisfy these two requirements more readily than triodes. The quality of the audio power is improved by the use of push-pull operation and large amounts of feedback. Use of a suitable amount and type of feedback with beam-power tubes overcomes the advantage of inherently low output impedance obtained with triodes. The development of the power amplifier discussed in this article was undertaken with the objective of providing a large amount of good quality audio power in a small package at relatively low cost.

Basic Circuit

The basic power amplifier circuit shown in Fig. 1 is capable of employing large amounts of feedback with good stability. This circuit has been operated with 36 db of feedback without showing any trace of instability. However, since the driving voltage required under these conditions is too great, the circuit is normally used with only 24 db of feedback.

The 12AX7 is used as a phase inverter, amplifier and driver stage. It is direct-coupled to the beam-power output tubes and the operation is essentially class B_1 since the high-impedance driver stage is incapable of driving the power-tube grids positive. An added advantage of the direct-coupled driver is that it eliminates the possibility of blocking due to excessive input signal.

The two output-tube cathodes are returned to ground and therefore any combination of screen and plate supply voltage may be used. The circuit shown will keep both screen and plate dissipation below the rated values for full-signal class-B_1 operation with either 1614's or 807's. The bias for the output tubes is supplied by the 12AX7 and is normally adjusted to produce a zero-signal plate current of about 15 ma per tube. The high value of cathode resistance makes the driver circuit fundamentally stable.

A test with six 1614's and twelve

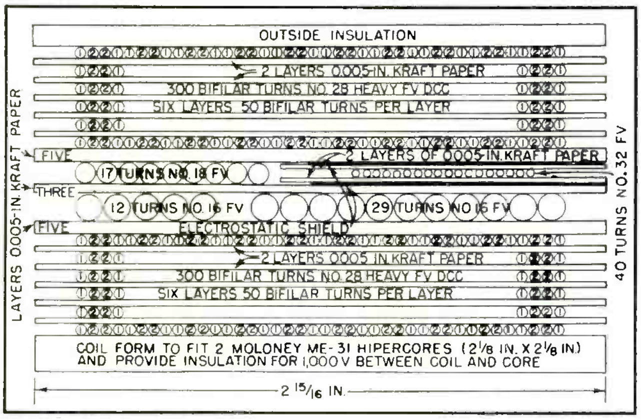

FIG. 3—Output-transformer coil buildup for fifty-watt amplifier using 1614 tubes

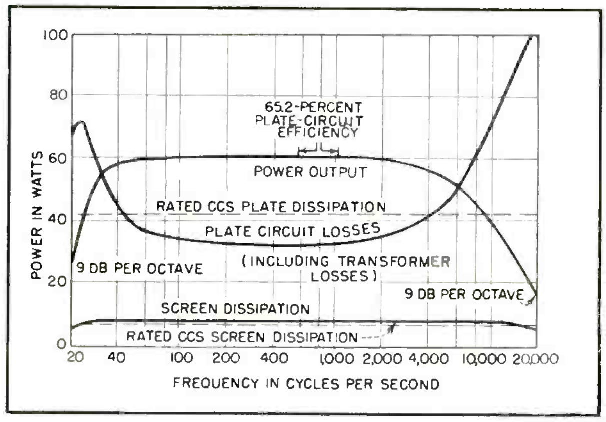

FIG. 4—Power relations for fifty-watt basic amplifier with transformer-coupled input

for High-Quality Audio

Push-pull amplifier uses transposed-bifilar output transformer to overcome difficulties associated with class-B operation. Quality is enhanced by 24-db feedback. Winding and core data are given for construction of transformer

12AX7's, of different manufacturers and chosen at random, produced a zero-signal plate current variation ranging from 10 to 25 ma per tube. Full-signal operation was substantially independent of the choice of 12AX7 and beam power output tubes.

The feedback winding is electrostatically shielded from the secondary, but very closely coupled to it. The electrostatic shield greatly increases the amount of feedback that can be used successfully.

The problems encountered with class-B operation are considerably more severe than those occurring in class-A operation, but the higher efficiency makes it possible to increase the power output by a factor of three or more, for the same investment and space.

Bifilar Windings

One of the major problems associated with class-B operation is due to energy stored in the leakage reactance between the two primary windings. This stored energy gives rise to a conduction transfer notch which must be eliminated before class-B operation can be used successfully.[1] Several different winding schemes will reduce the leakage reactance below the critical value but the most successful one is that of using a bifilar winding for the two primary sections.

A significant problem caused by the use of bifilar windings is that appreciable capacitance exists between the adjacent wires and charging current must be supplied to this capacitance before any voltage can be developed between the wires. This charging current must be supplied through the output-stage tubes and is one of the major factors limiting high-frequency power-delivering capacity of an amplifier.

This problem can be understood more readily by examining the circuit of Fig. 2A. The bifilar primary has been separated into two sections and the secondary sandwiched between them to keep leakage reactance between the primaries and secondary low. The four primary sections have been symmetrically interconnected and there is negligible d-c voltage between them. If a peak signal voltage of 250 volts is assumed on each of the primary sections, as shown by the vertical arrows, this will give rise to a peak signal voltage of 500 volts between all adjacent points on the bifilar winding as shown by the horizontal arrows. The undesirable feature is that before this voltage can appear between the two primary windings the interwinding capacitance must be suitably charged and charging current must flow through one of the two tubes.

An experimental transformer of this type, wound with adjacent wire layer bifilar winding, using No. 28 HF wire, was found to have a capacitance of 0.045 microfarad between the two primary windings.

Primary Variations

Figure 2B shows a different connection of the primary sections. The voltage between the lower sections of the bifilar winding has been reduced to 250 volts but the voltage between the upper sections has been correspondingly increased to 750 volts. The total interwinding charging current is the same as before but the insulation burden on the upper section is greater than before. Further sectionalization and reconnection of the primary will not reduce the charging-current problem and will in most cases increase the burden on the insulation.

The design of the transformer used in Fig. 1 presents a solution to the problem introduced by the primary interwinding capacitance. In the general case of two isolated parallel circular wires an increase of the spacing between the surfaces from 10 percent to 20 percent of the diameter of the wire will reduce the capacitance between these wires by approximately 30 percent. An increase of this spacing from 10 percent to 100 percent of the diameter of the wire will reduce the capacitance by approximately 70 percent.

In the transformer winding the same general principles apply. Each electric material, the capacitance between the wires in the layers accounts for approximately two thirds of the total capacitance. Capacitance between wires in adjacent layers accounts for one third of the total capacitance. Since transposition of the wires can halve capacitance between wires in a layer without disturbing the capacitance between wires in adjacent layers, it should reduce the total capacitance to two thirds of its original value. Use of insulating materials such as cotton, varnish and wax and accumulation of moisture will all tend to increase the capacitance.

The safety factor provided by the bifilar type of winding has so far been sufficiently large to avoid the appearance of the conduction transfer notch.

Figure 3 shows the coil buildup

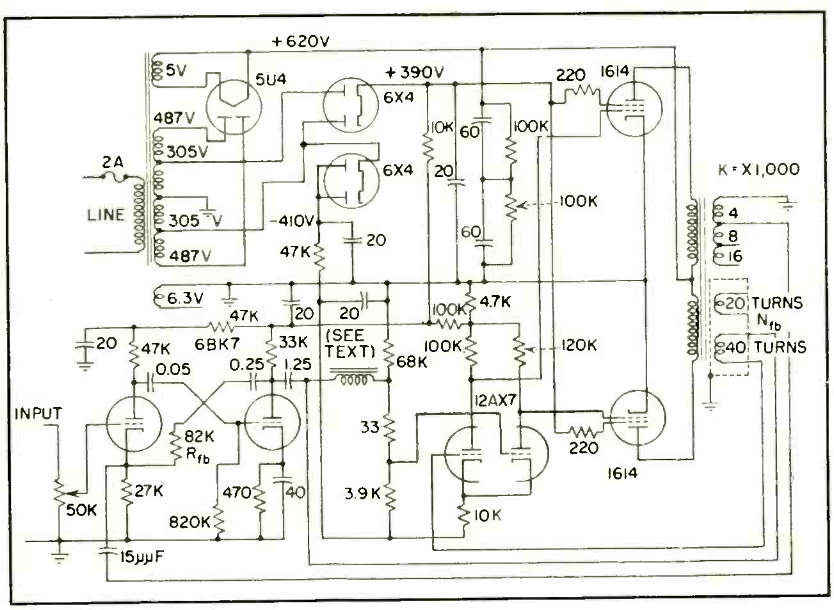

FIG. 5—Complete fifty-watt amplifier with preamplifier delivers full output with 0.8-volt rms input signal. Voltages indicated are measured with zero-signal input

wire will have capacitance to the two wires on each side of it in the same layer and also to the wires in the layers above and below it. The capacitance between wires in the same layer can be cut in half by transposing the two wires of the bifilar wire at every turn. The capacitance between wires in adjacent layers will not be modified by this process. In the nontransposed winding, assuming the same spacing between layer centers that exists between adjacent wire centers in a layer and uniform di-

of the output transformer used in the circuit of Fig. 1. This figure is drawn in proper vertical scale. The horizontal scale has been modified to show the relative positions of the windings in a reasonable amount of space. This transformer winding was designed to be used with two grain-oriented Hipersil C cores. The nominal impedance levels were intended to be 4, 8 and 16 ohms but the optimum levels obtained with this transformer were 4.63, 9.25 and 18.5 ohms. An optimum value resistor was used on the

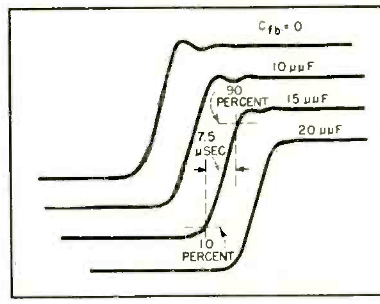

FIG. 6—Response of complete amplifier to a 10-watt 5-kc square-wave input. Increasing the value of the feedback capacitor tends to reduce the slight amount of ringing present

9.25-ohm tap in all of the succeeding tests.

The transformer of Fig. 3 had a primary interwinding capacitance of 0.010 microfarad when it was vacuum impregnated with clear baking varnish and baked for the prescribed amount of time. This transformer was potted and has maintained the same value of capacitance since that time.

To obtain the same low-frequency power-delivering capacity with an ordinary non-grain-oriented core it is necessary to increase both the core cross section and the number of turns by about 25 percent. The combined effect of these increases is that the primary interwinding capacitance increases by a factor of approximately 50 percent.

Amplifier Specifications

The circuit of Fig. 1 was used with the transformer of Fig. 3 with transformer-coupled input. The input transformer had an electrostatic shield connected to ground. With well-regulated screen and plate supply voltages, the residual hum in the output was 96 db below 50 watts. For this particular amplifier, without any special attempt to obtain good balance, a ripple voltage of 42 volts inserted in series with the plate supply or 9 volts inserted in series with the screen supply was necessary to bring the residual hum level in the output to 80 db below 50 watts.

The power delivering capacity of this amplifier was tested by setting the input signal level at the value necessary to produce 2-percent distortion in the output. Figure 4

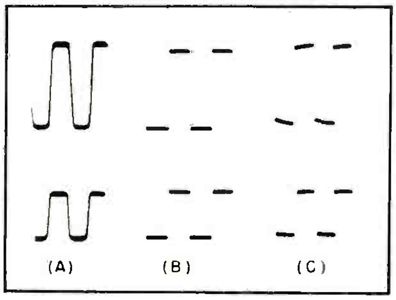

FIG. 7—Square-wave response of amplifier at 50 (A), 500 (B) and 5,000 cps (C). Amplifier input level is 40 watts for upper waveforms and 10 watts for lower waveforms

shows the results of this test. In the range below 30 cps the output was limited by the inability of the 1614's tubes to supply adequate magnetizing current to the transformer. Between 30 and 3,000 cps the output was limited by peak clipping due to the inability of the 12AX7's to drive the 1614 grids positive. Above 3,000 cps the output was limited by the inability of the 1614's to supply the charging current required by the primary interwinding capacitance.

Most of the power in speech, song and music is contained in the fundamental tones with frequencies below 3,000 cps. The power levels of the higher frequency fundamental tones and of the harmonics of the lower-frequency fundamentals drop off at a greater rate than the power-delivering capacity of this amplifier.[2]

The amplifier develops its full-power output of 60 watts over most of the middle-frequency range with total plate-circuit losses, including transformer losses, considerably lower than the rated CCS values.

Since transformer-coupled input is not usually available for amplifiers of this type the circuit of Fig. 5, which includes a preamplifier and power supply was developed. This circuit was designed to deliver 50 watts of high-quality power over most of the middle-frequency range. Since the output stage is insensitive to ripple in the screen and plate supplys, very simple power supply filter circuits are adequate.

Preamplifier

The preamplifier consists of a two-stage R-C amplifier with feedback between the second plate and first cathode. This feedback provides good wave shape and low output impedance on the preamplifier.

The preamplifier is coupled to the 12AX7 grid with a 1.25 μf capacitor and a Thordarson T20C51 choke modified by interleaving its laminations. A low d-c resistance is necessary because the 12AX7 has appreciable grid current when the grid voltage becomes more positive than −1 volt and this grid current must not be allowed to change the bias relations of the phase inverter. This coupling circuit has a low-Q resonance between 10 and 15 cps.

Feedback from the secondary of the transformer is incorporated and additional overall feedback introduced from the 4.63-ohm tap to the first cathode in the preamplifier. A complex bridged-T network produced the best high-frequency square-wave response, but the square-wave response was adequate when a simple 15-μμf capacitor was substituted in the overall feedback circuit. This capacitor has no effect on the low-frequency response but reduces the tendency of the amplifier to ring slightly with sharp-risetime square-wave inputs. The waveforms of Fig. 6 show how ringing, following the leading edge of a 10-watt 5-kc square wave, is modified by varying the value of this capacitor. The rise time of the leading edge is approximately 7.5 microseconds between the 10-percent and 90-percent points and the ringing frequency is approximately 100 kc.

The complete square-wave response at 50, 500 and 5,000 cps and power levels of 10 and 40 watts is shown in Fig. 7.

The results of tests made to determine the best balance between the various types of feedback are shown in Fig. 8. Curves 1 and 2 have inadequate feedback turns to correct for class-B operation at low-power levels. The bridged-T overall-feedback network produced 6-db feedback at operating frequencies so that curve 1 is lower than curve 2 at high-power levels. Curve 3 has much less low-level distortion than curve 2 because of the additional feedback turns, but it requires more drive from the preamplifier and therefore has higher distortion than curve 2 at high-power levels. Curve 4 uses approximately 6-db additional feedback in the pre-

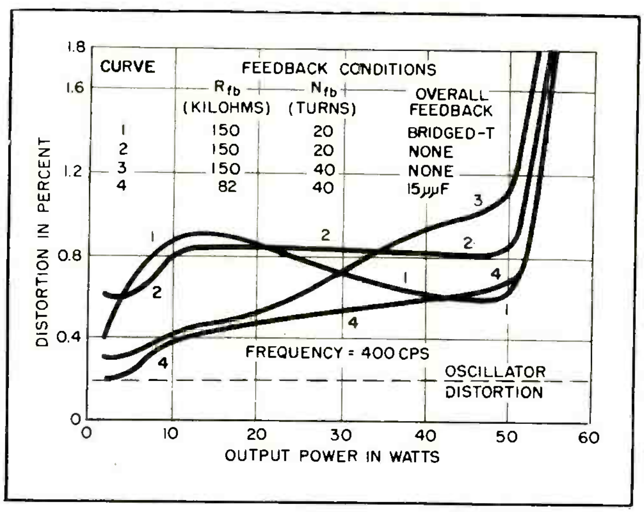

FIG. 8—Feedback-distortion characteristics

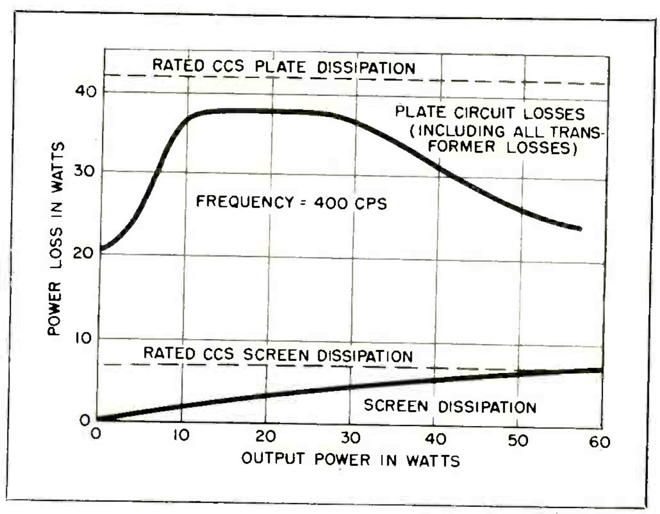

FIG. 9—Plate-circuit power loss characteristics

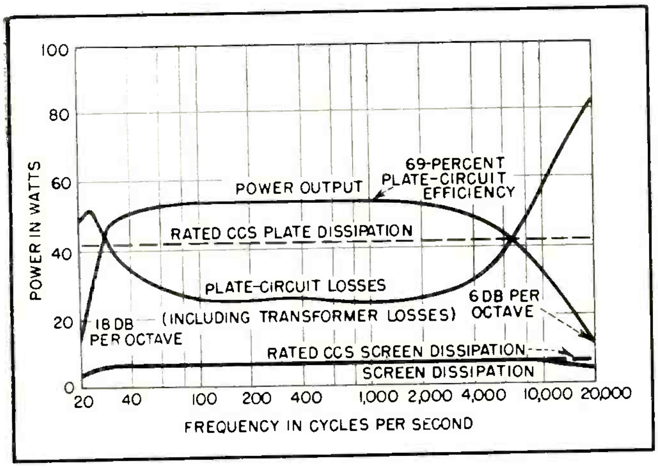

FIG. 10—Power characteristics at 2-percent distortion

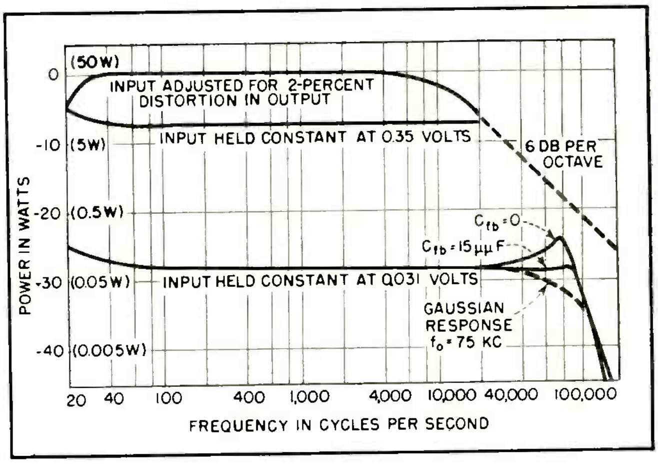

FIG. 11—Overall frequency response of amplifier

amplifier and its distortion is satisfactory at both low and high-power levels. The 15-μμf overall feedback has no effect at these frequencies.

The values of feedback turns and preamplifier feedback resistance used in obtaining curve 4 represent a practical compromise between low-input signal and low-output distortion. Additional reduction in distortion could be obtained by increasing the turns on the feedback winding and reducing the value of the feedback resistor in the preamplifier. Both of these changes would increase the input voltage required to produce full output power. The conditions specified for curve 4 are the ones shown in the circuit diagram of Fig. 5 and are used in all succeeding tests.

Power-Loss Characteristics

Figure 9 shows the curves of plate-circuit losses (including transformer losses) and screen dissipation as the output power is varied. The plate-circuit losses are less than the rated CCS values for all operating conditions. The screen dissipation becomes equal to the rated CCS value at the highest power level shown but is less than the rated value at lower levels.

The 2-percent distortion power-delivering capacity together with the corresponding plate-circuit losses and screen dissipation are shown in Fig. 10. The highest plate-circuit efficiency, including transformer losses, occurs at 1,000 cps and is 69 percent. If the transformer losses are considered a part of the tube output, the plate efficiency becomes 72 percent.

The frequency-response characteristics, together with the power-delivering capacity curve, plotted on a db scale, are shown in Fig. 11. The diagram shows that as long as the operating level is below the 2-percent distortion curve the response is flat between 100 and 20,000 cps. Below 100 cps the response rises slightly due to series resonance in the impedance-coupled circuit. This rise can be controlled by modifying the values of the coupling capacitor and choke.

At low levels the response above 20,000 cps depends on the amount of feedback capacitance used. The curve for $C_{fb} = 0$ rises to a maximum at about 85 kc and then drops off rapidly. The curve for $C_{fb} = 15$ μμf is almost perfectly flat to 95 kc after which it also drops off very rapidly. A curve for Gaussian response with a −3-db point at 75 kc has been shown for comparison. The ringing frequency of approximately 100 kc corresponds closely to the region of maximum deviation of the actual response characteristic from the Gaussian response. This shows also why the use of $C_{fb} = 15$ μμf reduces the ringing amplitude obtained with a square-wave input.

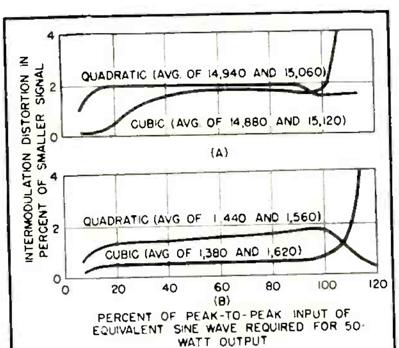

FIG. 12 — Intermodulation-distortion characteristics with 4:1 ratio of 60 and 15,000 cps signals (A); 60 and 1,500 cps signals (B)

Distortion

Figure 12 shows the results of intermodulation-distortion tests using 4:1 combinations of 60 and 1,500 cps and 60 and 15,000 cps. The resulting distortion is plotted as a percentage of the smaller of the two signals. The values shown are acceptable beyond the 100-percent peak-to-peak equivalent input.

Good transient response for loudspeaker loads is assured by the low output impedance which is approximately 10 percent of the nominal impedance between 20 and 20,000 cps.

The residual 120-cycle hum in the complete amplifier is slightly greater than that measured in the basic amplifier with transformer-coupled input—about 80 db below 50 watts.

Residual 60-cycle hum is picked up inductively from the power transformer by the unshielded modified choke and is about 66 db below 50 watts.

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Regulated D-C Supply Has High Efficiency

Two-hundred-watt power supply uses magnetic amplifiers to regulate slow line-voltage and load changes and electronic circuitry to regulate rapid changes. Technique may be applied to regulation of d-c generators as well as rectifier power supplies

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MODERN USE of electronics often imposes requirements on regulated d-c power supplies that can be met only by high efficiency regulation. These requirements are large power output, small size, low output impedance at all frequencies and reliable operation under conditions of high ambient temperature and low air density.

A method of accomplishing high efficiency regulation is to divide the responsibility between two different high efficiency regulators—namely, a magnetic amplifier which regulates against slow line-voltage and load changes, and a circuit, termed a clampac, which regulates against fast changes of a-c load and line voltage.

Conventional regulated d-c power supplies accomplish regulation with control tubes, which are connected either in series with the d-c output to furnish a variable voltage drop, or in parallel with the load to control the output voltage by drawing a current through the internal impedance of the supply. In either case, these control tubes lower the supply efficiency greatly by their continuous plate and filament power dissipation.

A more efficiently regulated d-c power supply is one using a magnetic amplifier to provide a variable voltage drop in the a-c portion of the supply. Such a device can provide this drop while suffering only the small losses due to power dissipation in the copper, cores and internal impedance of the control and bias power sources. However, the magnetic amplifier has an inherently slow response which destroys its usefulness in many regulated power supplies unless it can be used in conjunction with some circuits which cancel out the fast load and line changes. While this circuitry need regulate only fast changes, it must involve such low losses and little additional space that the gains from using the magnetic amplifier are not lost.

Slow Regulation

Circuits using magnetic amplifiers for regulating against slow changes of load and line voltage in a rectifier-filter type d-c power supply are shown in Fig. 1. Rectifier tubes are employed in Fig. 1A, while selenium rectifiers are made use of in Fig. 1B.

There are other circuit configura-

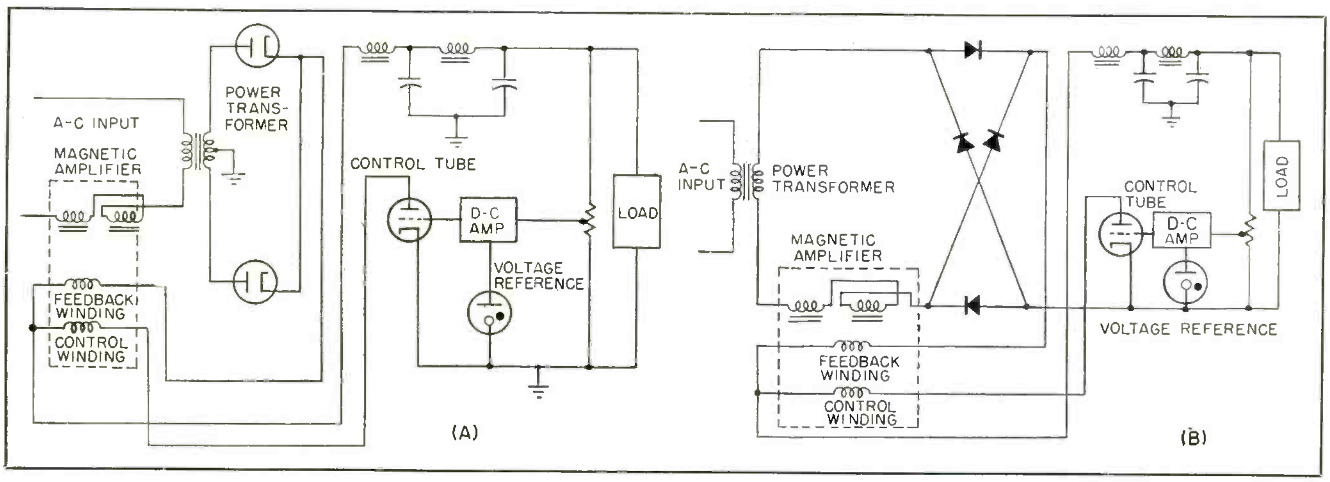


FIG. 1—Direct-current power supplies with L-input filters using magnetic amplifiers for regulation; full-wave (A) and bridge (B)

tions which incorporate a magnetic amplifier as a regulator in this type of supply, but the circuits of Fig. 1 make it possible to use an inductor-input filter along with a magnetic amplifier of any type core.

The advantage of an inductor-input over a capacitor-input filter cannot be overlooked when designing a high-efficiency supply. The form factor of the current drawn through the transformer and rectifier can be as high as three with a capacitor-input filter, and as low as one with an inductor-input filter. The current form factor is an indication of supply efficiency, since by definition it is the ratio of the rms to the average value of the current.

The difficulty involved with using a magnetic amplifier with an inductor-input filter arises when using a magnetic amplifier made of cores with rectangular hysteresis loops in the magnetic amplifier and thus making it essentially a gating device. It then must create a discontinuous current while the choke attempts to create a continuous current. This situation is avoided in the circuits of Fig. 1 since they provide a path for a circulating current which passes through the choke, but not through the magnetic amplifier.

Note also in Fig. 1 that a d-c amplifier is used to amplify the error voltage and drive the magnetic amplifier by means of a control tube. Use of electronic circuitry to drive the magnetic amplifier can be defended on the grounds that less gain in the magnetic amplifier is then needed and the magnetic amplifier can thus be made faster and with characteristics more independent of environment and manufacturing tolerances. However, in the complete regulated supply which will be described in this article, the d-c amplifier is a necessary part of the system. By using it to drive the magnetic amplifier it becomes part of a low-pass negative-feedback loop, thus eliminating the drift problem in the d-c amplifier.

Stabilization of the high-gain, degenerative-feedback loop, which includes the magnetic amplifier, is a difficult problem because of the phase shift through the two-section filter provided to attenuate the ripple. A large amount of filtering is necessary when using the regulator, since it will always attempt to remove the ripple in the output and will become saturated if the ripple is too large. The filter can be made smaller by the use of a 400-cps input-power source to increase the ripple frequency. The clamper itself aids the stability of the magnetic-amplifier control loop in several ways. It regulates down to frequencies as low as several cps, thus allowing the magnetic amplifier to have a long time constant. Also, the clamper maintains such a low output impedance at frequencies above several cps that the output capacitor is effectively shorted

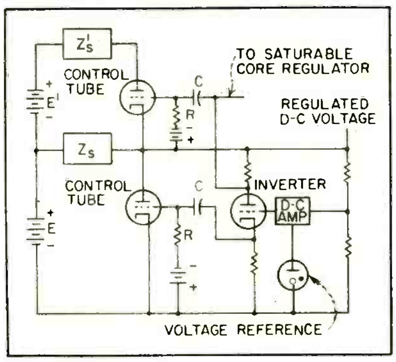


FIG. 2—Clamper circuit with d-c supply

at these frequencies and the phase shift through the filter is reduced.

Fast Regulation

Electronic circuitry to supplement the action of the slow magnetic amplifier is shown in Fig. 2. The name clampac was suggested by the fact that this circuit effectively clamps the output voltage of the supply against a-c load and line changes.

The circuit contains two control tubes operating class B push-pull. The tubes may receive their driving voltage from a d-c amplifier, but are made insensitive to d-c changes by a conventional R-C coupling circuit. One tube is connected across the load (a d-c voltage can be connected in series with this control tube if the output voltage of the supply is not a suitable value for plate voltage) and the other is connected between the supply output and some higher voltage. Conduction by the tube in shunt with the load will cause the output voltage to decrease. The tube connected to the higher voltage is effectively in series with the load, so its conduction causes the output voltage to increase. The error voltage is amplified and then split and fed in phase opposition to the two control tubes.

In Fig. 2, the voltage is split by a phase-inverter circuit. When the output voltage of the supply tends to increase, it is held by the shunt tube being driven into conduction while the tube going to the higher voltage is driven into cutoff. When the output voltage of the supply tends to decrease, it is retarded by the tube (to the higher voltage) conducting, while the shunt tube is driven into cutoff. In either case, the R-C circuit between the inverter and each control tube forces these tubes only to supplement the regulation of the slow, but highly efficient, magnetic amplifier. Proper adjustment of the time constants of these R-C coupling circuits would force the system to lose regulation to a step change at a rate just slow enough to allow the magnetic amplifier to take over the regulation. In other words, the low end of the clamper passband just meets the high end of the magnetic-amplifier passband.

The large power and space saving in this type of regulator is due to the control tubes normally operating near cutoff and drawing large currents only when regulating a-c changes. Thus, the control tubes have a low plate dissipation and small tubes can be used.

The system is used most advantageously with supplies which must provide large direct currents and low ripple. Electronic circuitry usually provides this type of load. If these conditions were reversed, then it would be of benefit to use a series-tube regulator, for a large rms a-c could create undesirably heavy plate dissipation in the control tubes. Also, the system cannot ordinarily tolerate as much ripple from the unregulated supply as can the series-tube regulator, for the clamper removes ripple by drawing current through the internal impedance of the supply. Since this impedance usually is low at the ripple frequency, pro-

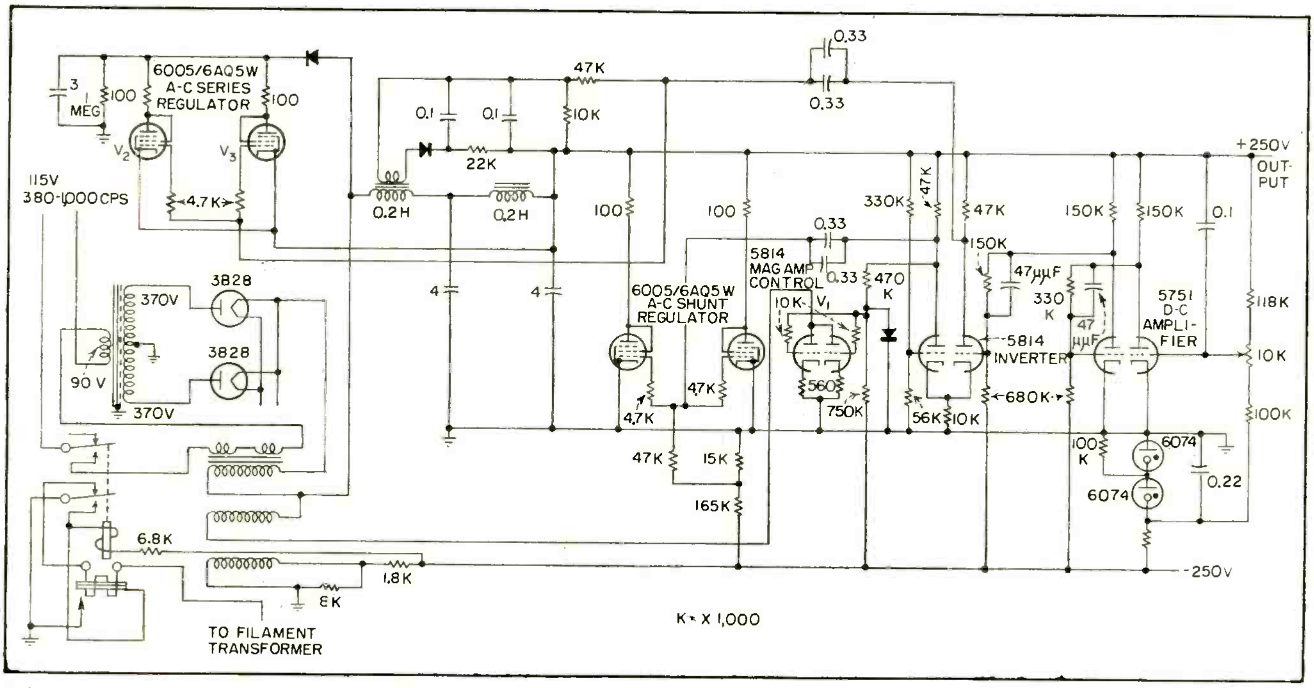


FIG. 3—Power supply with magnetic amplifier and clamper regulation has 250-v, 800-ma output at 55-percent efficiency

hibitively high currents may be drawn by the two triode control tubes.

The immediate problem in applying the clamper is obtaining the high voltage for the upper control tube. Only a small quiescent current is drawn at this voltage, but large peak currents must be furnished. These requirements can be met by half-wave rectification into a large capacitor. No further filtering should be needed.

In a power supply using a magnetic amplifier and an inductor-input filter, peak voltages in the order of twice the output voltage of the supply appear at the filter input. These peaks can be used to charge a capacitor through a rectifier to a high d-c potential. This latter arrangement is advantageous in that the capacitor is charged at twice the line frequency and the rectifier back voltage never exceeds the voltage across the capacitor. Such an arrangement is used in the supply of Fig. 3.

Circuit Example

The circuit of Fig. 3 provides an output of 800 ma at 250 volts with an efficiency of 55 percent. This is an output of 200 watts and a power loss of 162 watts. The output impedance is less than one ohm at all frequencies and less than 0.1 ohm up to 20 kc. This output impedance holds for d-c load changes from zero to full load and for instantaneous load changes as great as 250 ma. Full regulation is maintained as the a-c input voltage varies from 100 to 130 volts and from 380 to 1,000 cps.

Design Features

The magnetic amplifier in the supply of Fig. 3 is wound on toroidal cores of a material with a rectangular hysteresis loop. This was done to obtain small size and high performance in spite of the condition that the input voltage can vary from 380 to 1,000 cps.

The 8,000-ohm resistor across the bias winding of the magnetic amplifier is used to adjust to a desired speed of response for the magnetic amplifier.

The relay system allows time for the tube filaments to warm before voltage is applied to the power transformer. It also removes the voltage from the power transformer when the negative 250 volts is not being provided.

The rectifier from the grid of the magnetic-amplifier control tube, V_1, to ground is necessary to prevent the control current from getting so large, under conditions of excessive line voltage, that the magnetic amplifier goes into the negative-gain region of its operation.

Bias for the a-c series-regulator tubes, V_2 and V_3, *is* effectively obtained from the same point as is the voltage which provides the plate voltage for these tubes. This is necessary since the plate voltages of V_2 and V_3 vary directly with the peak voltage at the input of the filter. This peak voltage, in turn, varies directly with the line voltage (although the average value is held constant by the magnetic amplifier). Thus, the quiescent currents through V_2 and V_3 would vary with line voltage if their biases were constant. However, since the bias voltages here vary with the plate voltages and the tubes are operating in the low-gain region near cutoff, plate currents change little with line voltage.

D-C Generator Regulation

The same basic type of regulation can be used for d-c generators as has been described here for a rectifier-filter type supply. Now, however, the clamper can be used either in conjunction with a magnetic amplifier or a carbon pile. If used with a carbon pile, the pile can be made use of either in its usual role of a complete regulator or as an amplifier-control element driven by the error signal existing in the circuitry.

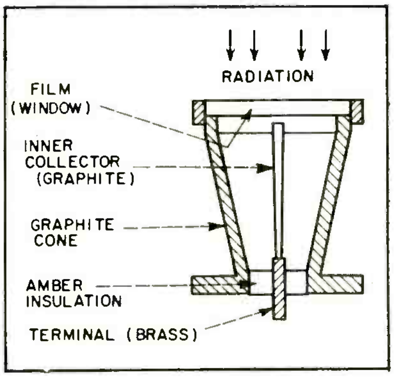


FIG. 1—Sectional view of ionization chamber used as sensing element

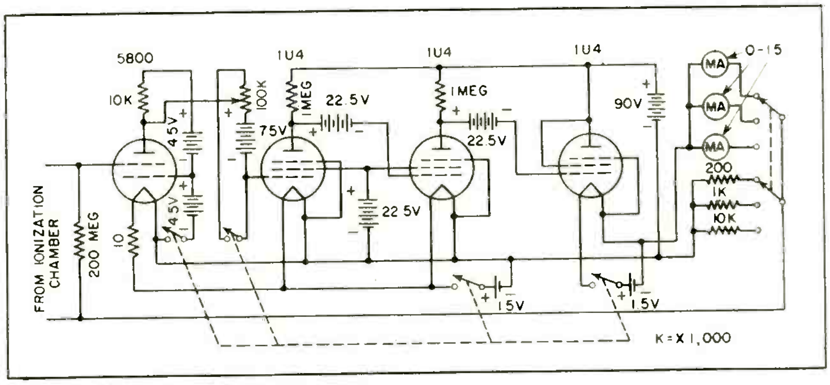


FIG. 2—Direct-current amplifier uses battery power to achieve portability for maximum usefulness in measuring Grenz rays

Direct-Reading

Portable instrument using ionization chamber and d-c amplifier measures radiation strength of soft x-rays over ranges of 500, 2,500 and 25,000 roentgens per minute. Battery power source permits portable operation for application in x-ray therapy

GRENZ-RAY THERAPY has gained considerable prominence for the treatment of a number of diseases and afflictions. These rays are very soft x-rays with a wavelength in the order of a few angstroms. Because the rays are very easily absorbed, even in organic matter, their measurement presents special problems in the design of equipment (dosimeters) with which their dosage rate can be determined. The dosimeter to be described gives an accurate measurement of the Grenz-ray radiation impinging on the area under treatment.

Design Considerations

The radiation intensity depends upon the potential and current of the machine producing the radiation, the distance between the source and area under treatment and, especially in the case of Grenz rays, on the window of the tube through which the rays are transmitted.

The physician administering the treatment must know accurately the number of roentgen units applied to the area under treatment. It is therefore necessary to calibrate the output of each Grenz-ray machine in roentgens per minute, for each potential, current and distance. It is also necessary to determine the penetration power or quality of the Grenz rays. This is usually given in terms of the half-value layer in microns of aluminum, which is the thickness that will halve the dosage rate of radiation.

Ionization Chamber

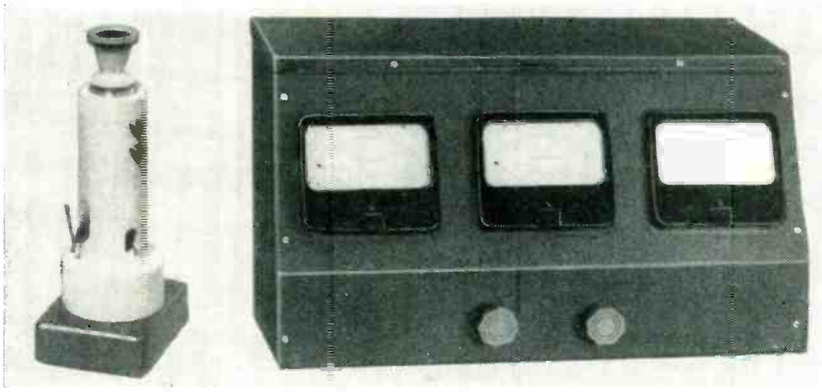
To obtain a meter indication proportional to the number of roentgens per minute it is necessary to obtain a small current exactly proportional to the number of roentgens per minute and amplify this current to a value sufficiently high to be read on an indicating instrument.

The first requirement, that of a proportional current, is obtained with an ionization chamber, shown in Fig. 1. The outside element is made of graphite and has the shape of a truncated cone. The larger diameter and height of the cone are about 1 cm and the wall thickness is between 0.5 and 1 mm.

The inner element or collector is a thin graphite rod, about 1 mm in diameter, similar to the lead of a mechanical pencil and insulated with amber from the outer element. A larger diameter of the collector must be avoided in order not to decrease the effective volume of the chamber. A very thin rod would produce too high a field strength near its surface.

The chamber is filled with air. At the top of the chamber is a thin film of organic material, which is coated with colloidal graphite (Aquadag) to render it conductive. Kodapak I, a commercial material, can be obtained in a thickness of 0.001 in. (25 microns) and has proved satisfactory. It is sufficiently strong so that the watery slurry of Aquadag can be easily applied with a brush. The film is chosen for its ability to transmit even the soft radiation with negligible absorption; at 10-micron aluminum half-value layer, less than 10 percent of the radiation is absorbed. In this way, the idea of the window of the Grenz-ray tube is applied to the ionization chamber.

In such an ionization chamber, the current depends only on the voltage applied to the chamber, until saturation is reached. The saturation current is proportional to the impinging dose rate of the ionizing radiation and, if the walls of the chamber are built of a material with the same effective



Saturation current of graphite ionization chamber (left) produces a meter indication proportional to roentgens per minute. Three meters prevent reading wrong scale

Table I—Calibration of Grenz-Ray Dosimeter

Grenz-Ray Potential	Dose Rate	Instrument Reading	Sensitivity
kv	r per min	ma	r per min per ma
6	58.7	0.102	578
8	237	0.408	581
12	378	0.652	580
12	1,065	1.83	582
15	1,977	3.56	558

Grenz-Ray Dosimeter

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atomic number as air, the saturation current readings will be approximately independent of the wavelength of the radiation. This is the reason for the use of graphite as the chamber material.

Saturation current in the ionization chamber is in the order of 5×10^{-9} amp for a Grenz-ray dosage rate of 1,000 r per min.

Amplifier

The amplifier is a conventional d-c feedback amplifier consisting, as shown in Fig. 2, of an input stage utilizing a 5800 electrometer tube, two amplifier stages and a cathode follower.

If the amplifier is simplified to the diagram of Fig. 3, the following analysis shows its performance

$$e_i = i_s R_1 - i_2 R_2$$
$$i_2 = Ge_i = G(i_s R_1 - i_2 R_2)$$
$$i_2 = Gi_s R_1/(1 + GR_2)$$

where R_1 is the input resistor, R_2 is the output resistor, G is transfer function of amplifier, i_s is input saturation current (proportional to radiation dosage rate), i_2 is output current and e_i is input voltage.

If the requirement is met that $GR_2 >> 1$, $i_2 = i_s\ R_1/R_2$. For this amplifier, $GR_2 > 10{,}000$, so that the

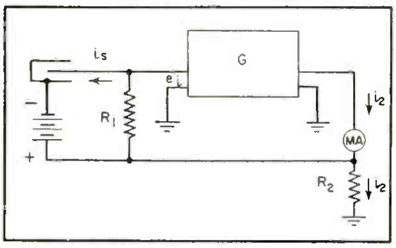

FIG. 3—Four-terminal network representation of amplifier in Fig. 2

error introduced by this approximation is negligible compared with the other sources of error, even for considerable variations in G. In the equation $i_2 = i_s\ R_1/R_2$, G is not present so that the amplifier is linear and continues to function properly even with considerable change in battery voltages and transconductances of the tubes.

The current amplification is the ratio of the input to output resistance and can be calculated accurately to a tolerance determined by these resistors and the indicating instruments, without considering G at all.

Battery operation was resorted to for this dosimeter, because (1) current requirements are small; (2) line voltages fluctuate greatly when Grenz-ray machines are turned on or off; (3) power-line voltages of proper kind are not always available at the locations of Grenz-ray machines; (4) the instrument is thus easily portable.

Calibration

Since the constant of the ionization chamber is difficult to calculate, the whole dosimeter is calibrated against a standard. The instrument described was calibrated by the National Bureau of Standards against an open-air ionization chamber and found to be exact within the usually permissible error.

Calibration values are listed in Table I. The last column shows that the sensitivity is constant, independent of dose rate and operating potential of the Grenz-ray machine. Additional tests have indicated that the error does not increase substantially even up to intensities of 25,000 r per min.

The complete instrument uses three indicating meters to prevent unskilled persons from reading wrong values, which might occur with multiple scales. The scales read directly in r per min. The three ranges of the instrument cover dosage rates to 500 r per min, 2,500 r per min and 25,000 r per min.

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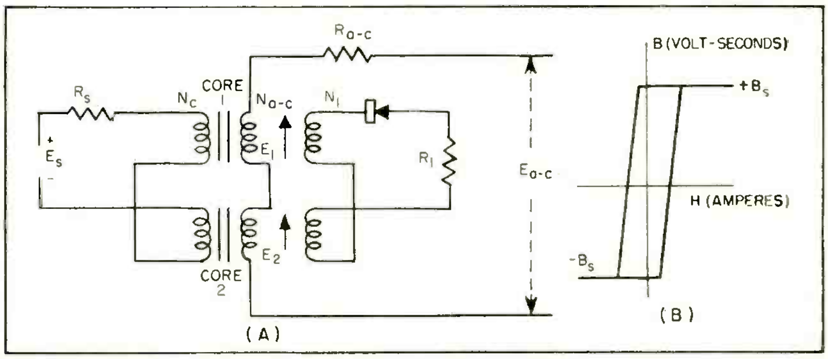
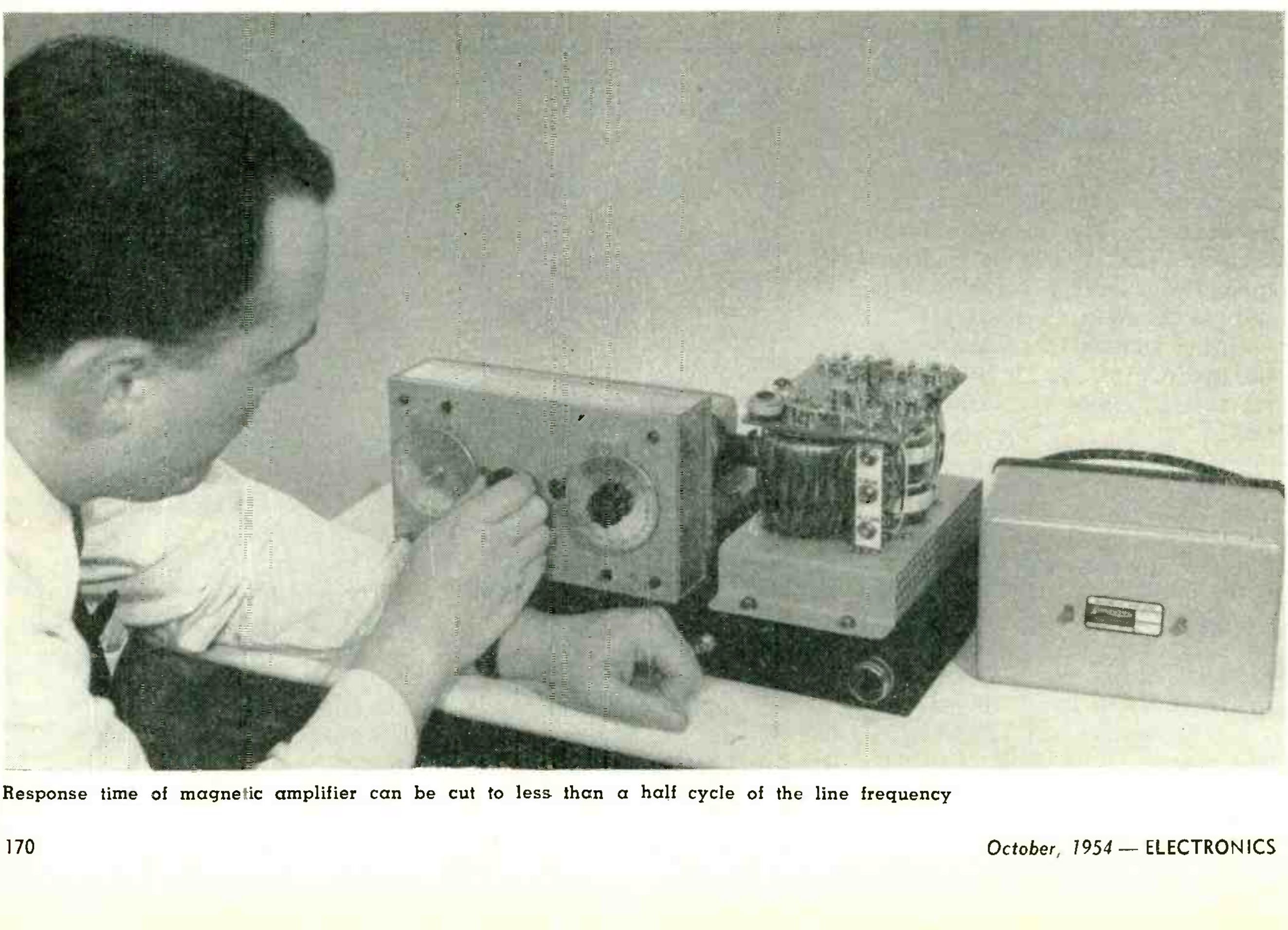


FIG. 1—Basic circuit (A) of high-speed amplifier and idealized hysteresis loop for core material (B)

Fast-Response Magnetic

MAGNETIC AMPLIFIERS have an inherent delay of one-half cycle of the supply frequency for each stage of amplification. The fast-response magnetic amplifier described in this article is capable of being used in several cascaded stages with a total time lag of less than one-half cycle. Ultimate speed of response is limited by the magnetic materials and by power considerations rather than by supply frequency.

The reduction in time lag between input and output signals of the magnetic amplifier results in an increase in the gain-bandwidth factor. This factor is a measure of the performance capabilities of an amplifier. A servo system utilizing a high-speed magnetic amplifier will be capable of greater accuracy and bandwidth than a system using a slower responding amplifier. These improvements in accuracy and bandwidth can be achieved with no reduction in system stability. Consequently, it is possible to design magnetic amplifiers into high-performance servo systems which



Response time of magnetic amplifier can be cut to less than a half cycle of the line frequency

Table I—Core Data For Three-Stage High-Speed Magnetic Amplifier

STAGE 1 Core—Arnold Eng 5340-S1				
	Amplifier		Switch	
Winding	Turns	Wire Size	Turns	Wire Size
Signal	300	42		
Load	1,600	38	1,600	38
Line	2,500	42	2,500	42

STAGE 2 Core—Arnold Eng 5233-S1				
	Amplifier		Switch	
Winding	Turns	Wire Size	Turns	Wire Size
Signal	100	33		
Load	2,100	33	2,100	33
Line	2,900	33	2,900	33

STAGE 3 Core—Magnetics, Inc. 50041-4A				
	Amplifier		Switch	
Winding	Turns	Wire Size	Turns	Wire Size
Signal	150	27		
Load	2,700	27	2,700	27
Line	800	23	800	23
Transformer			240	29

Servo Amplifier

Performance of vacuum-tube amplifiers is approached by cascaded high-speed magnetic amplifiers for servo systems. Three-stage unit responds in less than half cycle of supply-voltage frequency, permitting use of error-rate feedback for stabilization

will approximate the performance of servo loops utilizing vacuum-tube amplifiers. This is especially important when power is available only at 60 cycles per second.

Circuit Operation

To achieve fast-response characteristics, input and output of a magnetic amplifier must occur during the same half-cycle of the power-supply voltage. The basic circuit of the high-speed amplifier is shown in Fig. 1A with an idealized hysteresis loop of the cores in Fig. 1B.

To describe the operation of the circuit let the turns ratio between the signal windings N_c, the line windings N_{a-e}, and the load windings N_l be unity. If line voltage E_{a-e} is chosen so that any winding on one core will support one-eighth of the volt-seconds during one-half cycle of the supply voltage, then the two cores in series will saturate after one-fourth the volt-seconds of the line voltage per half cycle. Waveforms at various points in the circuit are shown in Fig. 2.

During any half cycle of supply voltage, there exist three possible states for the cores; both cores unsaturated, one core saturated and one unsaturated or both cores saturated. If line voltage is applied when both cores are in the minus saturated state ($-B_s$), Fig. 1B, then the line voltage will divide evenly between the cores and both cores will saturate in the plus state ($+B_s$) after one-fourth the volt-seconds in the half cycle. During the remainder of the half cycle, the line voltage will appear across R_{a-c} of Fig. 1A. The second half cycle will be the same except that the line voltage will have reversed and the cores will return to the $-B_s$ state.

If a signal voltage E_s is introduced at the start of the second cycle of line voltage, the instantaneous voltages on cores 1 and 2 will differ by the signal voltage. For the polarity of signal voltage shown, there will be no current flow into load R_l. The signal voltage appears at the load windings, but the rectifier prevents current flow. Thus, the current from the signal source will be the incremental magnetizing current for the cores.

If the line voltage is positive at the top of the line windings at the time of the signal, core 1 will have the greater voltage and will saturate before core 2. When core 1 saturates, core 2 will have to support a number of volt-seconds equal to those of the signal in the time interval between the start of the half cycle and saturation of core 1. If R_s is very large compared to R_{a-c}, the voltage on core 2 will be the line voltage less the IR drop in R_{a-c}.

Since the signal source was required to supply only the incremental magnetizing current, it is possible to make R_s rather large without appreciably reducing the effectiveness of the signal voltage. Core 2 will transmit power from the line into load resistor R_l after saturation of core 1 and before saturation of core 2. This results from the fact that the polarity of the voltage at the load winding of core 2 is correct to pass current through the rectifier in series with the load. The volt-seconds delivered to the load will equal the volt-seconds from the signal while both cores were unsaturated.

If the signal continues for the next half cycle, core 2 will saturate first and core 1 will transmit power from the line to the load.

To cascade several stages of

amplification, R_1 can be replaced by a signal winding of a second stage supplied from the same line voltage. The requirement for the second stage is that the cores should support more voltage than for the first stage. This is necessary since the signal-input period of each stage is the time when both its cores are unsaturated. In the same manner, additional stages of amplification can be achieved within the same half cycle of the supply voltage.

Full-Wave Operation

The basic circuit described is useful only as a d-c amplifier because reversing the polarity of the input signal causes signal current to flow into the load resistor and essentially no power gain results. To permit amplification of either polarity of input signal it is necessary to replace the rectifier in the output of the amplifier with a switch which is open when both cores are unsaturated and closed when one core is saturated and the other unsaturated.

This will disconnect the load from the circuit during the signal-input period and the signal source will be called upon to furnish only the incremental magnetizing current for either polarity input. The polarity of the input signal will determine the polarity of the output which, in turn, will make the amplifier-output polarity reversible for d-c signals, and phase reversible for signals at power frequency.

A suitable switching mechanism with magnetic amplifiers is shown in Fig. 3. Amplifier cores 1 and 2 are the same as before and cores 3 and 4 are constructed identically, except that no separate signal winding is used. The operation of the amplifier, cores 1 and 2, is the same as before. When the signal is applied, both cores are unsaturated and the signal voltage is transferred to the load windings of the amplifier.

The path for current flow into the load circuit, resulting from the signal voltage, is through resistors R_1 and R'_1, the load windings of cores 3 and 4 and two rectifiers of the bridge. Since cores 3 and 4 are always in the same state as cores 1 and 2, the signal voltage

Table II—Servo System Performance

Power	115 volts	60 cps
Motor	Diehl	FPE 25-22
Amplifier	3-stage	
	Power gain...	100,000 without feedback
	Maximum power output.	15 watts
	Voltage gain..	7.5 with stabilization
Stabilization	Error-rate feedback using linear passive elements	
Control Transformer	Geared down 1:10 from motor, sensitivity 1 volt per degree	
System Performance	Static error...	0.2 max
	Velocity error.	1 deg per 140 deg per second
	Bandwidth...	10 cycles per second
	Damping ratio	0.5.
	Maximum stall torque...	5 in. oz at motor
	Slewing speed.	3,300 rpm

will result in the incremental magnetizing current flowing into the load windings of cores 3 and 4. The entire signal voltage will be impressed on cores 3 and 4. Load windings of this core pair act as the signal-input windings and the current supplied by the signal source is the incremental magnetizing current for core pairs 3-4 and 1-2. At the time that one core in the amplifier pair 1-2 saturates, one core in the switching core pair will saturate.

Regardless of the polarity of the signal E_s, the incremental magnetizing current through the switching cores will always flow in one direction due to the rectifier bridge. Consequently, the output pulse of the switching-core pair will be of the same polarity and send current into both legs of the rectifier bridge. This current effects the closing of a switch between the load resistor R_1 and the load winding of the amplifier.

If R'_1 is equal to R_1 and R'_{a-c} equal to R_{a-c}, the switch will remain closed, during the period that the amplifier output power is delivered. The voltage across the unsaturated core will be impressed at the load resistor while one core in each pair is unsaturated.

Three-Stage Amplifier

A three-stage magnetic amplifier was constructed to energize the control phase of a two-phase, 60-cycle servo motor. The schematic diagram of this amplifier is shown in Fig. 4. Core winding data is given in Table I. The amplifier and switching cores for the first stage saturate after one-quarter of the a-c power volt-seconds have elapsed. The second-stage cores saturate at the one-half point and the third stage at the three-quarter point. To insure a proper sequencing, power for all three stages and their switching circuits comes from the same source. This removes the possibility that line voltage or frequency variations could alter the signal and power sequences for the cascaded stages.

The second and third stages of amplification and their respective switching circuits are operated directly from the 115-volt, 60-cps source. The series line windings in the second stage support 30 volts

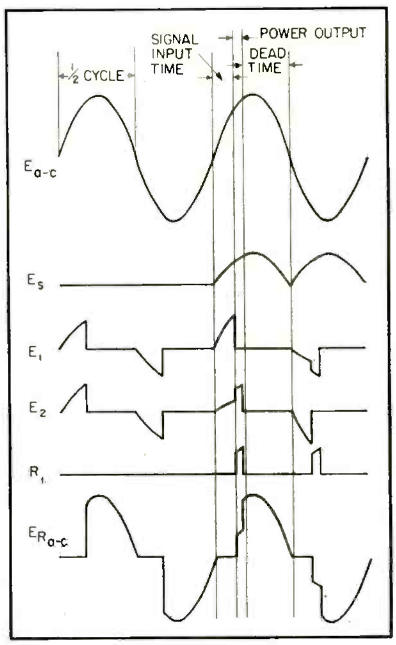


FIG. 2—Waveforms in high-speed amplifier circuit of Fig. 1A

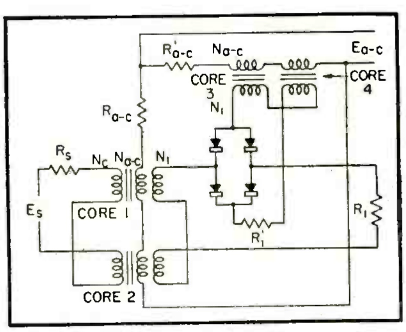


FIG. 3—Magnetic amplifier circuit designed for full-wave operation

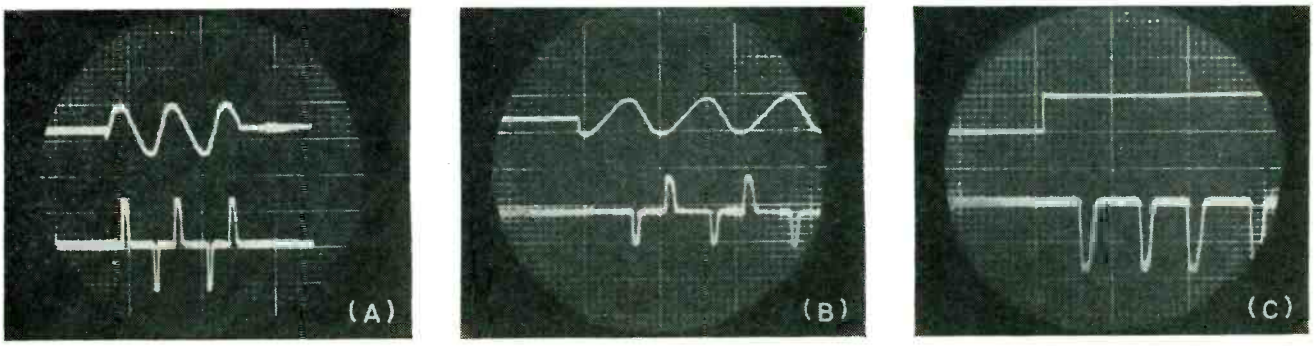


FIG. 5—Input and output waveforms for 2-v 60-cps control signal with minimum delay (A) and maximum delay (B). Output (C) is for d-c step-voltage control

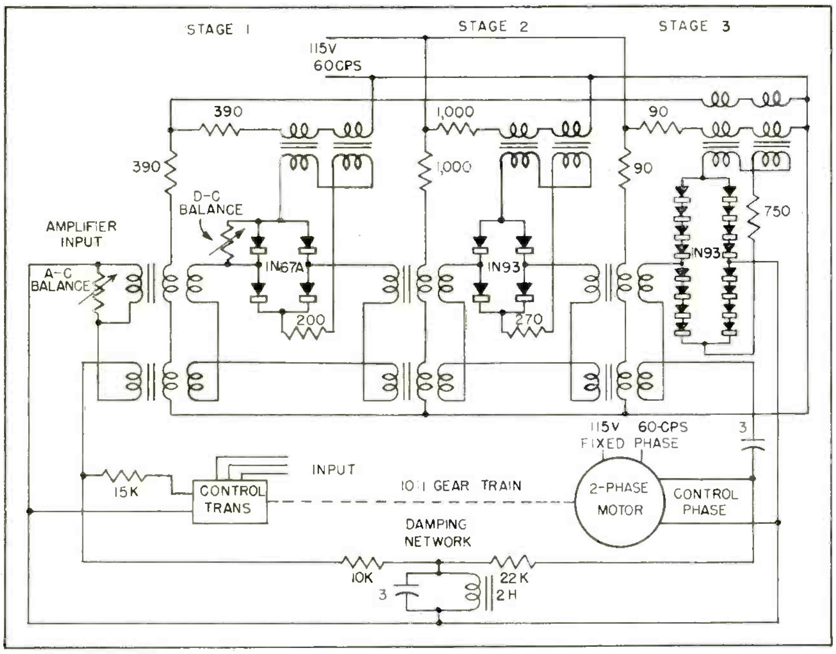


FIG. 4—Cascaded three-stage magnetic-amplifier circuit for servo-motor control

for each core, so that saturation occurs at the midway point for the two cores. The line windings of the third stage support 40 volts each. This causes saturation in both cores slightly before the three-quarter point of the half cycle of supply voltage.

It was impractical to design the first stage to support one-eighth of the line voltage for each core, since the small size of the cores used would make the number of turns prohibitive. For this reason, a reduced line voltage for the first stage was obtained by transformer coupling of the switching cores for stage 3. After both cores of the switching circuit for the third stage saturate, the line voltage of stage 1 drops to zero. This does not alter operation, since the cores in stage 1 are all saturated and no signal is effective until the line voltage reverses and the cores come out of saturation.

Oscillograms were taken, using a dual-beam oscilloscope, to illustrate the fractional-cycle response of the three-stage amplifier. Figure 5A shows the input-output relationship for a 2-volt 60-cycle rms signal. The output starts approximately one-fourth cycle later. Figure 5B shows the maximum delay for the three-stage amplifier. The input signal starts just after the saturation time of the cores in the first stage. The output does not start until the middle of the next half cycle. Figure 5C shows the response to a d-c input step. Output load for the amplifier was a 450-ohm resistor for all cases. Power gain is approximately 100,000.

The damping network used to stabilize the servo system of Fig. 4 serves a dual purpose. In addition to providing error-rate damping for the servo loop, the degenerative feedback around the amplifier reduces amplifier drift. This type of stabilization is made possible by the fast response of the amplifier.

To provide damping for the servo loop, the stabilizing network must have lag. When used with three stages of half-cycle response magnetic amplifiers, the stabilizing network causes oscillations of the amplifier because the lags of the amplifier and stabilizing network are too large to permit much negative feedback around the amplifier.

When used with the fast response magnetic amplifier, a large amount of negative feedback can be used around the amplifier without causing oscillations. This results in a simple stabilizing system and considerable reduction in drift for the servo system.

Although the drift of this type of magnetic amplifier is inherently low, the changing characteristics of rectifiers, particularly those associated with the first stage of amplification, can introduce some drift errors. Tests on the effect of rectifier leakage were made by shunting rectifiers with resistors to simulate leakage currents three times the manufacturer's ratings. With the stabilizing network reducing the effect of drift, the resultant change in the output position of the servo system was 0.1 degree. Without the stabilization, the drift would have been between one and two degrees.

The performance characteristics for the system described are listed in Table II.

High-Speed Counting With One-Tube Decades

Hundred-kc counter uses decade scaler tube with 6J6 for zero reset. Experimental one-mc circuit has pulse resolution time of less than one μsec. Diode biasing makes possible interval timer and other circuits where scaling to less than ten is needed

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SINGLE-TUBE decade counters have created considerable interest because of their low power drain, of particular advantage where multiple scaling is required, as in multichannel pulse-height analyzers.

The E1T decade scaling tube[1], Fig. 1, is designed for the counting of voltage pulses at high speed. It consists of the necessary electrodes to form a ribbon-shaped beam of electrons, a screen with ten slots, each of which corresponds to a digit from zero to nine and a fluorescent screen for displaying the position of the beam. A feedback system using a fine-mesh anode screen causes the beam to be completely stable in any one of the ten positions.

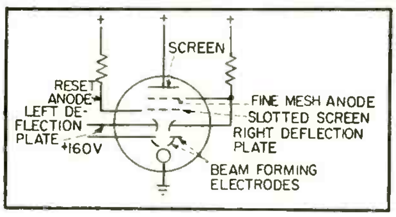

FIG. 1—The E1T decade scaling tube

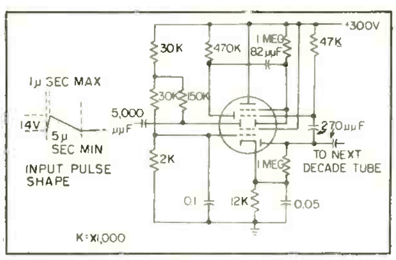

FIG. 2—One-tube decade counter circuit with passive elements

The left deflection plate is maintained at 160 volts, while the right deflection plate will vary from about 245 volts in the zero position to 109 volts in the nine position. Stepping from one position to the next may be accomplished by applying a positive triangular-shaped pulse to the left deflection plate. The pulse rise time is fast enough to move the beam from one stable position to the next and the trail-off time is sufficiently long to allow the beam to stabilize itself in the new position. The tenth pulse moves the beam to the reset anode, giving rise to a negative pulse which may be used to reset the tube to zero. The beam strikes the fluorescent screen to indicate its position. The position of the beam is indicated electrically by the voltage of the right deflection plate.

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Single-Tube Circuit

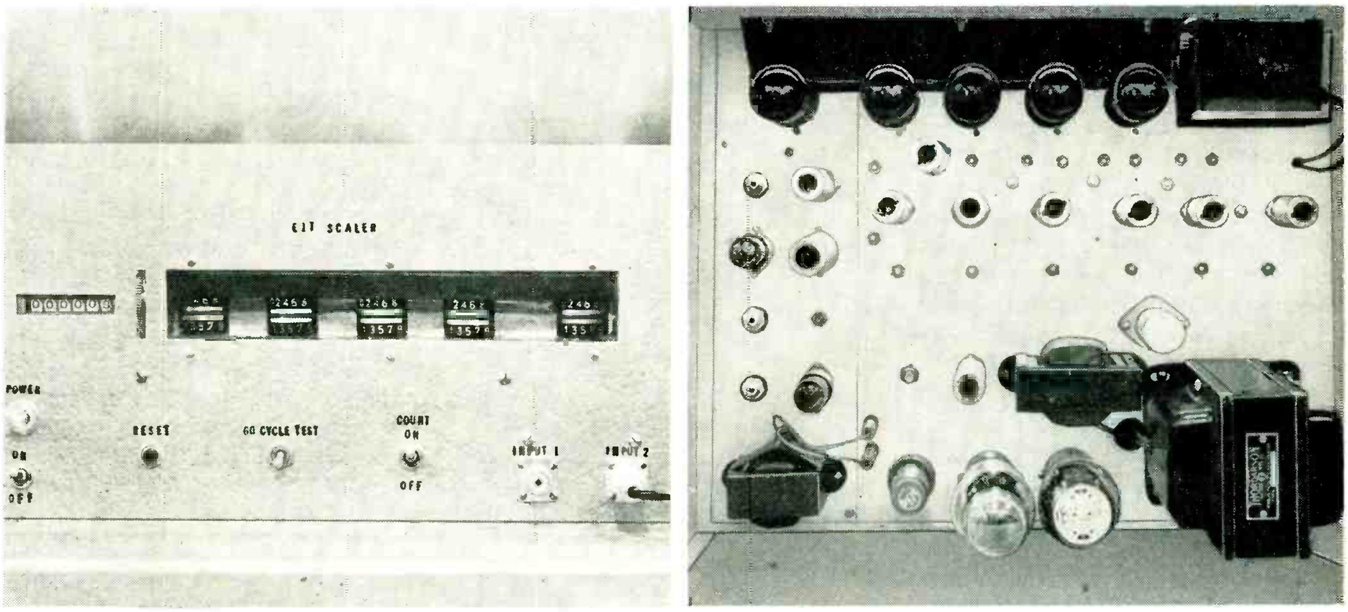
It is possible to operate the E1T tube as a decimal counter using only passive elements in the circuit as shown in Fig. 2. Several of these counters have been constructed and operated with some success. It was found that of 40 counter tubes on hand approximately one-half operated in this circuit satisfactorily. When the reset coupling capacitor was increased from 100 μμf to 250 μμf, approximately 30 of the tubes operated well in this circuit.

The common difficulty encountered was the problem of getting the tubes to reset reliably to zero. Some tubes reset to position one regularly and others reset to zero most of the time but to position one occasionally. Since increasing the reset coupling capacitor lowered the maximum counting rate of the tube, other, more complex circuits seemed justified.

30-KC Counting

The circuit[2] shown in Fig. 3, using a 6J6 to reset the tube on the tenth pulse, was observed to have a maximum counting rate limited by the reset time, as was also true in the one-tube circuit, and by the resolving time of the input univibrator V_1. The circuits gave reliable reset to zero in a much shorter time than the one-tube circuit. Tube V_3 was operated as a univibrator, applying a negative pulse to the control grid when triggered. This cut the counter tube off and allowed the right deflection-plate voltage to rise, returning the beam to the zero position. The time required was determined by the capacitance of the deflection plate and wiring and the one-megohm load resistance.

The univibrator also provided a positive shaped pulse to drive the next scaler tube or the register driver tube. The counter tube was capable of stepping from one position to the next in about 5 micro-



Front and top views respectively of experimental circuit consisting of one-mc strip, 100-kc circuit and three 30-kc circuits

seconds but reset required closer to 30 microseconds. For counting speeds of less than 30,000 counts per second this circuit was satisfactory.

Increased Counting Rate

Primarily a modification of the previous circuit, Fig. 4 shows a circuit, with the reset mechanism changed, capable of 100,000 counts per second. Since the tube will step from one position to the next in less than 10 microseconds, no modification of this function was made. The plate load resistor was changed on the normally conducting half of the 6J6, so that the voltage at the plate was less than the right deflection-plate voltage in position nine.

When the beam strikes the reset anode, the normally conducting half of the dual triode is cut off and the anode voltage correspondingly rises.

The rise is more rapid than in the 30,000 count per second circuit because of the reduced load resistance (56,000 ohms in series with the resistance of the coupling diode instead of one megohm). Since the diode is then in a conducting condition the right deflection-plate voltage also rises, bringing the beam back to the zero position. The cut off portion of the dual triode begins conducting again, the time determined by its own *R-C* time constant, and the coupling diode is rendered nonconducting so that counting action can proceed.

This action takes place in about eight microseconds, which is not appreciably longer than the time required to step the counter tube from one position to the next. As in the 30,000 count per second circuit, a shaped pulse is fed from the cathode of the reset univibrator to drive the next stage.

A 6AL5 is used as the coupling diode because of the inverse working voltage required, but it may be possible to substitute a semiconductor diode.

Scaling to Less Than Ten

In a number of timing applications it is often desirable to scale to less than ten. A modification of the circuit, Fig. 5, allows the tube to perform this function. The right deflection plate rises only part of the way toward the zero position because of the conduction of the diode and thus resets to whatever position the voltage at the cathode of the diode corresponds. The circuit constants given allow the tube to scale by six. This converts, for instance, 60-cycle pulses into $\frac{1}{10}$-second pulses for timing purposes

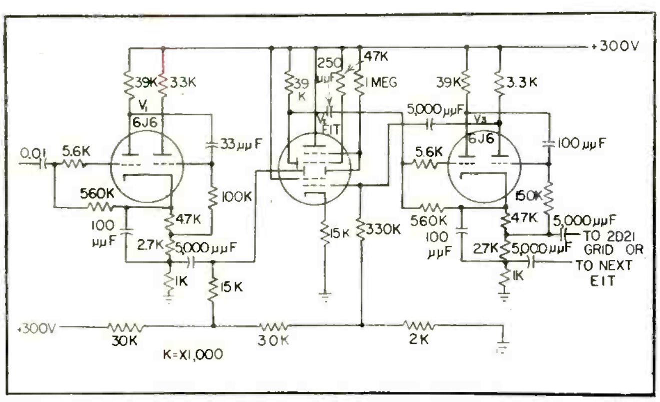


FIG. 3—Philips 30,000 counts per second circuit. The 6J6 resets the tube on the tenth pulse

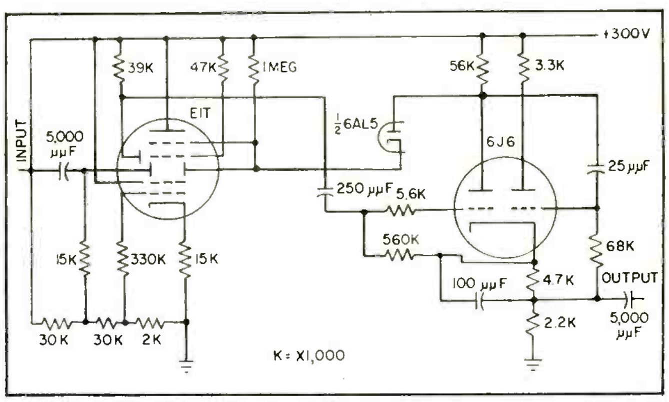


FIG. 4—Circuit for driving the tube to 100,000 counts per second incorporates certain modifications

and an additional scale of six converts the rate to 1/100-min pulses. The circuit preceding the scale of six converts the smoothly varying 60-cycle current into sharp voltage pulses capable of driving the univibrator-pulse shaper which in turn drives the counter tube. Coupled with a driver tube and a register, this system then becomes an accurate interval timer. Any scale from one to ten is possible with this circuit. It is probably not economical to use less than a scale of three, except for special applications where a range switch changes the scaling factor of the tube.

Register Driving Circuits

Two register driver circuits have been developed. The first circuit, shown in Fig. 6, uses a 5963 (12-AU7) tube as a long time-constant univibrator. This tube is triggered by the final counter tube or by the reset univibrator if the faster circuits are used. The positive output pulse from this tube is fed to the grid of the 6AQ5 driver. This tube, normally cut off, then conducts and causes the mechanical register to advance one count. The 6AQ5 returns to the nonconducting state when the positive voltage is removed from the grid, as determined by the time constant of the univibrator driving it. This circuit is capable of driving the register to its maximum reliable counting rate.

The second circuit, Fig. 7, uses a 2D21 miniature thyratron to perform the register driving function. Unloading of the 2D21 is accomplished by the *L-C* network from plate to ground. Although this circuit uses one less tube than the first, it has the disadvantage of having two one-μf capacitors as part of the circuit. A 600-volt (bathtub) dual capacitor may be used. Both drivers work reliably at 300 volts anode supply and both have the disadvantage of causing a considerable drain on the high-voltage supply feeding them. A regulated supply is adequate for supplying both the counter and the driver circuits, but if two separate power supplies are used neither need be regulated. A register requiring less power than the Veeder-Root counter used would materially reduce the cost and complexity of the power supplies and would probably allow both systems to be operated from the same unregulated supply.

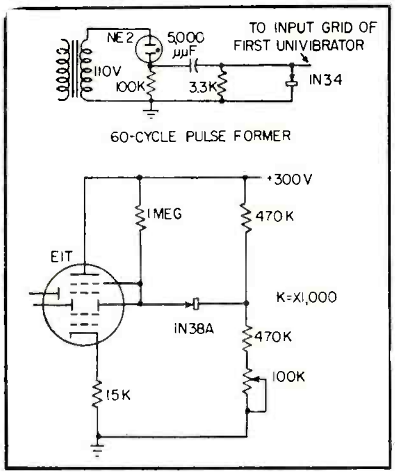


FIG. 5—Basic circuit for interval timer. System shown is for scale of six

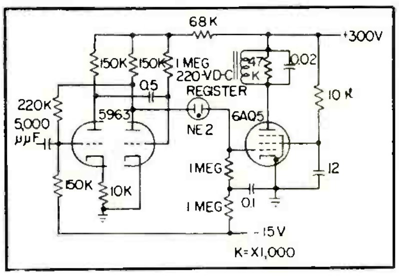


FIG. 6—Register driving circuit uses type 5963 as a long time constant univibrator triggered by the final counter

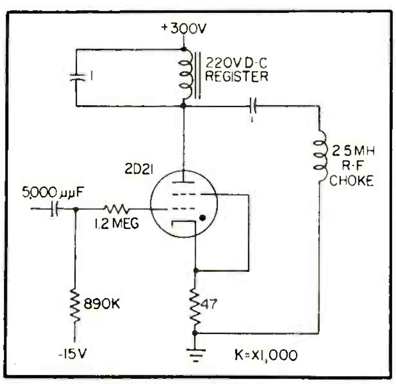
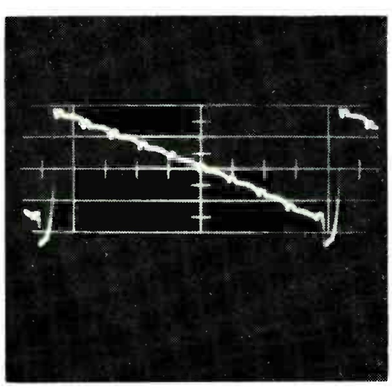


FIG. 7—Register driving circuit employs 2D21 miniature thyratron



Voltage waveform of right deflection plate of E1T tube. Pulses are ten microseconds apart

A third register driving circuit is given in Fig. 8. This is a modification of the circuit of Fig. 7, in which the unloading of the thyratron is accomplished by the application of a 60-cycle a-c signal at the plate. In addition, an inexpensive power supply is provided, using two selenium rectifiers in a voltage-doubler circuit, so that the counter tubes may be operated from a separate unregulated supply.

One-MC Circuit

An experimental circuit, which has been operated at speeds slightly above one megacycle, is shown in Fig. 9. The tube is caused to step from one position to the next by driving the right deflection plate negative. One-half of the 12AX7 performs this function. Double or triple pulse resolving time of this circuit, exclusive of the reset function, is essentially zero. This is due to the fact that if two input pulses appear at the same time the tube will step two positions instead of one. The reset is accomplished in the same manner as in the 100-kc circuit, except that a high-current 5687 univibrator is used to allow reduction of the plate load resistor, and thus shorten the reset time. Reset is accomplished in about 0.8 microsecond.

Random Pulses

If this circuit is used to count random pulses, as from nuclear detection devices, the resolving time is made up of two factors: the stepping time from one position to the next and the reset time. Thus

$$T_d = 0.9\ T_s + 0.1\ T_r$$

where T_d is the dead time of the circuit, T_s the stepping time and T_r the reset time. If the input circuits are arranged such that two pulses occurring at the same time are presented to this circuit as a single double-size pulse, the stepping time T_s is zero and the dead time becomes simply 0.1 T_r, or 0.08 microsecond.

The second half of the 12AX7 serves to amplify the pulse from

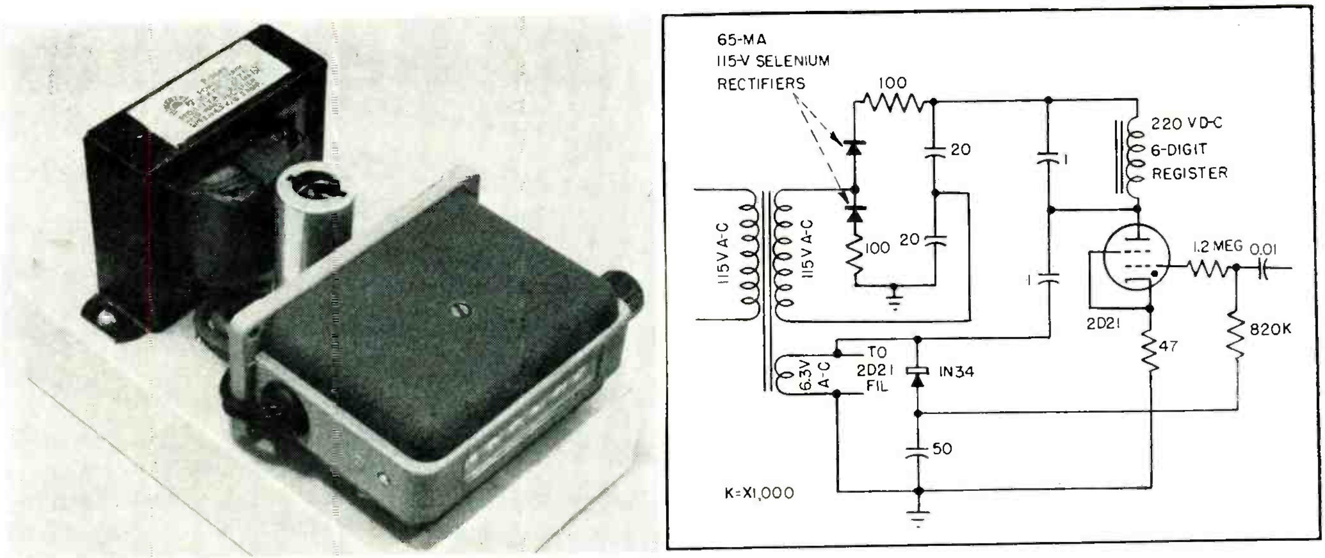


FIG. 8—Modification of circuit in Fig. 7 with power supply. Photograph shows complete unit mounted on 4 by 6 by 1½ in. chassis

the reset anode of the counter tube to trigger the 5687 univibrator. By its conduction, it maintains the first half of the tube at cutoff. Use is made of the change in triode conduction with changing plate voltage to provide smaller and smaller pulses as the position of the beam in the counter tube moves from position zero to position nine, since smaller pulses are required as the right-deflection-plate voltage drops.

The size of the input pulse is quite critical in this circuit, and must be carefully controlled. The shape of the pulse is not too important, as long as the proper charge is delivered to right deflection plate. Two methods have been used to provide this pulse. The first used a saturation amplifier to limit the pulse height and an open-ended delay line to determine pulse width. The second method used a univibrator similar to the reset univibrator. Pulse widths in both cases were limited to about 0.3 microsecond and pulse height to about 20 volts.

Two views of the experimental unit are shown in the photographs. The experimental one-mc strip may be removed for modification. The remainder of the unit consists of the 100-kc circuit followed by three 30-kc circuits and the thyratron register drive. An electronically regulated power supply is used.

Magnetic Effects

Because the EIT tube is very similar to a cathode ray tube, the beam is considerably affected by magnetic fields. This was demonstrated in the first scaler constructed when the Veeder-Root register was mounted directly over the counter tubes. The magnetic pulse which occurs when the register is triggered caused a disruption of the counting function. This was overcome by enclosing the register in an iron box about $\frac{3}{32}$-in. thick.

The EIT decade counter tube represents an interesting departure from normal electronic development, in that it is designed to perform a single, relatively complex electronic task. Until very recently this function was performed by electronic tubes designed primarily for other purposes. It is therefore not surprising that the tube affords a reliable and comparatively inexpensive means of accomplishing the counting of voltage pulses at high repetition rates. It is encouraging that the design concept of special vacuum tubes for specific functions is being pursued. Although the tube shows some inherent limitations, it is not felt that these are serious.

The counting speed of 100,000 counts per second is satisfactory for most purposes, and speeds above one mc have been demonstrated at this laboratory and elsewhere. With the termination of the U. S. Atomic Energy Commission contract on June 30, 1954, continuation and completion of certain phases of the work will be carried on by the University of California Radiation Laboratory.

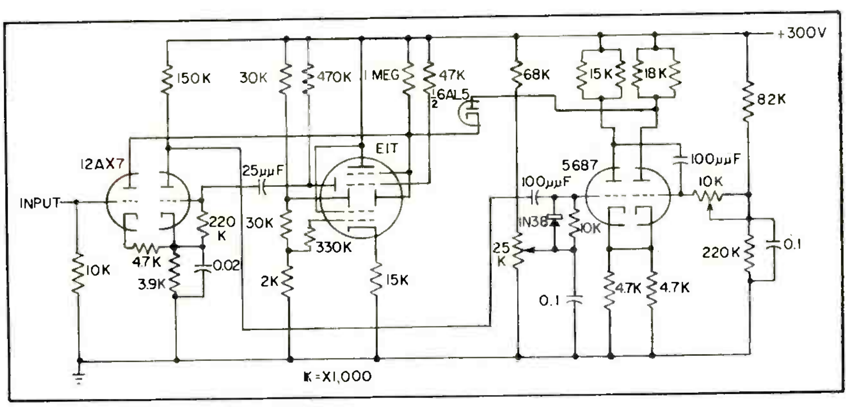


FIG. 9—Experimental one—mc scaling unit. Further development is needed to make circuit reliable enough for routine use

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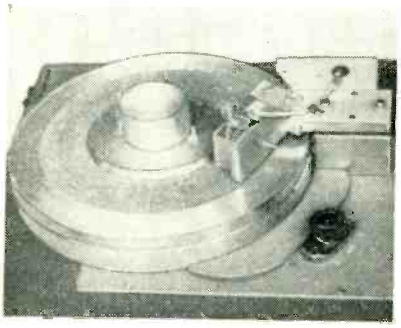
(1) *Philips Research Report*, 7, p 81, 1952.
(2) *Electronic Design*, p 8, July 1953.

Magnetic Recorder



Four-channel magnetic record-playback head and turntable

By MAX HOBERMAN

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SEVERAL METHODS are available for transient analysis, particularly by means of a magnetic disk recorder. Capturing the waveform permits its study by the more conventional techniques of steady-state analysis.

Among the simplest parameters that can be determined this way are those including the measurement of rise and decay times of electrical circuits, area under curves and peak amplitudes. These measurements are based upon obtaining suitable proportionality constants between the ordinate of the record and a parameter of the transient such as voltage, current or acceleration. It is also necessary to obtain a constant of proportionality relating the independent variable and the abscissa (generally time).

Time calibrating marks and voltage or current standards fix the reference and the procedure thereafter is straightforward. Purely mathematical scaling methods can be used to obtain rise and decay times and slopes. Application of numerical integration methods, such as Simpson's Rule, quickly determine the areas under selected portions of the record.

However, much more general information can be obtained from transient records. Among the most informative are those that depend upon the techniques described below.

The resonant frequency of a series *RLC* circuit can be written as

$$\omega_1 = \omega_0 \sqrt{1 - \left(\frac{1}{2Q}\right)^2}$$

where $\omega_0 = \sqrt{\frac{1}{LC}}$ and $Q = \frac{\omega_0 L}{R}$

For large Q's this indicates that the natural frequency of the damped circuit does not differ much from the undamped circuit. However, where the Q of the circuit is low, the frequency of oscillation may differ significantly from the undamped case.

The logarithmic decrement of the oscillation is defined as the natural logarithm of the ratio of two amplitudes of the oscillation differing by one period, for example the natural logarithm of the ratio of two successive maximum points shown in Fig. 1. In terms of the Q and the frequencies of the circuit, the decrements can be given as

$$\delta = \frac{\pi}{Q}\,\frac{\omega_0}{\omega}$$

If the damped and undamped frequencies are sufficiently close so that $\omega_o = \omega$, the logarithmic decrement can be very simply written as $\delta = \pi/Q$.

A measurement of δ can be used to obtain the Q of a circuit producing a damped oscillatory wave from observations of the recorded transient and the natural logarithm of two successive maximum voltages. The corresponding evaluation using steady state methods could be a prolonged procedure.

The spectrum of a transient record is most readily obtained from the Fourier transform of the time function and is given by the integral

$$g(\omega) = \int_{-\infty}^{+\infty} f(t)e^{-j\omega t}dt$$

This is equivalent to a continuous spectrum for the single transient.

It is the property of the Fourier integral that the effect on the frequency spectrum of the waveform repetition rate is to preserve relative amplitudes between spectral components. Thus recording the transient time function on a magnetic disk or tape will make it possible to obtain the Fourier spectrum through use of a wave analyzer on its recorded output.

Playback Analysis

The spectrum analysis made with a wave analyzer on the output of a transient recorder that plays back the transient at a cyclic rate would consist of a discrete frequency spectrum, with components spaced at intervals corresponding to the repetition rate of the recorder playback. The continuous spectrum of the single transient is the spectrum obtained from this by drawing a continuous curve between peaks of the discrete frequency spectrum. Also, since the sense (positive or negative sign) of the spectral components is not preserved, the absolute value of amplitudes alone is obtained.

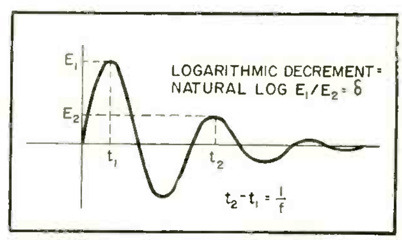

FIG. 1—Waveform shows transient method of determining Q

Frequency spectra can also be obtained from known tables of time-frequency transforms, such as that recently published by Hewlett-Packard Corp. By observation of a cyclic playback transient recorder and the measurement direct from the oscilloscope screen of a few parameters of the time function,

Arrests Transients

Single waveform on magnetic disk can be played back for oscillographic analysis giving corresponding frequency function from parameters of the time function. Equipment includes novel circuit with independent a-c gain and d-c level adjustments

the corresponding frequency function can be immediately obtained.

A rapid method for the determination of natural modes of vibration of either mechanical or electrical systems depends on the recording of the response to a system excited by an impulse. Briefly, an impulse is a function that is zero except for an arbitrarily small interval around $t = 0$ where it becomes infinitely large such that the area under the impulse function is unity. The unique property of the impulse is that the spectrum of the impulse (obtained from the Fourier integral) has constant amplitude and zero phase for all frequencies.

It is this property of zero phase at $t = 0$ that gives infinite amplitude of the impulse at this point. Thus exciting a system with an impulse is equivalent to exciting the system with all frequencies simultaneously. If the system has a natural mode of vibration at any frequency, it will vibrate at this mode, to produce a damped oscillation at that frequency. True impulses cannot be obtained physically but sufficiently close approximations can be produced to enable rapid determination of vibratory modes in either an electric circuit or a mechanical system. By recording the output of such a system when excited by an impulse the natural modes will be directly recorded.

A transient recorder developed for the recording of four simultaneous transient events over the bandwidth of 0 to 2,000 cycles simultaneously displays any two of these events upon a dual-beam oscilloscope.

The electronic circuits include a means for converting the desired transient signal into a pulse-modulated wave-train, means for recording the pulses upon a circular magnetic surface, playback demodulators to convert the record pulses back into an electrical signal and triggering and synchronizing equipment to stop the recording process after a transient has occurred. A synchronizing system is provided for triggering an oscilloscope sweep at periodic intervals such that cyclic playback is presented on the oscilloscope as a stationary pattern.

Storage Mechanism

Design of the mechanical section, was dictated by several considerations. The cyclic playback must be synchronous to prevent speed fluctuations from manifesting themselves as spurious signals. In similiar equipment for short-pulse recording, a permanently recorded reference timing track was used to minimize the effects of speed variations[2]. For the present application the consideration of convenient storage of the recording prevented use of this technique. Constancy of speed is attained through the use of a hysteresis synchronous motor with an added disk to provide a large moment of inertia. Vertical runout, that is, up and down motion of the recording surface, would not be a serious problem at very low speeds. At surface speeds of twenty to thirty inches per second used in this equipment the possibility of recording head bounce with respect to the surface (with consequent signal dropouts) was a problem.

A specially machined turntable was fabricated, which includes three vertical screw adjustments spaced symmetrically about the surface to enable holding the static and dynamic vertical runout to less than one-thousandth of an inch. The multiple recording head cassette is mounted on a low-inertia pivoted arm capable of being adjusted for recording head parallelism.

The recording surface is a specially prepared disk, made easily replaceable by providing a boss assembly to clamp the disk against the turntable. To minimize head

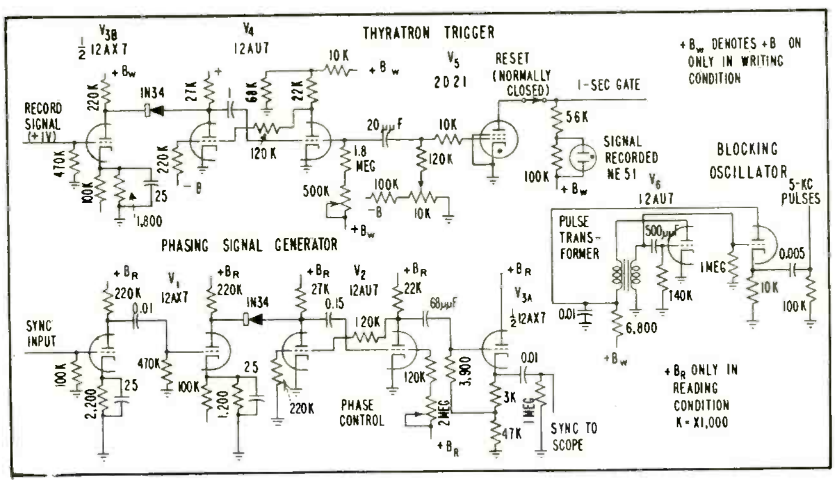

FIG. 2—Common unit includes thyratron trigger, blocking oscillator and phasing-signal generator. Record-playback switching is not shown

wear owing to friction, a compliant rubber disk is placed between the recording surface and the aluminum turntable. This disk provides additional smooth travel by building up a static charge to hold the recording surface flat. In this manner an easily replaceable recording surface was obtained, which permitted the storage of a four- channel transient recording.

The recording head is a standard Brush multichannel type with wide spacing between the recording heads to decrease crosstalk. A compliant phosphor-bronze member is attached to the recording head arm to provide for adjustment of head pressure and thus prolong disk life.

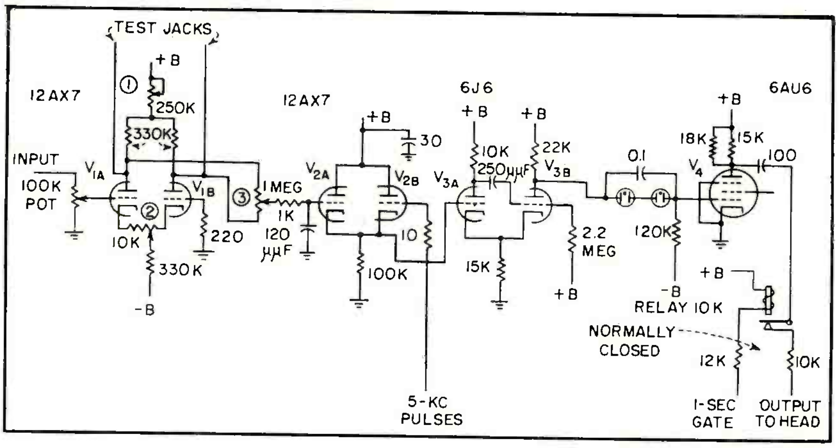

FIG. 3—Modulator accepts 1-volt peak signals and is triggered by 5-kc pulses

As many as four inputs can be connected to the modulators. Input level required by the instrument is at least 1 volt into 100,000 ohms. Preamplifiers that extend the input level down to 1 millivolt into 1 megohm are used close to the electrical transducer when necessary. The input level potentiometer on each individual unit adjusts the gain of the modulator to prevent overmodulation on peak signals.

This is one consideration that requires some knowledge of the amplitude of the expected transient before it occurs. However, in the event that the peak amplitude is unknown, a trial recording can be made and the oscilloscope trace examined for evidence of overmodulation. Then the event can be recorded again with a somewhat lower setting of the input potentiometer.

The common unit (shown in Fig. 2) provides triggering pulses for the individual modulators and generates a phasing signal from a single pulse permanently recorded on the turntable to provide a variable phasing signal for oscilloscope synchronization. A thyratron trigger circuit stops further recording once a transient has been recorded.

The 5.25 kc triggering pulses are generated by a 12AU7 blocking oscillator V_6, which is energized only when the function selector switch is in the record position. In this way, possibility of crosstalk from this source when the unit is replaying a recorded transient has been eliminated.

The phasing signal to enable viewing any portion of a recorded transient is generated by a monostable multivibrator, V_2, which is driven through amplifier V_1 from a single pulse generated by a groove filled with red oxide in the turntable. This pulse occurs once during each revolution of the turntable and initiates the period of the monostable multivibrator.

Duration of the period is determined by the R-C time constant of the multivibrator, which can be varied by a front-panel control. The trailing edge of this square wave is differentiated and used to synchronize an oscilloscope driven sweep. By this means the sweep can be started at any desired point with respect to the recorded transient and thereby any portion of the transient can be viewed using an expanded sweep.

The upper limit to the sweep speed is limited by the persistence of the cathode-ray tube phosphor, but as small as 10 percent of the recorded transient can be expanded in this fashion to cover the entire horizontal sweep of the oscilloscope screen.

Shutoff Circuit

Since the instrument was designed to permit the recording of a transient at any time it may occur, means are provided to stop recording once such a transient has occurred and has been recorded. This is accomplished by opening a relay in the output circuit of each modulator after a transient has been recorded. This section of the common unit comprises V_3, V_4 and V_5. A special RECORD SIGNAL terminal is provided on the front panel. When a small voltage is applied to this terminal (such as would occur by connecting to it the output of a modulator that is to receive a transient) the monostable multivibrator V_4 is triggered and at the end of its one-second period causes thyratron V_5 to conduct. The plate circuit of this thyratron is connected to a relay in each modulator that opens the modulator connection to the recording heads, preventing further recording.

This delay multivibrator thus limits the one-second of recording to that interval immediately following the application of a voltage to its input terminals. These terminals need not be connected to a modulator input only, but provide convenient means for the operator to select the instant at which he wants the recording period to begin. For some applications it may be necessary to begin recording somewhat sooner or later than the

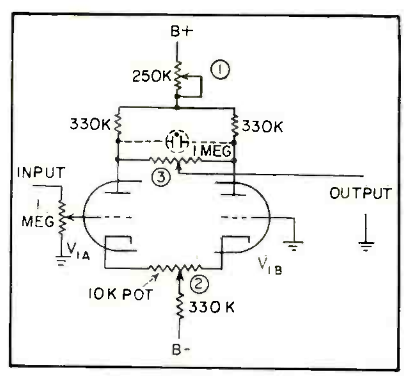

FIG. 4—Detail of amplifier V_1 of Fig. 3

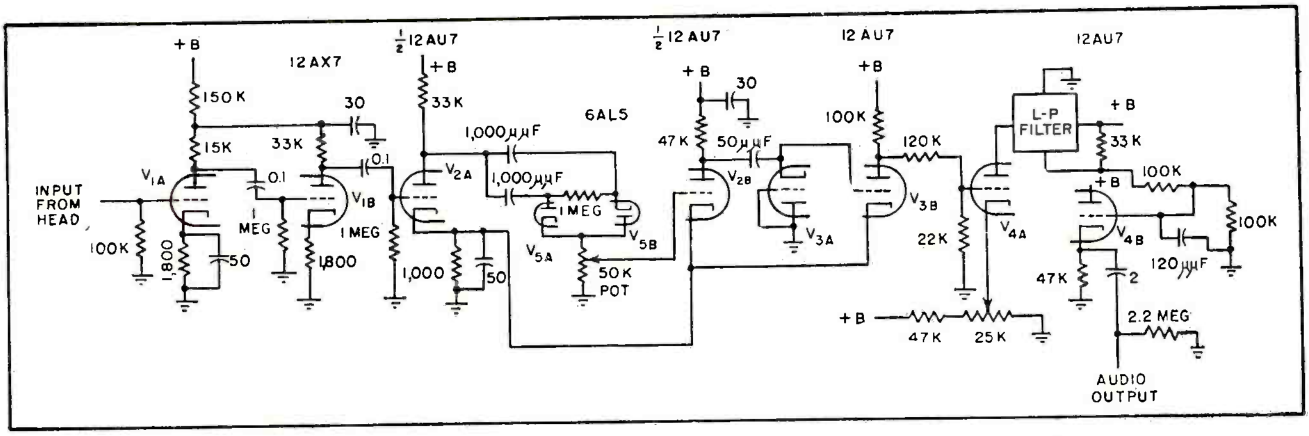

FIG. 5—Demodulator unit converts signal into pulse-width modulated train before demodulation in low-pass filter

actual beginning of the transient.

When the thyratron has been triggered, a front-panel indicator lights, informing the user that a transient has been recorded. A reset button momentarily disconnects plate voltage to the thyratron thus closing the modulator relay circuit.

The pulse modulator shown in Fig. 3 consist of a monostable multivibrator whose period is determined by the d-c level at the control grid of V_{3A}. The 5.25-kc signal from the blocking oscillator of the common unit is applied to one grid of V_2 and the amplified transient signal to the other grid of this cathode mixer. The sharp pulse from the blocking oscillator triggers the multivibrator and the transient-signal component determines the recycling time of the multivibrator.

Thus, variable-width pulses are generated with a starting time determined by the blocking oscillator pulse and duration determined by the information to be recorded. Since variable-width pulses have a low-frequency component, neon lamps are used for d-c coupling to the output amplifier V_4. The d-c amplifier V_1 is a novel circuit arrangement permitting independent a-c gain and d-c level adjustment of an amplifier. Its operation can be explained by reference to simplified schematic in Fig. 4.

The input signal is fed to one grid of a cathode-coupled d-c amplifier, whose other grid is grounded. The amplified signal voltage appears between the plates of the coupled amplifier. Potentiometer 2 in this figure is used for eliminating any initial unbalance between tube sections. At the arm of 3 the amplified signal appears at any level up to the maximum gain possible and of either polarity with respect to the input. Potentiometer 1 controls the quiescent voltage at the plates of these tubes and thus provides independent d-c level setting while 3 gives independent gain setting of the amplifier. By adding a neon lamp between the plates to limit the maximum plate-to-plate voltage, 3 also selects any portion of this voltage-limited signal. In this manner, neon tube limiting can be obtained at any voltage reference up to the maximum operating potential of the neon tube. The output signal can thus have independent gain and level setting with limiting if desired.

Demodulator Unit

Since the recorded pulses consist of a train with constant-period positive portions and variable-position negative portions, the signal must first be converted back to a pulse-width modulated train prior to demodulation in a low-pass filter. This conversion takes place in the pulse demodulator shown in Fig. 5. Tube V_1 amplifies the read-out signal and drives the grid of V_{2A}. This stage applies alternate-polarity symmetrical signals to peak selector V_5. The peaks are clipped and amplified in V_{2B}. One half of V_3 comprises a pulse position-to-width converting circuit. The pulse train, now a width-modulated signal, is amplified and applied to the low-pass filter, which eliminates the carrier signal and passes only the information component—that is, the low-frequency component of the pulse train.

From the filter, the signal passes to the grid of a cathode-follower and thence to the output terminals. The output coupling is through an extremely long-time-constant circuit to eliminate the d-c component of the cathode-follower signal without deteriorating the low-frequency components of the recorded transient. Coupling of this type can be safely use on transient recorders that record to d-c since the playback signal is cyclic with a period of one second. Thus, any time-constant that will preserve a one-second square wave without serious distortion can be used faithfully to play back signals with d-c components.

When study of the transient is completed, the recorded signals can be erased by pushing the reset button. This action starts recording of the modulator-pulse train over the previously recorded signals, thus effectively obliterating them. In this manner disks can be reused many times. This process of convenient and rapid record and erasure is particularly useful in laboratory investigation where changes are made in equipment and the resultant output recorded and immediately examined.

Thanks are due to K. Wisner for assistance with the mechanical design of the transient recorder.

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Automatically Plotting

Continuous equipotential lines representing electric-field patterns are plotted with two-percent accuracy on resistive paper. Technique avoids disadvantages of electrolytic methods. Typical uses include investigating fields in waveguides and between tube electrodes

WITHIN RECENT YEARS attempts have been made to obtain field plots in ways which avoid the disadvantages of an electrolytic method,[1] namely, the polarization effects, surface tension and the use of a spillable electrolyte. Such methods are the use of a resistive network[2] and the use of uniformly resistive paper.[3]

All of these methods involve either the determination of the potential at fixed points, as in the resistive networks, with the consequent interpolation necessary to determine specific field lines or the manual searching for specific field points and the subsequent manual plotting of the lines connecting these points.

In contrast to these methods, the automatic field plotter is capable of producing continuous field lines without manual searching or plotting and of drawing these lines directly on the plot of the electrodes. This is accomplished by using the resistive paper technique in conjunction with an X-Y recorder.

The plotter, is a modified commercial X-Y recorder selected for this purpose because of its large 30-inch square plotting surface.

Principles

The principles of operation may be seen by referring to Fig. 1. Electrodes, shaped as desired, are painted with silver paint or resistive paper. Appropriate connections from the silver-paint electrodes are made to a 1.5-volt battery. This sets up a field pattern in the resistive paper.

The pickup probe resting on the paper senses the voltage at that point and through the sliding contact refers this voltage, e_f, to the input of the servo amplifier. The positions of the knobs on the decade potentiometer determine the voltage e_p, which is also referred to the input of the servo amplifier. The algebraic difference between these voltages, e_f-e_p, determines if the servo motor will move the pickup probe across the paper and, if so, in which direction it will move. Motion occurs until e_f equals e_p at which time the servo system is in balance and no further motion occurs.

To obtain an equipotential field line, the arm on which the pickup probe travels is caused to move perpendicular to the direction in which the voltage is applied across the paper. For a given potentiometer setting, the probe will then trace a single equipotential line. By changing the potentiometer settings and moving the probe back and forth across the paper a complete series of equipotential lines will be plotted.

To obtain a comparison of the performance of the automatic field plotter with manual plotting systems, identical electrodes were silk-screened on commercial plotting paper[3] and on black paper such as is used to interleave photographic film. The equipotential lines obtained by the commercial point-by-point method are shown in Fig. 2, on the left, and the continuous lines drawn by the automatic field plotter are shown on the right. The plots shown indicate that the position of the lines may be depended upon to within 2 percent of the distance represented by the total potential applied.

Modifications

To convert an X-Y recorder to this type of operation several modifications are necessary:

(1) The pen must be insulated.
(2) Means must be provided for

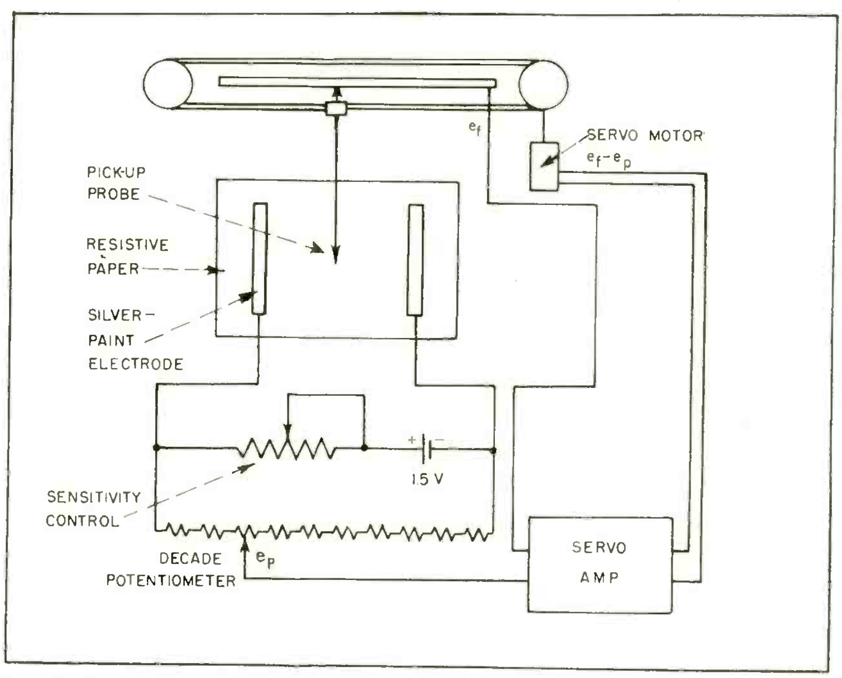

FIG. 1—Simplified diagram of automatic electrostatic field plotter setup

Electrostatic Field Lines

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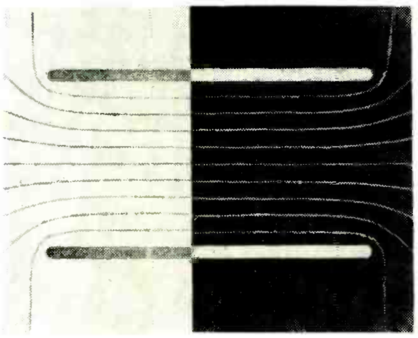

FIG. 2—Typical field plot made with manual method (left) and with automatic field plotter (right)

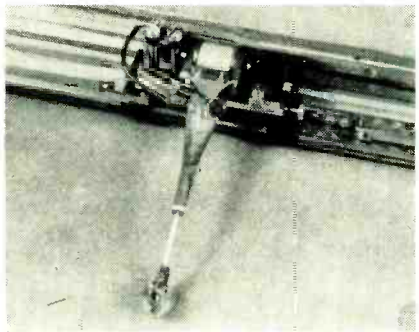

FIG. 3—Pickup probe details; sliding contact on rail; insulating bracket and pen mount with LeRoy lettering pen

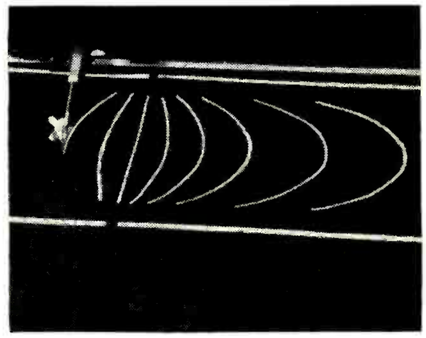

FIG. 4—Field plotter in operation; silver-paint electrodes can be seen at the top and bottom of the field lines

taking the voltage from the pen to the servo-amplifier input.

(3) A pen suitable for use with conducting ink must be provided.

The insulation of the pen is accomplished by substituting a plastic pen-mounting bracket for the metal one provided with the equipment as shown in Fig. 3. Cellophane tape around the metal plate directly behind the pen arm provides the additional insulation necessary to assure isolation of the pen.

The voltage sensed by the pen is transferred to the servo amplifier by means of a sliding contact on the pen carriage, which moves along a rail to the servo-motor end of the cross arm. Appropriate wiring takes the pickup voltage from there to the input of the servo amplifier.

The pen provided with the recorder is replaced by an arm designed to hold a LeRoy lettering pen.

Operational Requirements

A paper having uniform resistive properties is necessary. This paper should have a low resistance per square, from several hundred to a few thousand ohms. In addition to its low resistance it should be possible to sense the voltage on it with light contact pressure.

The silver paint used for the electrodes must have a resistance in the order of a few ohms when properly dried. Air-drying silver paint commercially available was found suitable for this purpose. Two kinds were used in the experiments, one suitable for use with brush or pen and the other suitable for use with silk-screen.

Three methods of making contact to the silver-paint electrodes were used with good success. Weighted probes are used with simple electrode patterns where it is desired to change the patterns readily. Cellophane tape may also be used to hold fine wires in contact with the electrodes. For complicated patterns and for the best contact fine wires may be soldered directly to the silver paint using a pencil-type soldering iron.

A number of inks were tried for this application, the most satisfactory being a diluted silver paint.

Very satisfactory results have been obtained in the operation of this equipment when two precautions are observed. The plotter should not be expected to work properly when plotting lines within ten degrees of the line of motion of the pen carriage. The sensitivity control (a variable resistor in series with the battery to reduce the voltage applied to the plotting paper) should be adjusted for optimum operation. This requirement is necessitated by the servo system which operates most satisfactorily when the potential gradient across the plotting paper is uniform. If the gradient becomes too steep the probe hunts and if, on the other hand, it is too shallow the probe fails to track the equipotential line properly. For most cases a satisfactory position can be found. The device is shown plottings an electrostatic-lens field pattern in Fig. 4.

The help of Raymond Winfield in setting up the equipment described and performing the initial experimentation with it is gratefully acknowledged.

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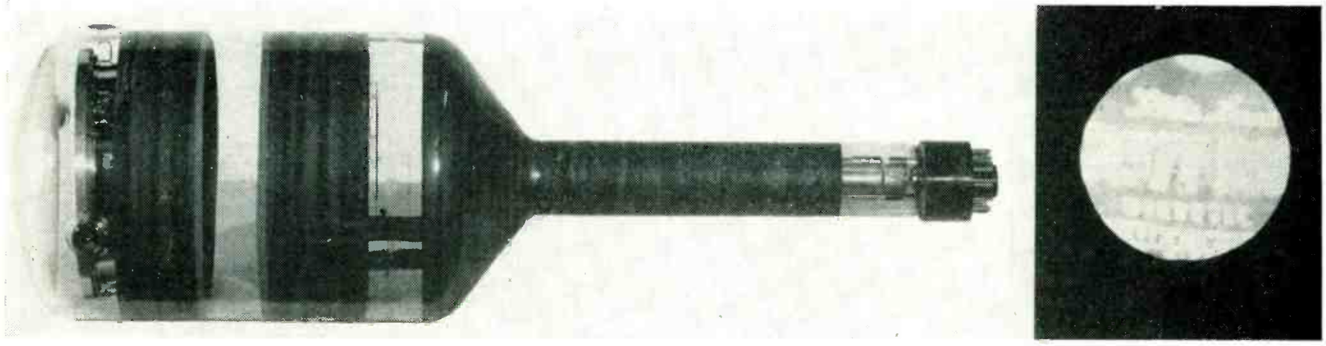


Hergenrother recording storage tube QK 245F (left) has both direct view and electrical output. Television signal readout (right) after an hour's storage in the QK 245F which has relatively low light output

Operation of CRT

Practical information for designers on how to obtain optimum operating conditions with various storage tubes. Limitations as well as applications of storage tubes are discussed in detail to facilitate selection

WITHIN their applicable range, storage tubes possess many advantages. An excellent cockpit display of airborne radar is obtainable by using either a dark-trace or a direct-viewing storage tube. These tubes provide excellent visibility in sunlight and store a clear distinct image from one scan to another. Dark-trace tubes require simpler circuitry but require several seconds to erase. Direct-viewing charge-storage tubes have faster erasure and can erase during writing.

In computer use, electrostatic storage tubes provide large storage capacities with rapid access to information while in a special oscillograph, storage tubes allow the recording of single fast transients with extremely wide bandwidths.

Some applications of several different storage tubes are given in Table I.

Construction

A storage tube consists of an electron gun, deflection circuits and storage elements. Three functions are essential, namely: writing; reading; erasing of information. To perform these functions, tubes are built with one, two or three electron guns. These electron guns are modified conventional cathode-ray tube guns. The output of a storage tube may be visual, electrical or a combination of both.

The storage surfaces are usually a dielectric deposit on a mesh or other metallic surface. These screens have a tendency to flake off with hard handling, which causes possible blemishes, and hence lack of storage capability at certain locations on the storage screen. A continuation of the electron beam following a sweep failure can burn a hole in the storage surface and limit the tube usefulness by creating a blemish. Simple protective circuits such as a relay in the deflection amplifier, which can open the storage tube cathode circuit, can prevent this.

In tubes with mechanically supported meshes, these metallic meshes are free to vibrate with respect to one another. With voltages impressed, the action is that of a condenser microphone or a microphonic audio signal which can obscure the desired video readout. This is illustrated in Fig. 1.

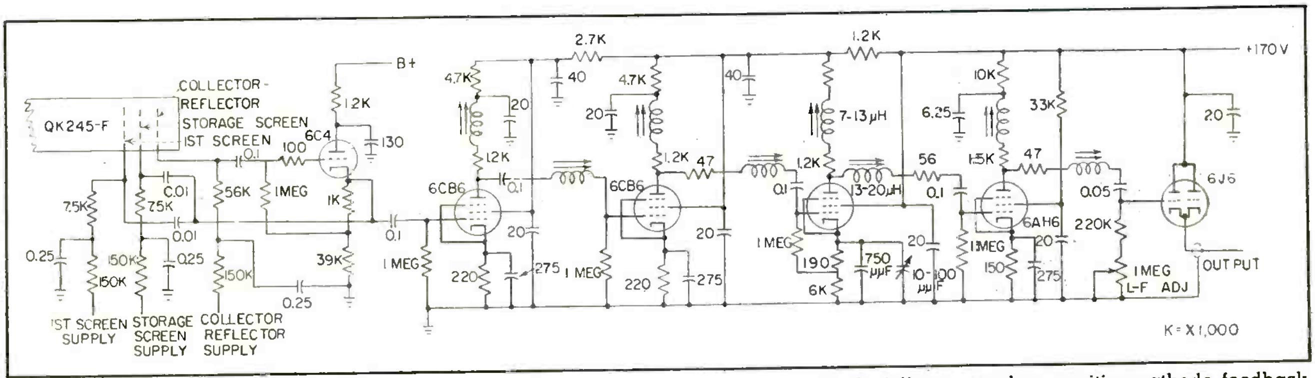
The storage element is the screen itself in a Williams tube or in a dark-trace tube, while in a Graphecon it consists of a copper mesh, a signal plate and an insulator. In the Raytheon storage tube, the storage element has three components, a first screen, storage screen and a collector-reflector, all of which are energized. In this tube, the first screen should be operated at as high a value as possible to obtain the smallest spot size. A screen voltage of 450 volts with an anode voltage of 2,200 volts is optimum.

The storage-screen and collector-reflector voltages vary with the function. For writing, the optimum voltages are 300 volts and −300 volts; for reading, 27 volts and 200 volts and for erasing, 75 volts and −300 volts, respectively. Carefully regulated power supplies are essential for these voltages and additional filtering may be indicated.

Ripple and other noise voltages will modulate the reading and writing beams and will appear in the output where their importance is exaggerated by the low signal levels available. Another source of trouble is any slow drift of these voltages, which will cause a deterioration of the signal quality.

Beam Current

Use of alternating current for filament heating has been found satisfactory, but the filament volt-



Readout amplifier for operation with large input capacitance storage tubes. Input cathode follower employs positive cathode feedback

Storage Devices

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age must be held to better than five percent and preferably to one percent. This requirement is important when employing low beam currents, one microampere, in the Williams system or two to six μa in the reading beams of the Raytheon and Graphecon tubes. Larger beam currents would increase the scanning speed. However, in the Graphecon this will be accompanied by a reduction in the storage time.

Ion Spot

In the QK 245F an ion spot appears in the center of the storage surface and slowly builds up as repeated readings are made. The effect is similar to a blemish except that the area grows with continued use and can be erased. To avoid this effect, very low reading currents must be used. Using a beam current of two μa, more than 30,000 consecutive readings may be made without noticing any harmful effects or deterioration of the stored pattern.

It is estimated that a one-percent change in grid bias will cause a 25-percent change in beam current. The grid bias voltage must be obtained from a well-regulated power supply with 0.1-percent regulation or better. In addition, the ripple and noise must be kept below three millivolts and should be near one millivolt.

Since spot size determines the storage capacity, the highest possible accelerating voltages should be used in order to obtain a small spot size. The equations for estimating the required anode voltage regulation are

$$R = 4L/K \qquad (1)$$

for magnetic tubes and

$$R = 2L/K \qquad (2)$$

for electrostatic tubes where R is voltage regulation, L is allowable deflection error as a fraction of spot size and K is resolution expressed as the number of spots obtainable per line (or the line length divided by spot size).

An idea of the order of magnitude can be obtained by assuming a 100-mm line length with a one-mm spot size and an allowable error of 0.05. Under these conditions a magnetic tube needs 0.2-percent regulation and an electrostatic tube must have 0.1-percent regulation. Higher resolving power can be obtained with magnetic tubes because they require less regulation than electrostatic tubes.

Choice of writing beam current depends upon the rate of informa-

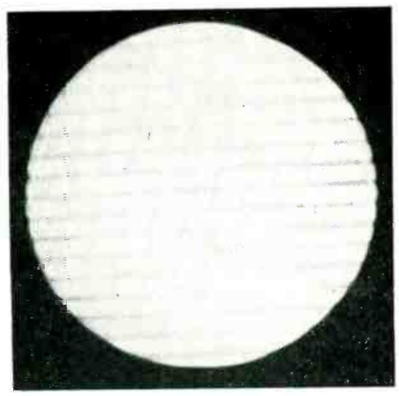


FIG. 1—Monitor screen showing vibration during writing

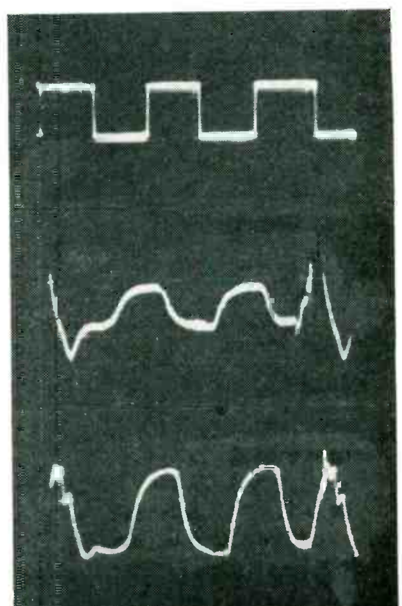


FIG. 2—Storage-tube input at top, output signal after 15 minutes storage, read out by a 1.20 microampere beam current, middle and 6 microampere beam current at bottom

Table I—Storage-Tube Applications

Use	Suitable Tube Types	Comments
(1) Aircraft cockpit weather mapping	Dark-trace tube	7 inch available; contrast independent of illumination: shock-mounting required
	Iatron	New development; very-high brilliance direct-view screen; high anode voltage
(2) Television-film conversion or radar-scan conversion	Iatron and tv camera	See use No. 1 Iatron
	Dark-trace tube and tv camera	Use erase filament with slow erase voltage applied
	QK 245F and tv camera	Low light output
	Knoll's storage tube	Recent development
	Graphecon	Registration problem of two-electron guns; electrical input and output; extreme care required in deflection and focus-coil alignment
(3) Digital computers	Haeff-tube types, barrier-grid tube types, QK 357A. Radecon, Selectron and Graphecon	Low power-supply ripple required; anode-voltage regulation; careful switching and detection circuitry design; selection of blemish-free tubes
	Williams System	
(4) Analog computers	Haeff-tubes, QK 357A, Radecon and Graphecon	Limited tonal range
(5) Moving-target indication radar (a) Single-tube system	QK 245F	Low visible output; requires large element voltage switching, requires gain change between writing positive and negative; regulate anode voltage
	QK 357A	Electrical output; sensitive to vibration (also see QK 245F, last three items)
	Iatron	See use No. 1; positive and negative writing characteristics may not match
(b) Two-tube mti operation	All digital and tonal tubes	For best results. tonal ranges should not be used.
(6) Radar signal-to-noise dark-trace tubes improvement		Simple crt circuitry; place bias on erase filament during writing to prevent shadow; optical surfaces give multiple reflections; see use No. 1
	Iatron	Excellent tonal range; variable persistence; see use No. 1
	Graphecon	Two-gun registration; two electron-gun voltage: see use No. 2
	QK 357A	See use No. 5 a
(7) Bandwidth reduction (tv and radar)	All tube types	This can be accomplished in two ways, sampling and transmitting difference between successive stored scans.

tion insertion, since the writing speed is proportional to the ratio of beam current to spot size. However, the writing-beam current is limited by the level at which the peak signals saturate the storage surface. At saturation, the maximum video-signal output exists.

Reading Current

The reading current is generally a compromise. Typical readout signals for 1.2 μa and six μa are shown in Fig. 2. To achieve the largest signal output, a high reading beam is required. However, ion effects tend to cloud or distort the signal, reducing its amplitude and tones. In magnetic tubes this starts by an erasure at the center and moves out. In electrostatic tubes a deterioration over the whole stored pattern ensues. Since the ion effects depend upon current and time, fast single readouts permit high read currents while long repetitious readouts require low beam currents. Storage tubes with tonal ranges are designed particularly for low reading currents.

The small beam currents used during the reading operation require anastigmatic focus coils. The astigmatism found in most commercial focus coils is objectionable. The focus-coil positioning is very critical and no skewing to achieve centering can be tolerated. Centering must be achieved by suitable deflection circuitry and the focus coil located at the optimum-focus point.

Limitations

A basic limitation in most storage tubes is the registration, the ability of the electron beam to repeatedly strike the same point on the storage surface. For a 0.05 deflection error with a one-mm spot size and 100-mm line, a 0.1-percent regulation is needed. This can be estimated from the equation $R = 2L/K$.

The deflection errors caused by anode voltage and deflection voltage (or current) variation are additive and estimates of 0.1-percent and 0.2-percent regulation should be considered as maximum.

Superimposed on this amplitude variation is the jitter in the scanning raster. A rule-of-thumb value

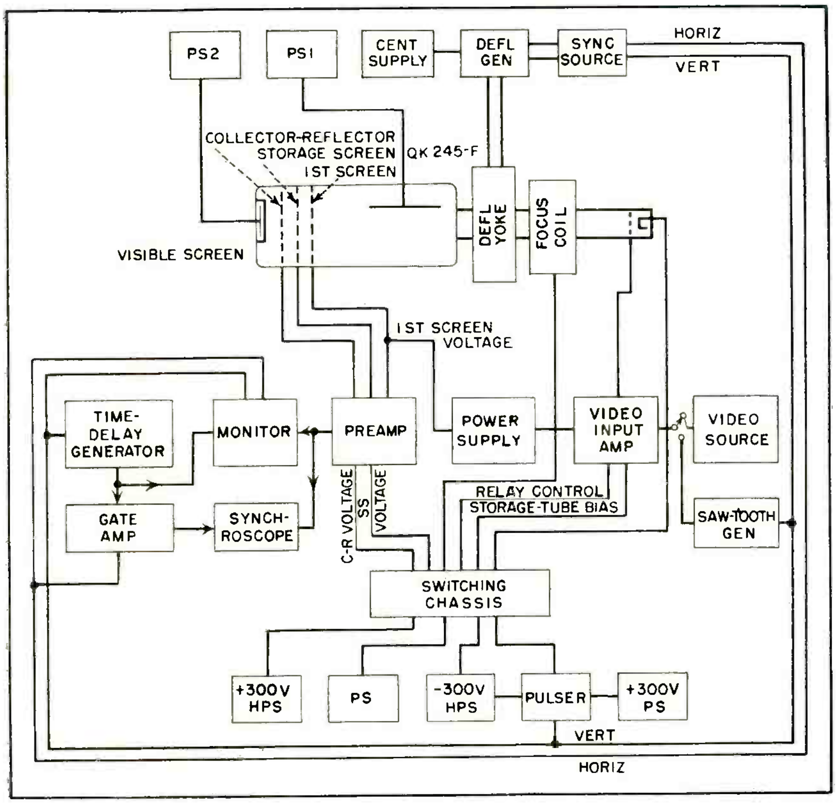


FIG. 3—Complete equipment arrangement for experimental operation and evaluation of magnetic-deflection storage tubes. System is sufficiently flexible to be adapted to most available storage and dark-trace tubes

for the maximum allowable jitter is given by

$$\text{jitter} = 0.2sT/D \qquad (3)$$

where s is spot size, T is period of the line scan and D is the effective tube diameter or usable line length. During writing, this jitter will produce smears instead of distinct lines. Due to pairing, a 525-line television interlaced raster is less satisfactory than a 200-line noninterlaced raster. A stationary raster is necessary for good operation and single-frame writing should be employed wherever possible.

Jitter in the system can be mistakenly attributed to poor focus. A case in point actually occurred in a field application of a dark-trace storage tube, where excessive deflection-system jitter produced a condition diagnosed by field personnel as poor focus in a gassy tube.

A similar effect in magnetic tubes is produced by mechanical vibration of the deflection yoke or the focus coil. When attempting to use storage tubes under conditions where shock or vibration may be encountered, careful shock mounting is recommended.

Blemishes on the storage surface limit storage tube operation by producing spurious signals. Little can be done except to try to reduce their effect by suitable band-rejection filters or by relocating the stored pattern elsewhere on the storage surface.

Application

Successful operation of the storage tube requires relatively noise free and distortionless amplifiers. The design of low-noise broadband amplifiers with Gaussian frequency response is described in the literature. The bandwidth employed depends on the application but should be no wider than necessary.

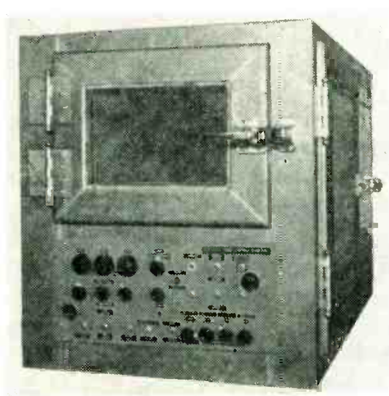


FIG. 4—Shielded enclosure contains storage tube and readout preamplifier

At the present time adequate low-level performance can be obtained with existing tubes, provided that careful design of equipment and good engineering practice is followed. The operation of storage tubes is difficult even under laboratory conditions. Experience indicates that they are delicate and must be handled and mounted carefully. Vibration or jarring can cause permanent damage to the screens and storage surfaces. Each tube is different and the results obtained vary from tube to tube.

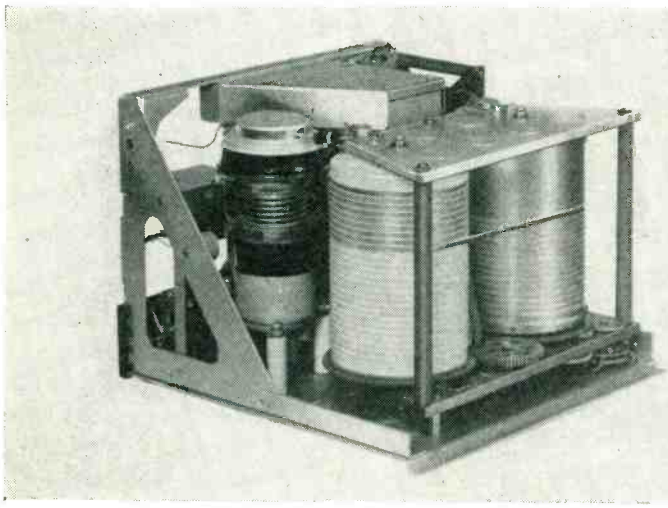
A block diagram of a complete equipment arrangement for experimental operation and evaluation of magnetic-deflection storage tubes is shown in Fig. 3.

In utilizing storage tubes, the system distortion and noise producing elements must be minimized. Operation of the storage tube and the readout preamplifier should be carried on inside a shielded cage, as shown in Fig. 4. Mu-metal shielding of the tube is necessary to reduce magnetic defocussing effects. Good regulation and filtering of power supplies are essential.

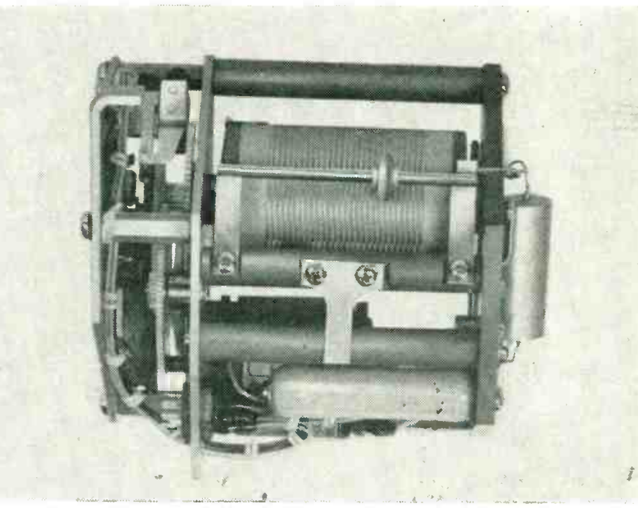
A 20-db signal-to-noise ratio is a workable figure and a bandwidth of six to ten megacycles is attainable. Signal-to-noise ratios of 20 to 30 db have been attained in practice and an increase in this figure should be possible with better electron guns and improved manufacturing techniques. It can be expected that signal-to-noise ratios of 40 to 50 db will be achieved and the operating bandwidth extended to 20 megacycles in the near future.

Although at the present time random noise is a negligible factor, the ultimate limitations will come from electron-gun performance and storage-surface characteristics.

The authors wish to acknowledge the contributions of W. S. Treitel and P. R. Liegey, who participated in the experimental program. Many thanks are due to D. H. Andrews and F. R. Darne for their encouragement and support.



Rear view of matching unit shows variable vacuum capacitor (left) and variable inductor (right) on which ribbon is wound



Autotransformer assembly used to match antenna coupling unit to 52-ohm output comprises rotating inductor and contact wheel

Servocoupler Matches

Automatic antenna-matching unit transforms impedances presented by all ordinary aircraft antennas to a 52-ohm resistive impedance for coupling to the transmitter in the range from 2 to 25 mc. Sensing unit controls servomotors that vary L and C

MOST IMPORTANT factor in the design of an automatic antenna-matching unit is that the device must transform the very wide range of antenna impedances commonly encountered in communication antennas to the particular resistive impedance into which the transmitter is designed to operate.

The automatic device must perform this function accurately, efficiently, rapidly and with little or no advance information regarding the type of antenna and operating frequency.

The particular automatic antenna-matching unit to be described is intended for operation with aircraft antennas in the frequency range from 2 to 25 mc with a transmitter that is designed to deliver its power to a 52-ohm resistive impedance.

Impedance-Matching Network

In this particular impedance-matching network three basic matching principles are combined to perform the complete matching function. The first of these is that an antenna impedance containing both resistance and reactance may be made to appear purely resistive by series-resonating the antenna. That is, an antenna with the impedance $r + jx$ may be made to appear as $r + j0$ by inserting in series with it a reactance equal to the antenna reactance, but of opposite sign.

The second basic matching principle is that exhibited by the T-section shown in Fig. 1. To establish a comparison between the circuit elements shown in this figure and their ultimate representation in the complete impedance-matching network, they are defined. Element r denotes the antenna resistance after the antenna reactance has been canceled according to the first matching principle. Element R is representative of the resistive impedance presented to the transmitter by the impedance-matching network, X_2 is the reactance of a fixed capacitor and X_1 and X_3 are variable tuning elements.

If the impedance equation is written for the circuit and set equal to $R + j0$ it is possible to obtain two simultaneous impedance equations in which r and X_3 are variables.

$$R + j0 = \frac{r\,X_2^2}{r^2 + (X_2 + X_3)^2} + j\left[\frac{X_2(r^2 + X_2\,X_3 + X_3^2)}{r^2 + (X_2 + X_3)^2} + X_1\right] \quad (1)$$

$$r^2 + X_3^2 + r\left(\frac{-\,X_2^2}{R}\right) + X_3\,(2\,X_2) + X_2^2 = 0 \quad (2)$$

$$r^2 + X_3^2 + X_3\,\frac{(2\,X_1\,X_2 + X_2^2)}{(X_1 + X_2)} + \frac{X_1\,X_2^2}{(X_1 + X_2)} = 0 \quad (3)$$

Fortunately, these simultaneous equations (Eq. 2 and 3) have the basic form of circles and, therefore, their solutions may be readily obtained by plotting the circles and noting their points of intersection. Such a plot is shown accompanying the circuit in Fig. 1.

It is important to realize exactly how the plot is determined. All

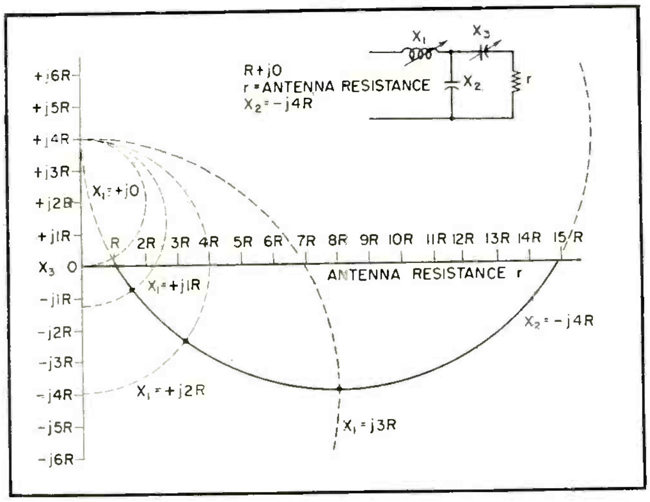


FIG. 1—T-section matching properties when X_1 and X_3 are variables in antenna-matching section

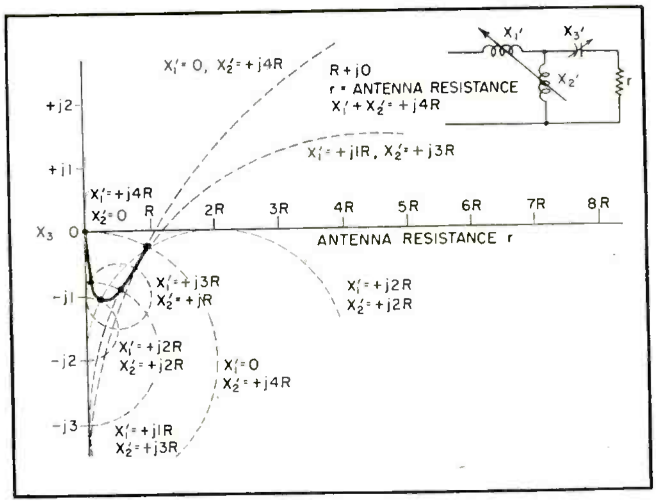


FIG. 2—T-section matching properties when X_1', X_2' and X_3' are variables in antenna-matching section

Aircraft Antennas

By E. W. SCHWITTEK

Collins Radio Co.
Cedar Rapids, Iowa

variables and constants are expressed in terms of the value of R. That is, they are expressed in terms of per-unit values with R as the base. Since it represents a fixed capacitance, X_2 can be considered constant at a given frequency. In this particular example, it is considered to have the value of $-j4R$. Plotting this information yields the X_2 circle, which is the plot of Eq. 2.

Other circles are drawn on this graph using the second simultaneous impedance equation (Eq. 3) for various values of X_1, wherein the value of X_1 is expressed as a per-unit value of R.

The locus of the intersections of the circles, indicated by the solid line, represents the solutions of the simultaneous impedance equations for various values of X_1. This plot, therefore, reveals that any value of antenna resistance r on the locus of solutions may be transformed to R, the required resistive load for the transmitter, with appropriate values of X_1 and X_3. If R is 52 ohms, as required for the example transmitter, then this circuit is suited for transforming antenna resistance values greater than 52 ohms to that desired value.

The third basic matching principle is that exhibited by a T-section also, but under slightly different conditions. The circuit employed for the third matching principle is shown in Fig. 2.

Again, r represents the various antenna resistances desired to be transformed to R, the required transmitter load. Reactance X_3 is a variable tuning element and X_1' and X_2' are tuning elements arranged so that the sum of X_1' and X_2' is a constant for any particular frequency.

Since the circuit is still basically a T-section, the same types of equations are used for the solution of the third matching principle as was used for solution of the second.

$$R + j0 = \frac{r\,(X_2')^2}{r^2 + (X_2' + X_3)^2} + j\left[\frac{X_2'(r^2 + X_2'\,X_3 + X_3^2)}{r^2 + (X_2' + X_3)^2} + X_1'\right] \quad (4)$$

$$r^2 + X_3^2 + r\left[\frac{-(X_2')^2}{R}\right] + X_3\,(2X_2') + (X_2')^2 = 0 \quad (5)$$

$$r^2 + X_3^2 + X_3\,\frac{[2X_1\,X_2' + (X_2')^2]}{(X_1 + X_2')} + \frac{X_1\,(X_2')^2}{(X_1 + X_2')} = 0 \quad (6)$$

Again, the simultaneous equations (Eq. 5 and 6) exhibit the general form of circles. The differences between the second and third basic matching principles result primarily from the fact that X_2' is now an inductance rather than a capacitance and that though now both X_1' and X_2' are variable tuning elements, their sum is a constant.

As before, it is important to realize how the plot is established. In this example, $X_1' + X_2'$ is a constant and is set equal to $+j4R$. Graphical simultaneous solutions are obtained by first assuming that $X_1' = +j1R$ and $X_2' = +j3R$, then $X_1' = +j2R$ and $X_2' = +j2R$, and so on. The intersections of the

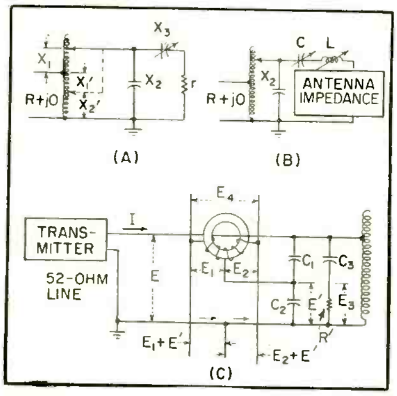


FIG. 3—Autotransformer combines properties of two T-sections (A), complete impedance-matching network (B) and discriminator for sensing phase and impedance (C)

various circles again produce a locus that represents the solutions of the simultaneous impedance equations for various values of X_1' and X_2' within the limit that the sum of X_1' and X_2' is a constant. This plot, therefore, reveals that any value of antenna resistance r on the locus of solutions may be transformed to R, the required resistive load for the transmitter, with appropriate values of X_1', X_2' and X_3. Again, if R is to be 52 ohms, this circuit is ideally suited for transforming antenna resistance values of less than 52 ohms to the desired value.

The circuits of Fig. 1 and 2 may be simply combined with the aid of an autotransformer to produce a new circuit capable of transforming resistance both above and below 52 ohms to 52 ohms. A schematic of this combination circuit is shown in Fig. 3A.

Autotransformer Action

When antenna resistance r values greater than 52 ohms are desired to be transformed to 52 ohms, the variable tap is in some position above the fixed tap of the autotransformer. The matching qualities of the second basic matching circuit are thus obtained. Some variation in theory exists owing to the presence of the portion of the autotransformer from the fixed tap to ground. However, if $X_1' + X_2'$ is large compared to R it does not materially affect the basic matching theory.

On the other hand, when r values less than 52 ohms are desired to be transformed to 52 ohms, the variable tap is in some position below the fixed tap of the autotransformer, as indicated by the dashed-line position in the figure. The X_1 portion of the autotransformer is eliminated from the circuit and X_1' and X_2' appear. Again the presence of X_2 tends to produce some variation in the matching theory by altering the value of $r - jX_3$ which it shunts. However, a slight readjustment of X_3 and the variable tap position of the autotransformer from the theoretical will cancel its effect. The presence of X_2 complicates the circuit slightly, but does not alter its basic operation.

The mutual inductance existing between X_1' and X_2' has been neglected in the foregoing circuit analysis. Its only real effect would be that of altering the assumption that $X_1' + X_2'$ is a constant at all variable tap positions that are below the fixed tap. This is not particularly serious, however, since at the limits when $X_1' = 0$ and $X_2' = +j4R$, or when the reverse is true, the mutual inductance is zero. Therefore, the end points of the locus of matchable values of r (Fig. 2) would not be altered. The only effect would be that the shape of the locus between its end points would deviate slightly from that shown.

The complete radio-frequency matching network is shown in Fig. 3B. It differs from the previous circuit in that a variable inductance as well as a variable capacitance are inserted in series with the antenna. These are the reactive elements used to series-resonate the antenna. The variable capacitor serves the dual function of series resonating any inductive antenna and providing X_3.

Discriminator Unit

The source of information used to direct the operation and ultimate tuning position of the various r-f matching network components is an impedance-monitoring device called a discriminator. It is connected between the transmitter and the r-f matching network, as shown in Fig. 3C, to perform the function of constantly monitoring the impedance presented to the transmitter. The impedance monitoring is done with respect to the ideal $52\angle 0°$ ohm transmitter load. That is, the discriminator monitors both magnitude and phase of the impedance presented to the transmitter and submits its measurement in terms of two d-c voltages. These voltages have polarity dependent upon the direction of impedance deviation from $52\angle 0°$ ohms.

Sampling E and I

The phase of the impedance presented to the transmitter by the r-f matching network in monitored by noting the phase relationship between the transmission line voltage E and line current I. To determine the phase relationship existing between E and I it is necessary to sample each. The means of sampling is important since it must be accurate throughout the wide frequency range over which the system is required to operate.

Line current I is sampled by inductive coupling to the transmission line. The center conductor of the coaxial line is passed through the center of a ⅝-inch diameter

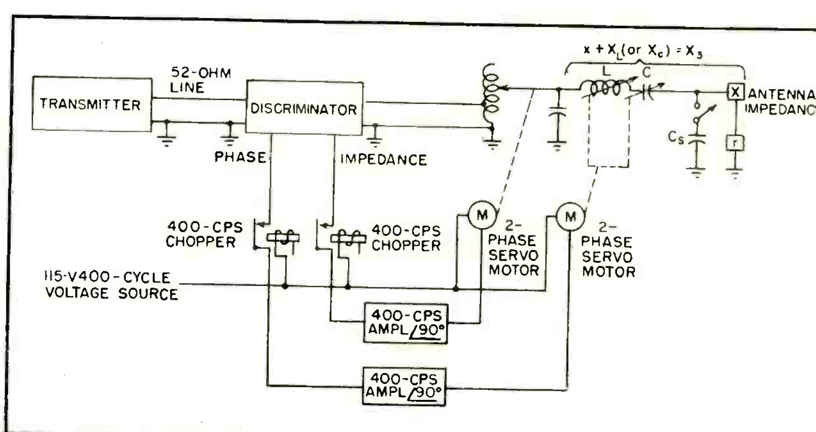


FIG. 4—Elements of complete motor-controlled automatic antenna-matching unit

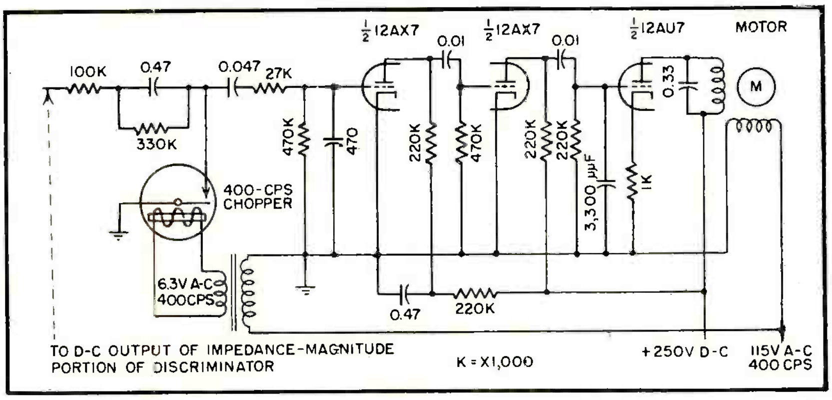


FIG. 5—Typical 400-cps servoamplifier used in matching unit adds phase shift

powdered iron ring. A center-tapped five-turn toroid winding about the ring serves to provide the inductive coupling to the line. Induced voltage produced in the five-turn winding is proportional to line current and 90 degrees out of phase with it. Line voltage E is sampled by a capacitive divider consisting of C_1 and C_2.

The means of sampling E and I provides the essential voltages at the proper phase so they may be added vectorially in the same manner as that employed in the ordinary Foster-Seeley discriminator circuit. That is, if the vector sum of E_1 and E' is rectified and added and in polarity opposition to the rectified vector sum of E^2 and E', zero d-c output voltage is obtained if E and I are in phase. If E and I are not in phase, the circuit will provide d-c output voltage of a polarity dependent upon whether E leads or lags I.

With this type of E and I sampling it is practical to obtain phase monitoring of E and I to within ±5 degrees over the 2-to-25 mc frequency range.

One portion of the discriminator is sensitive to the magnitude of the impedance presented to the transmitter. It was previously stated that the induced voltage across the five-turn toroid winding is directly proportional to the magnitude of I. It is also directly proportional to frequency since the voltage drop across the portion of the line to which the toroid is coupled (primary) is directly proportional to frequency.

The same proportional properties can be made to exist between E_3 and E through the use of a simple circuit containing C_3 and R', when $R' << X_{C3}$.

With the frequency denoted by f, the magnitude of $E_4 \propto K_1 fI$. The magnitude of $E_3 \propto K_2 fE$. Through the choice of component values it is possible to make K_1 and K_2 constants that will allow $E_3 = E_4$ when $(E/I) = 52$ for all frequencies. Then if rectified E_3 is added in polarity opposition to rectified E_4 zero d-c output voltage is obtained from this portion of the discriminator when $(E/I) = 52$. If this ratio is not true, the discriminator will provide d-c output voltage of a polarity dependent upon whether the ratio of E to I is greater than or less than 52. With this type of E and I sampling it is practical to obtain ratio monitoring of E and I to within ±10 percent of 52 over the 2-to-25 mc frequency range.

Operation of Network

The manner in which the impedance-matching network operates in combination with the servosystem is shown in Fig. 4. Elements C and L are termed phasing elements. Together they provide the large range of reactance that is necessary to series-resonate the antenna reactance and provide the X_3 reactance that is essential to the impedance-matching properties of the T-section. The reactance of this element would be such that $X + X_L$ or $X_C = X_3$. For any particular tuning operation, only one of these reactive elements is necessary. This is accomplished in the actual unit by control circuits that retain C at its maximum value when L is required for tuning and L near its minimum value when C is required for tuning.

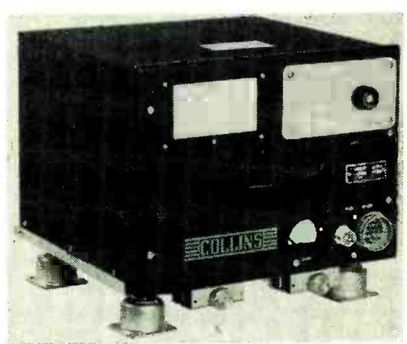
Examination of Fig. 5 indicates that the chopper coils and the fixed phases of the servomotors are all excited from a common 400-cycle source. The servoamplifiers themselves are merely 400-cycle amplifiers which in addition to amplification provide a 90-degree phase shift to the signal that is passed through them.

As an example of operation, assume the various impedance-matching network tuning elements are in such a position that only a slight discrepancy exists between the actual impedance presented to the transmitter and the required impedance of $52\angle 0°$ ohms. For the sake of explanation, assume that this impedance is $60\angle 10°$.

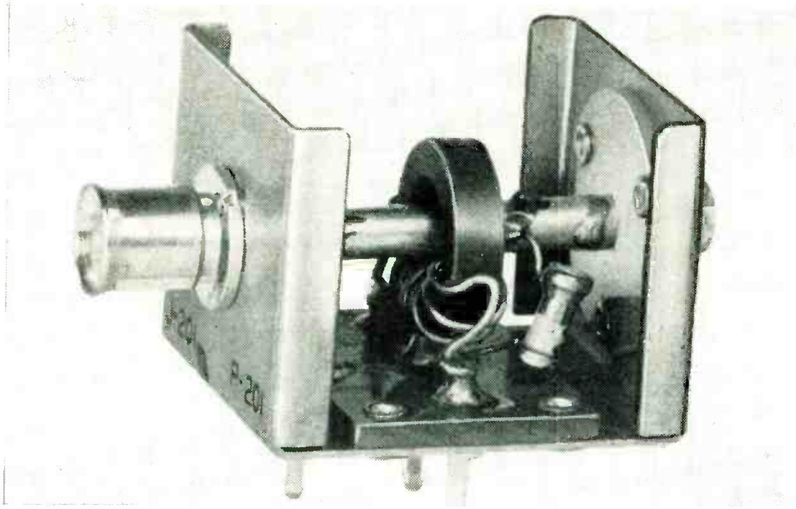
Error Detection

At the instant the transmitter delivers r-f energy, both the impedance-sensitive and phase-sensitive portions of the discriminator will detect this error from the ideal impedance and will each provide a d-c voltage of a particular polarity at its output point. The d-c voltage at the output of the phase- sensitive discriminator is applied to a 400-cycle chopper that converts the d-c voltage to 400-cycle a-c having phase in accordance with the polarity of the d-c voltage. The 400-cycle a-c is then amplified, shifted 90 degrees in phase and used to excite one phase of a two-phase motor. With the particular 10-degree impedance-phase-angle error assumed, the motor would operate the phasing element L or C to increase the value of capacitive reactance in the phasing circuit and reduce the phase angle of the impedance presented to the transmitter to zero degrees.

At the same time, the d-c voltage



Complete antenna-matching unit



Discriminator is formed from transmission line surrounded by powdered-iron toroid to which is coupled five-turn, center-tapped loop

appearing at the output of the impedance-sensitive discriminator is applied to another chopper, servo amplifier and two-phase motor that mechanically moves the variable autotransformer tap nearer ground to correct for the assumed 8-ohm error in impedance magnitude.

This is the basic operation of the system, with one exception. The explanation was indicative of a tuning sequence wherein the matching elements were only slightly mistuned from their ultimate positions.

Upon further examination of the circuit it becomes apparent that a more complex condition can, and usually does, exist.

Assume that the antenna-phasing elements L and C are considerably mispositioned from their ultimate tuning points. Under these conditions very little antenna current is able to flow. In fact, most of the r-f current sampled by the discriminator is the inductive current flowing from the fixed tap of the autotransformer to ground. It may also be current flowing from the fixed tap through capacitor C_2 to ground, depending upon the starting position of the autotransformer variable tap. The problem exists of trying correctly to tune the phasing elements L and C to series-resonate the antenna with information obtained from a discriminator, which under these conditions cannot detect antenna current because of its relative absence.

This is the usual tuning condition and results in the necessity of forcibly operating the phasing elements at the beginning of each tuning operation by automatically applying a voltage to the motors until such time as they are near enough to resonating the antenna to allow the discriminator to assume control of the situation and complete the tuning function.

Shunt Capacitor

Owing primarily to practical considerations with regard to component minimum and maximum values it is still possible to present an antenna to this network, as it is thus far described, which the network is not capable of transforming to $52 + j0$. Since this cannot be tolerated, in these instances a relay-operated fixed capacitor C_s is provided within the antenna-matching unit and permitted to shunt the antenna and change its effective impedance to a matchable value.

Whenever C_s is required for the solution of a matching problem, it decreases matching efficiency. Its use, therefore, is restricted to antenna impedances that represent limits of tuning range and for which the construction of a series-resonating reactance or autotransformer would be impractical. The necessity for use of C_s is determined automatically by providing switches at the extreme limits of L and C and the autotransformer, such that if any one of these elements reaches the limit of its tuning range it will operate the relay to connect C_s in shunt with the antenna.

The unit as constructed is capable of operation with antennas from 25 to 90 feet in length over the 2-to-25 mc frequency range. The antennas may have their remote ends either grounded or ungrounded. Tuning accuracy of the entire unit is approximately equivalent to a 1.3-to-1 standing-wave ratio.

The efficiency of the unit is dependent primarily upon the relationship existing between the antenna Q factor and the Q factors of the phasing inductance L and autotransformer. The greater the value of coil Q with respect to antenna Q, the greater is the matching efficiency of this network.

The time involved in matching any particular antenna depends upon the antenna and the starting position of the various tunable elements. Time values from 1 to 25 seconds represent the limits in time that will elapse from the instant the transmitter is keyed to the moment the antenna has been completely tuned.

For antennas and frequencies within design limits, no further information is required by the unit except a grounding pulse from the transmitter whenever a new frequency is selected. Control circuits within the automatic antenna-matching unit perform the function of keying the transmitter prior to tuning, and unkeying the transmitter when the antenna has been properly tuned.

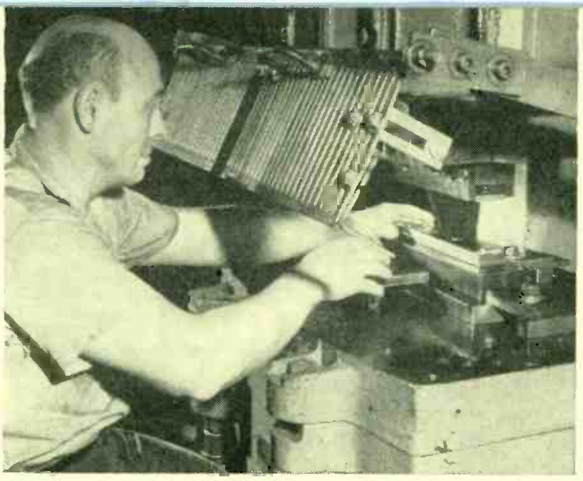
Some changes in antenna characteristics occur during operation, particularly in aircraft, wherein antenna-impedance variation occurs between ground operation and flight. The unit is designed to monitor the impedance presented to the transmitter and continually correct for this type of variation.

The techniques exemplified in this paper represent the efforts of many. In particular the author wishes to acknowledge the advice and guidance of D. W. Weber and the contributions of J. Sherwood, S. Morrison, M. Ludvigson and V. Newhouse.

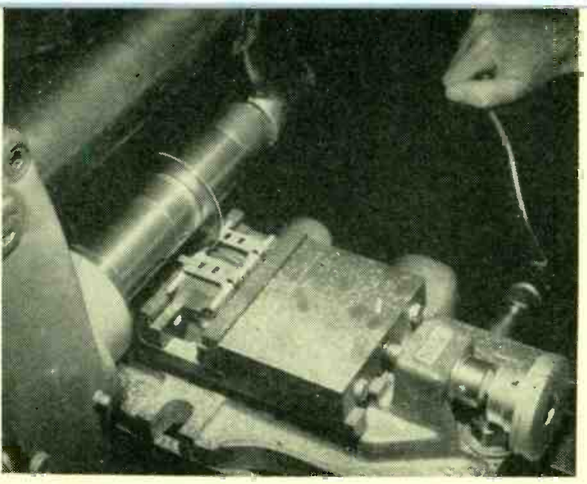
See p 194, after Mechanical Design insert, for this month's Electronics Reference Sheet

MECHANICAL DESIGN
of electronic equipment . . . . .

An
electronics
Special Report
OCTOBER · 1954



DESIGNING THE CHASSIS involves selecting materials, laying out the work and specifying the finish. Operator is punching out subassembly chassis with a 75-ton geared press



MAKING SMALL PARTS requires processes such as machining, casting, brazing and welding. Operator pictured uses a hand milling machine to trim rods on variable capacitor

The Importance of Mechanical Design

By JOHN M. CARROLL
Associate Editor, ELECTRONICS

Good design is reflected in increased production of reliable equipment. This special report gives a rundown on the latest in methods, machines and materials

Mechanical Design of Electronic Equipment

SHIELDING AND POTTING include both electric and magnetic shielding as well as use of casting and potting resins. These transformer cans are filled with molten beeswax

MOVING PARTS used in electronic equipment include shafting, gears, springs, cams and bar linkages. Operator is assembling gears for an all-band communications receiver

POWER DEVICES employed are subfractional a-c and d-c motors, clutches, brakes, damps and complete synchro systems. Engineer is checking a 2,929-rpm magnetic drum

ASSEMBLY TECHNIQUES entail use of screws, rivets, special fasteners, fittings and connectors. Operator is assembling one of the instrument panels of a large radar

MECHANICAL DESIGN can be either the strength or the weakness of electronic systems engineering. Considerations such as price, rate of production, reliability, ease of operation and maintenance depend heavily upon the mechanical layout and construction of the equipment.

Modern trends in mechanical design are directed in general toward two objectives: automatizing manufacturing processes to increase production rates and reduce cost, and improving equipment reliability to achieve optimum, trouble-free operation under even the most severe environmental conditions.

manufacturing processes

In consumer products, mechanical design largely determines the competitive price position of the finished set. The configuration of parts and the mechanical layout of the chassis usually decide whether fabrication and assembly operations will be economical or costly.

In the design of an audio preamplifier a few minor changes in layout permitted the chassis to be stamped from a single piece of sheet metal rather than fabricated from three separate pieces by riveting. Savings in direct labor and cost of materials were 30 percent.

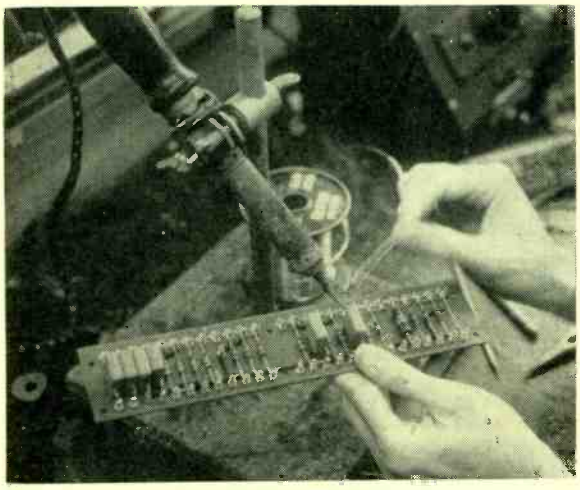
Such savings are magnified when indirect labor and overhead charges are applied percentagewise and serve significantly to reduce the selling price. Thus a minor change in mechanical design that permits a small metal part to be broached, extruded or die cast, avoiding expensive machining operations, will have an important influence on gross sales of the finished product.

Military planners are interested in design from the standpoint of reducing production time. In design of military equipment, cost necessarily must defer to optimum performance and maximum reliability. But time is an important factor and production bottlenecks can be costly in lives as well as equipment cost.

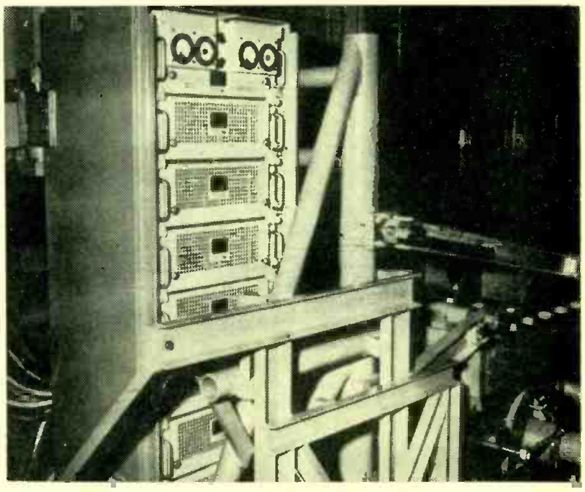
reliable equipment

Reliability is an important objective in military equipment design. The most advanced electronic gear is worse than useless if it cannot be depended upon to function in emergencies.

Toward the end of World War II, the Navy installed an advanced type of radar to control the main battery fire aboard some of its latest warships. The equipment provided exceptional gunlaying accuracy. However, usually only the first salvo could be fired under electronic control. The recoil shook electron tubes loose and, while technicians scrambled about pushing them



WIRING AND SOLDERING are important steps in production. Conventional soldering operations like the one shown are still important



DESIGNING THE CABINET entails planning housings for both stationary and mobile equipment. Cabinet shown is undergoing test on a vibration table

back into their sockets, optical fire control equipment had to be relied upon—often this was rendered hopelessly inadequate by fog or darkness.

In another type of radar equipment designed for use on destroyers, chassis were mounted in removable drawers for ease of servicing. Ashore, the equipment performed well but when subjected to the intense vibration caused by marine turbines it often developed accordion pleats in the cabinet that jammed drawers shut and rendered servicing all but impossible

recent problems

Modern equipment such as that used in high-speed aircraft and rocket-powered guided missiles places even more exacting requirements upon the equipment designer's art. For example, much airborne gear must pass vibration tests at 500 cps and higher. This has required development of new means for vibration isolation.

High sound levels have also been found injurious to electron tubes and other components and acoustic techniques are becoming important in airborne equipment design.

Stockpiling weapons such as missiles has brought up the problem of hermetic sealing to avoid corrosion and insure that the weapon will deliver 100-percent performance when taken from the shelf.

Other problems involve subminiaturization to cram essential electronic gear into ever-smaller equipment spaces, heat dissipation to permit operation under high ambient temperatures and space-heating and deicing schemes where low ambients are expected. There is, also, explosion proofing of equipment required to function in explosive atmospheres, waterproofing, splash proofing and drip proofing, resistance to salt spray, high humidity and fungus growth, and pressurization for operation at extremely high altitudes.

The mechanical engineer has been, for some time, a full-fledged member of the electronic design team. He may be a full-time worker in a research and development group along with electronic engineers and possibly physicists, chemists and mathematicians, or he may be assigned to a department where his specialized knowledge is available to several project engineers.

designer's role

In some organizations, mechanical engineers may be grouped in a separate department that functions as a clearing house for the mechanical problems of all design task forces. In others the mechanical engineer may be summoned in a consulting capacity, or the project engineer may be required to guide his electronic engineers in solving mechanical problems.

However the mechanical engineer may be represented, mechanical design plays a vital part in the design of electronic equipment. The following eight articles represent a compendium of recent design trends, production processes and manufacturing techniques aimed primarily at giving the electronic engineer the mechanical information he needs to articulate his particular problems and either solve them independently or intelligently seek the aid of a mechanical design specialist. It is also aimed at providing the trained mechanical engineer new to the field of electronic equipment design an insight into the particular problems, techniques and processes he will encounter while working with electronic equipment.

The editor thanks the Hammarlund Manufacturing Co., Westinghouse Electric Co., General Electric Co., Sperry Gyroscope Co., Grant's Pulley and Hardware Co., International Business Machines Co., Signal Corps Engineering Laboratories, Naval Electronics Laboratory and many other friends in industry and government whose advice, comments and criticism were most helpful in the planning and preparation of this report.

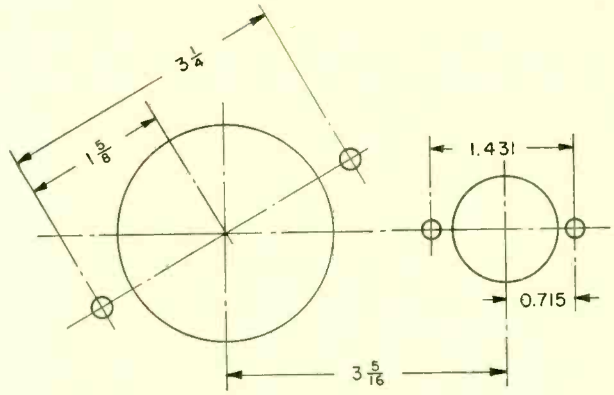


FIG. 2—Close-tolerance dimensions are given decimally, while wider tolerance dimensions are given fractionally

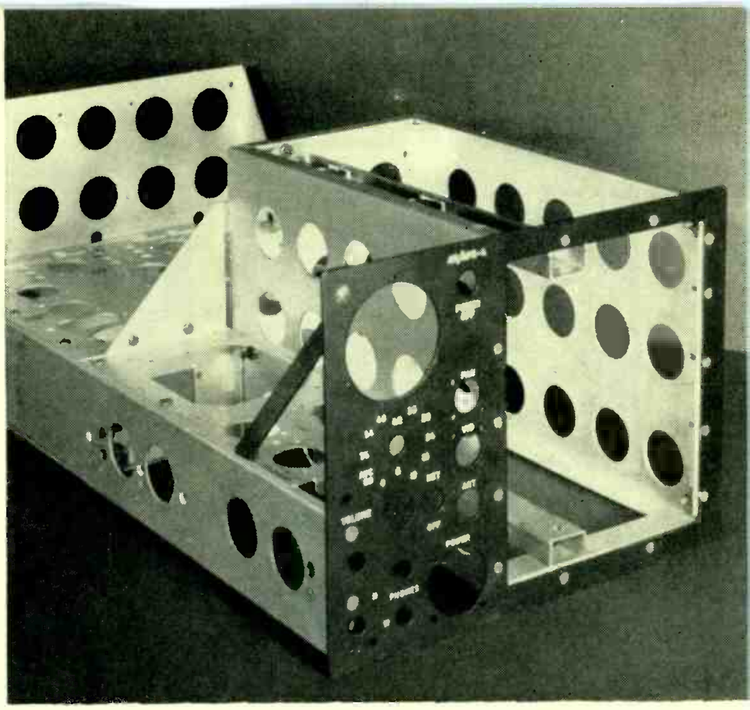


Fig. 1—Military equipment chassis, illustrating use of removable top and side skirts and plug-in subchassis

Designing the Chassis . . .

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Properly designed chassis increase reliability, facilitate maintenance, reduce cost and enhance appearance of electronic equipment. Common chassis materials are discussed as well as techniques for fabricating and finishing sheet metal

MATERIALS used in manufacturing chassis include both metals and plastics. The metals may be ferrous or nonferrous. Plastics include acrylic and phenolic plastics, fiber board and laminates.

Selection of material is based on the service requirement of the equipment. Important factors are: weight, tensile strength, electrical properties, resistance to corrosion, magnetic properties and cost.

Table I indicates weight per square foot in various gages for various metals. Carbon steel is commonly used because of low cost, good tensile strength and economy of fabrication. It has the disadvantage of poor resistance to corrosion and must have a protective coating of paint or plating.

size and shape

The chassis designer must keep in mind the following: electrical interference between components, distribution of weight throughout the chassis, wiring distance between terminals of components and overall dimensions of the equipment. With the current emphasis on miniaturization, the designer must place his components as closely together as possible. To facilitate wiring and assembly, chassis can be designed with removable top decks or removable side skirts as shown in Fig. 1.

Chassis can be made sectionally of subchassis that can be wired and assembled on separate production lines. These subchassis can be inspected and tested rapidly. There has been an increasing trend to plug-in chassis and subassemblies, particularly in military equipment, since they greatly facilitate servicing and repair.

For the manufacturer who has limited production runs there are available stock blank chassis from many sheet metal fabricators.

laying out the work

In conventional mechanical drafting tolerance occupies an important place. To maintain interchangability

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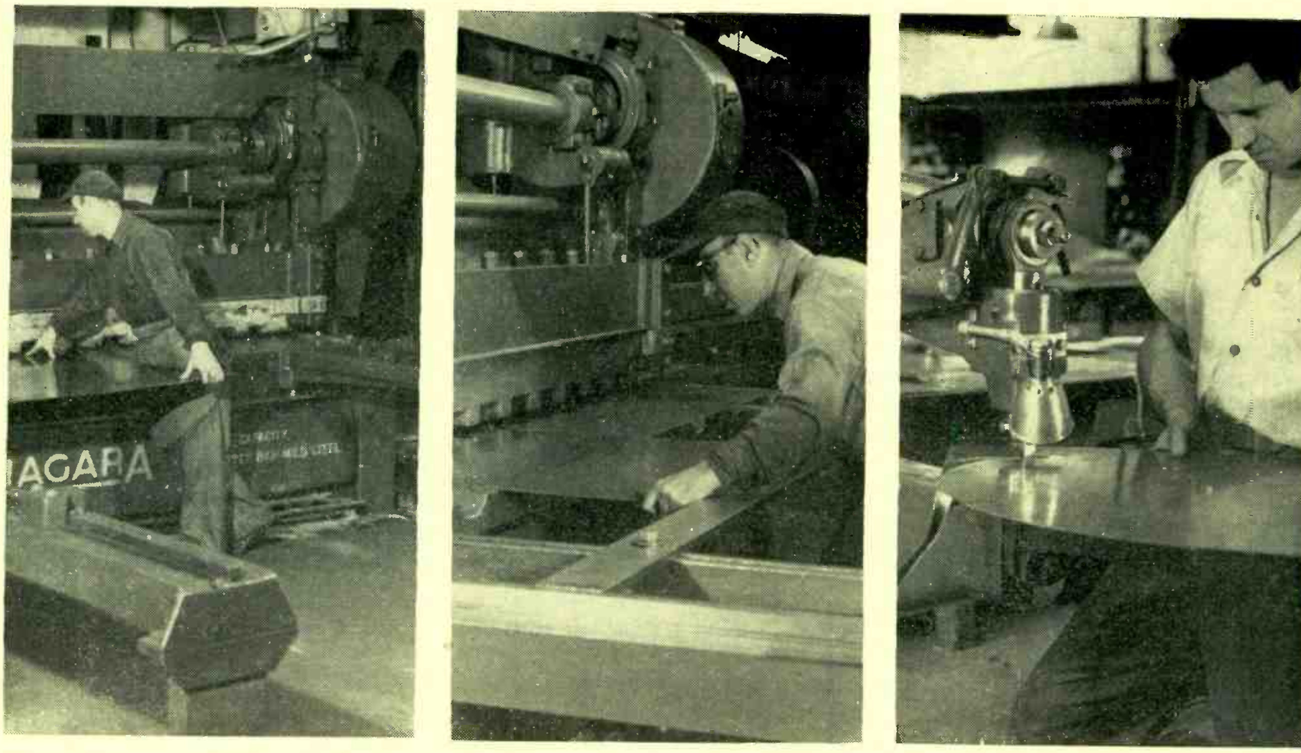


FIG. 3—Sheet-metal shearing. Operations shown are conventional shearing (left), front shearing (center) and use of circle shears (right)

of parts, close tolerance must be observed. Such tolerance, however, increases the cost of fabrication. Critical dimensions are usually indicated decimally with plus or minus 0.005-in. tolerance. Dimensions of overall size and locations of holes to an edge are usually located fractionally with a tolerance of plus or minus $\frac{1}{64}$ in.

Since it takes more labor to fabricate sheet metal to close decimal tolerances, they should be used only where the relative location of holes and bends is critical. Unless a chassis is to be enclosed in a tight-fitting case, the overall dimensions should be expressed fractionally. In a group of holes dimensions between mounting holes should be expressed decimally, but the whole group or cluster can be located fractionally from the edge of the chassis. See Fig. 2.

Where quantity justifies tooling costs, it is advantageous to use cluster dies which pierce the critically dimensioned holes at one time, insuring correct location.

Mounting holes can be dimensioned fractionally, however, if the holes are slotted or made slightly larger than clearance to accommodate the greater tolerance.

The chassis designer must specify the radius of bends in the part. If the radius is too small, the bend will fracture. Although most drawings of chassis are third-angle projections, it is sometimes convenient to draw a development of a sheet-metal part. A hole dimensioned past a bend will be located incorrectly on a development if allowance for the stretching or shrinking of material at the bend is not considered. The allowance for a 90-deg bend can be determined from the relationship $L = (\pi/2)\ (R + \frac{1}{3}\ T)$ where L = length, R = inside radius and T = thickness.

Many engineers find it convenient to use a blank chassis of the required overall dimensions and move their components about on the top, checker fashion, until they find the optimum location. To make a marking surface on the top of the chassis, template blueing can be applied or, if the chassis is aluminum, the surface can be satin etched or sandblasted.

cutting sheet metal

The first step in chassis manufacture is cutting the blank. Unless the blank is accurately cut, the location of all the subsequent operations will be incorrect. In conventional shearing practice, Fig. 3 (left), the blank is shoved against a gage behind the blade and held secured until the blade cuts the piece. For greater accuracy the blank should be front sheared or held against a gage in front of the blade and trimmed to the correct size. See Fig. 3 (center). For shearing rectangular pieces or for straight line shearing, this type of machine is used, but for cutting radii or circles a circle shear or a nibbler must be used, Fig. 3 (right). In large quantities, dies like that shown in Fig. 4 (top) are made which blank out the entire shape in one blow.

making holes in sheet metal

Although some drilling is necessary in most chassis construction, chassis are pierced where practical using punch and die sets. Generally, any round hole which has a diameter less than the thickness of the metal used should be drilled instead of punched. Punches should be kept sharpened to minimize burrs on the underside of the hole. Special piercing dies are made which will knock out specially shaped holes in one blow instead of chewing them out with a series of blows. Figure 4 (center) illustrates one such die.

Machinery is available to blank, pierce and form chassis, delivering a complete unit on each blow of the press. However, in production runs that are not of sufficient quantity to amortize high cost of such dies, it is necessary to use other machinery.

Movable punch and die sets can be used to great advantage. The bed of the die is either slotted for bolting down small piercing dies (Fig. 4, bottom) or the dies are held in place magnetically.

Turret presses utilize a turret which holds a number of die sets and can be rotated quickly to the correct size. The hole is located in the blank either by placing the blank against a gage (Fig. 5, left) or piercing through a template clamped to the piece.

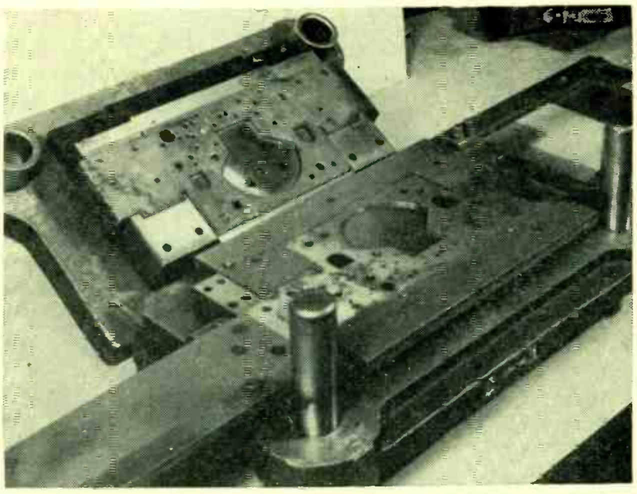
Another type of turret press utilizes a master template fastened to the bed of the press. A moving carriage firmly holds the blank and is registered to the template with a pantograph section as shown in Fig. 5, right. Kick presses and small power presses are used in limited quantity production runs; see Fig. 6.

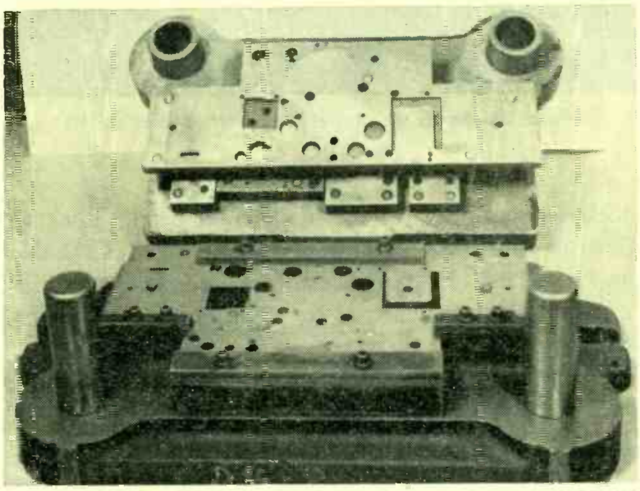
bending sheet metal

Piercing, cutting, blanking and notching should be completed before bending or forming. Bending is done on a brake. These range from manually operated devices such as fingerbrakes to powered brakes shown in Fig. 7. These are known as press brakes. Press brakes range in length from 3 to 12 ft and more. Sequence of bending is important. If the wrong bend is put in too soon, it is impossible to finish bending the chassis. A Dutch bend illustrated in Fig. 8A can be used at the edge of sheet metal to strengthen the edge when working with light gages. Corner construction of chassis varies with the service requirement of the equipment. Various corner configurations are shown in Fig. 8.

fastening methods

Joints assembled with bolts and screws can be readily disassembled and reassembled. Thus, they are widely used as mechanical fasteners. The use of nuts can frequently be eliminated. Methods include threading holes previously pierced in the chassis. When the gage of metal is too thin to provide enough land for threads, the hole can be extruded to add extra thickness for the threads. See Fig. 9A. Self-tapping screws, Fig. 9B, are used to great advantage since they cut their own thread on initial insertion. A chassis can be lanced at its edge as in Fig. 9C to provide holding surface for sheet metal screws for fastening the chassis in a cabinet or for holding on a bottom plate.





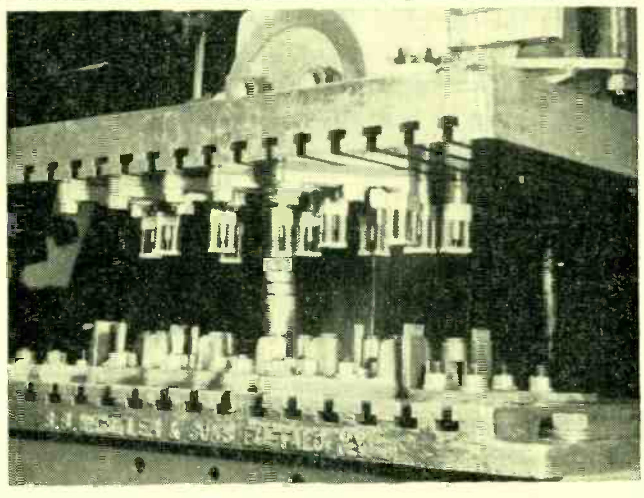


FIG. 4—Special punch and die sets (top, center) permit knocking out chassis with a single blow. Setup at right (bottom) is made with movable punches and dies bolted to die bed

Special screw fasteners are available for many applications. The locking types fall into four general groups: wedge, spring seating, spring stopnut and interference stopnut. The wedge type (Fig. 10A) is locked by wedging one part against the other.

Spring seating fasteners, Fig. 10B, are free running because the locking action does not occur until seating begins. The locking is due to a lever or spring action

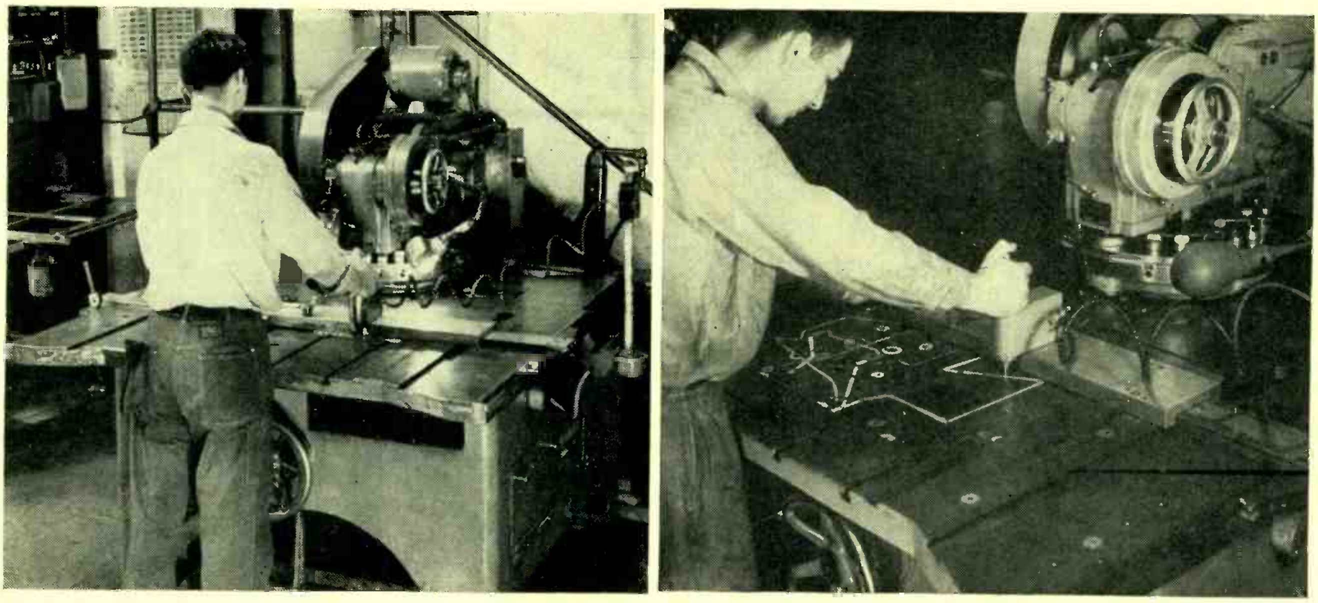


FIG. 5—Punching chassis with turret press, left. Model at right uses pantograph and template

within the periphery of the nut or bolt head. Locking action of the spring stopnut shown in Fig. 10C is also due to a spring clamping action. These fasteners differ from previous types in that the clamping action is continuous.

The interference stopnut employs a plastic or fiber collar to provide the locking action. See Fig. 10D. These collars are not threaded and when placed on the bolt are elastically deformed. Thus they tend to return to their original shape, squeezing against the threads and holding the nut in place. Quick-release fasteners, illustrated in Fig. 10E, are used for doors, panels and covers where intermittent closing and opening is required and a positive lock is necessary.

rivets

Riveting is a popular method for permanently fastening parts together. It is inexpensive and produces a sound joint without locking devices. Riveted joints are of two general types: lap joints and butt joints. Lap joined plates overlap while butt joined plate ends abutt each other and one or more cover plates or straps are employed. Both types of joint can be single riveted, double riveted, etc. depending on whether one row, two rows, etc. of rivets are used. Figure 11A illustrates several rivet types. Rivets are usually placed on lines parallel to the edge of the sheets. Lines which pass through the center of the rivet are gage lines. The distance from the edge of the plate to the first gage line is the edge distance. The distance between the centers of two adjacent rivets on the same gage line is the pitch of the rivet. Improperly riveted joints fail because of shearing of the rivet, tearing of sheet or coverplate, tearing or shearing between rivet hole and edge of sheet and crushing of the rivet or sheet at the edge of the hole.

Other failures may occur, such as popping of the head and head pulling through the sheet. These can be controlled by correct proportioning of the joint and by proper driving of the rivets. Correct proportioning of the joint involves factors of rivet size, material and spacing as well as hole size and edge distance.

methods

Where head protrusion is not desirable, countersunk-head rivets are used and driven in such a manner that the top of the head is flush with the surface. The top sheet must be dimpled or countersunk to the correct head dimensions during fabrication either in a press or by machine countersinking.

Rivets are driven by placing the driving tool against the head and a bucking bar against the shank end of the rivet. The driving tool is a rivet set attached to a pneumatic hammer or struck by hand. Riveting machines are also available which feed rivets by a raceway. Rivets can be also set with a squeeze action.

When using solid rivets of small diameter in thin sheets, the bearing area is so small that buckling of sheet may occur. To increase the bearing area without appreciably increasing rivet weight, tubular rivets are often employed. Use of tubular rivets also minimizes damage to the sheet. Two types of tubular rivets are available: the sleeve type and the solid head and a hollow shank rivet. See Fig. 11B.

Many standard fasteners require access to both sides of the assembly. Several types of blind rivets have been developed for special applications.

welding

Welding is the joining of two or more pieces of metal by application of heat and sometimes of pressure. The welding processes include: gas welding, arc weld-

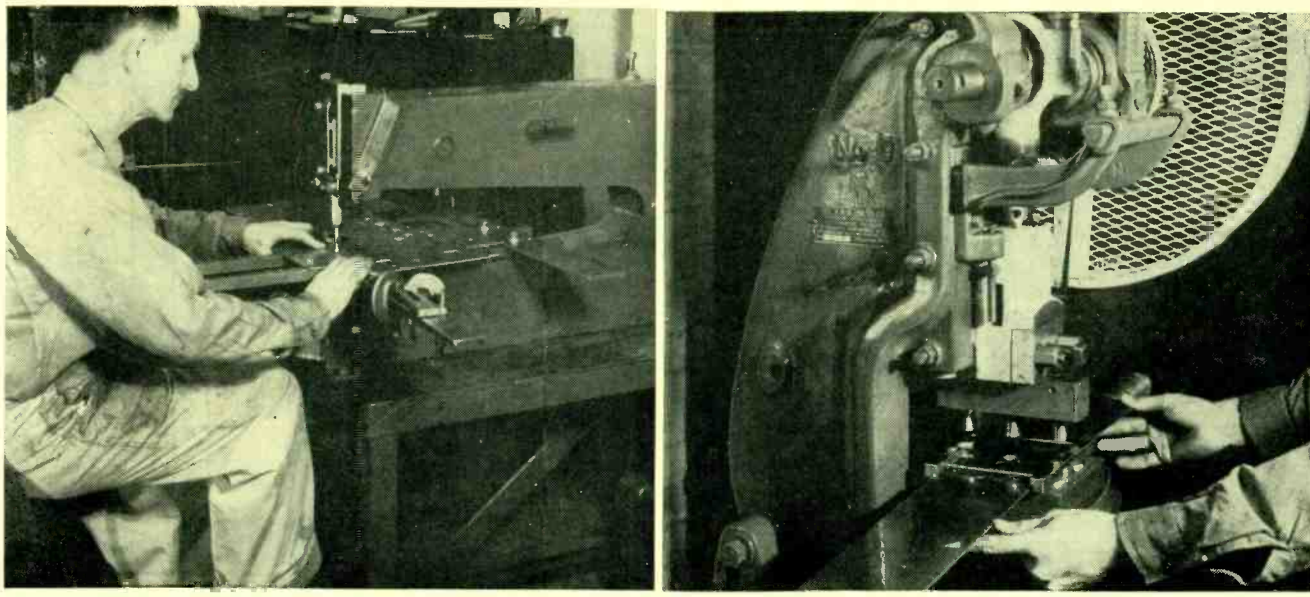


FIG. 6—Kick presses and small power presses are useful for small production runs

ing, resistance welding, brazing, induction welding, forge welding, flow welding and thermit welding.

Gas welding produces coalescence by heating with a gas flame with or without the application of pressure and with or without use of filler material. Gas welding covers many processes employing different fuel gases. They generally require oxygen to support combustion. Within certain limits the flame temperature increases with the oxygen in the mixture. A widely used fuel gas is acetylene. Oxyacetylene welding is used on the whole range of commercial ferrous and nonferrous metals and alloys.

An oxyhydrogen flame supplies a source of heat for low-temperature operations such as welding low-melting-point metals, brazing and braze-welding. The oxyhydrogen flame finds extensive use in welding aluminum and its alloys, particularly in the thinner gages.

materials for welding

Welding rods vary greatly in composition. For the thin gages of metal used in chassis construction, filler material is not always necessary. Thin materials, particularly aluminum, are often joined by flanging the sheet and melting this flange into the joint as filler.

A flux is usually used to combine with products of the welding operation which would interfere with the operation. The oxides of most alloyed metals generally have higher melting points than the metals themselves and remain as solids when the base metal is in the fluid state. Appropriate fluxes form a fusible slag with the oxides which tends to flow away from the weld area. The slag also forms a coating to protect the molten metal from oxidation. Fluxes are cleaning agents but should never replace proper cleaning of the base metal. Excess flux should be removed.

In arc welding coalescence is produced by heating with an electric arc. Its advantages are ease of edge preparation, fast welding speed and the elimination of flux. It also provides a concentration of heat which prevents excessive expansion and reduces distortion.

Metal-arc welding is done with flux-coated electrodes using direct current and reverse polarity (work negative). In gas-shielded tungsten-arc welding coalescence is produced by an arc between a tungsten electrode and work, shielded by an inert-gas envelope. This method has its greatest application when aluminum is the base material. It is capable of making clean, sound welds without use of corrosive fluxes. An inert gas such as argon shields the arc and the molten metal from the air, preventing oxides from forming. Such welding uses an h-f alternating current superimposed on 60-cycle welding current. The low-intensity arc produced by the h-f current provides a path easily followed by the main welding curent, which makes the arc easier to start and maintain. Filler material is used.

other welding methods

Resistance welding is a process in which a current is conducted through the parts to be joined. Heat is generated at the junction due to resistance. When this heat is combined with pressure applied by associated equipment, fusion is produced. Figure 12 illustrates operation of resistance welding equipment.

Spot welding and seam welding are resistance welding processes. Seam welding is spot welding with spots spaced so closely that they overlap to produce a continuous joint or seam. Timing is important in the spot-welding process. Pressure must be applied, maintained during the period of curent flow and the cooling period afterward.

A spot weld must first resist shear stress. The strength of a joint depends not only on the strength

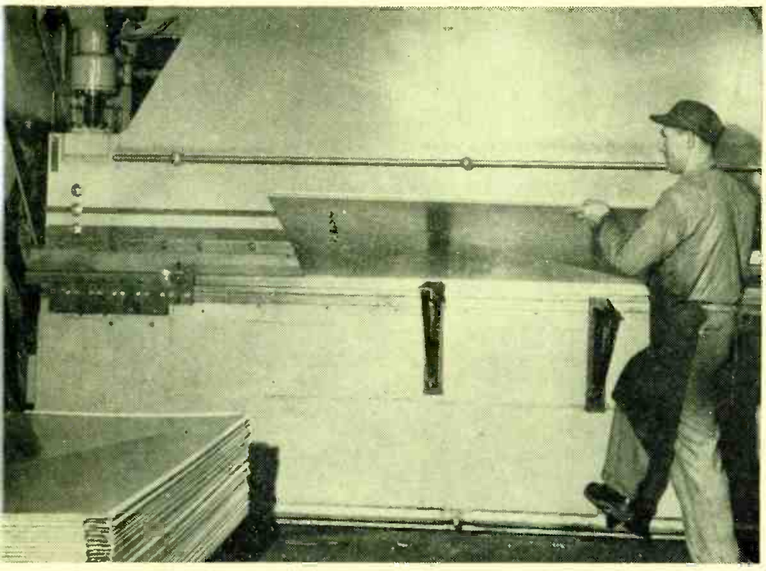


FIG. 7—Power brakes accomplish heavy bending operations on sheet metal

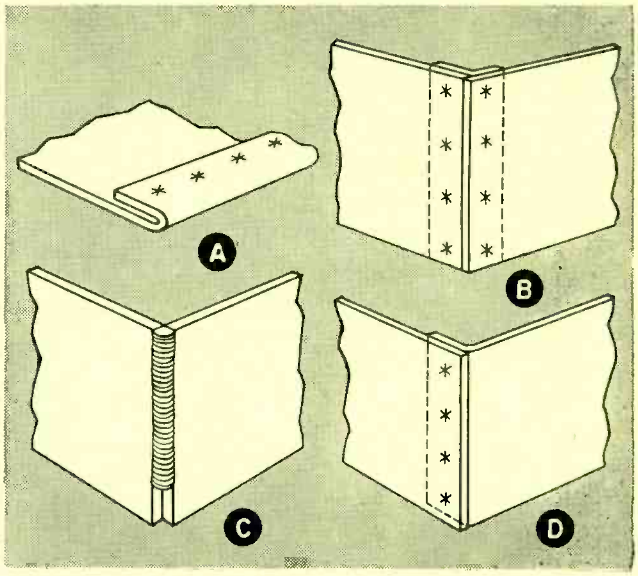


FIG. 8—Dutch bend (A) strengthens edge of light-gage metal. Other drawings illustrate various corner configurations

of the spot but also on the number and position of the spots. Because of partial short circuiting of welding current by a previous spot, it is necessary to maintain a minimum weld spacing (pitch) of the spots.

Minimum edge spacing is also important to prevent bulging and forcing out of the metal between the spot and the edge. Each spot weld tends to expand the sheet, so that correct weld sequence should be observed to prevent warping. The weld size recommended is three times the thickness of the thinnest outer piece, plus 0.06 inch. The specific sizes vary for each metal.

Penetration of the weld metal into the outer sheets of a joint is important. Weld penetration of less than twenty percent into one or both sheets will result in low weld strength. If the weld penetrates more than eighty percent, cracked welds can result.

The shape of the electrodes is also important. The contour of the tip depends upon the thickness of metal being welded, welding process and surface appearance desired. Materials of high thermal and electrical conductivity such as aluminum require higher welding current than steel. Aluminum and its alloys can be spot-welded satisfactorily only if the surface of the material is cleaned to remove the oxide coating. These oxides offer high resistance and prevent good welding. They can best be removed with alkaline cleaners. Since these chemicals also attack the aluminum and may produce a film with as much electrical resistance as the oxide film, they must be neutralized and washed from the aluminum.

brazing

In brazing coalescence is produced by heating to temperatures above 800 F and using a filler of nonferrous metal having a melting point below that of the base metals. The filler metal is distributed by capillary action. In making joints, the following factors should be considered: design of the joint, cleaning and preparation, fluxes, jigging, filler material and heating.

The strength of the joint can be controlled by the length of the lap. A reasonable length of lap is three times the thickness of the metal being joined. Maintaining a clearance of 0.001 to 0.003 in. is important to insure even flowing of the filler material. In aluminum the filler is aluminum alloy. The oxide coating of aluminum requires a flux which will melt below the brazing temperature and prepare the surfaces so that the filler material will flow. Parts may be spot welded before brazing to hold them in place. Parts to be brazed can be heated in a furnace, by gas torch or by induction heating.

metal finishing

Coatings are required either for protection from corrosion or enhancing of appearance.

Steel cannot ordinarily be used in its primary condition because it has little resistance to corrosion. Prior to finishing, dirt, grease, oils used in fabrication and surface scales and oxides must be removed.

Oils and greases can be removed with solvents. Washing by hand or wiping with a cloth or brush soaked with solvent is inefficient because the operator often spreads the impurity instead of removing it. Immersion in a tank of solvent is not effective because the oils and greases float on the surface and lifting the part out redeposits the contamination.

An effective method of degreasing is use of chlorinated solvents such as trichlorethylene and perchlorethylene. These are heated until they vaporize. Since these vapors are heavy as compared to air, they tend to stay in the container. The part to be degreased is suspended in the vapor for about thirty seconds. The

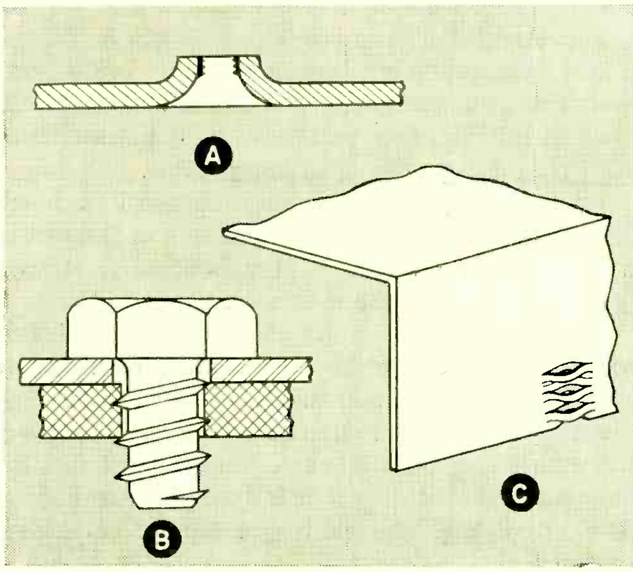


FIG. 9—Holes extruded in sheet metal can be threaded (A), self-tapping screws utilized (B) or the chassis lanced at its edge (C)

vapor condenses on the piece and streams off, washing the greases away.

If the final finish is to be an electroplate, no other surface treatment may be required. However, if paint is to be used, further chemical treatment of the surface will increase adhesion qualities of the material. One type of coating is Bonderizing. This coating is composed of zinc phosphates and has a strong affinity for paint. It also protects the surface against corrosion. Iron oxides (rust) have an alkaline reaction with moisture. These alkalies react with paint to form soaps which prevent adhesion between the steel surface and the paint. The phosphate coating prevents oxidation. Phosphate coatings are produced by several manufacturers.

Excessive scale and rust can be removed from steel by pickling in acids or by sandblasting.

finishing aluminum

Aluminum must also be cleansed of impurities on its surface. Vapor degreasing is an efficient method of removing oils and greases. Aluminum has high corrosion resistance as compared to steel. The natural oxide film protects the material but offers poor adhesion to paint. Proprietary solutions are available which not only chemically remove this film but also leave a phosphate deposit which aids adhesion.

Certain oxide films are deliberately added to the surface of aluminum either for additional corrosion resistance, increasing adhesion qualities or both. One process specifies immersion of material in a hot solution of 2-percent sodium carbonate and 0.1-percent potassium dichromate, with a subsequent bath of 5-percent potassium dichromate, and offers an excellent base for paint.

Another process produces an insoluble phosphate

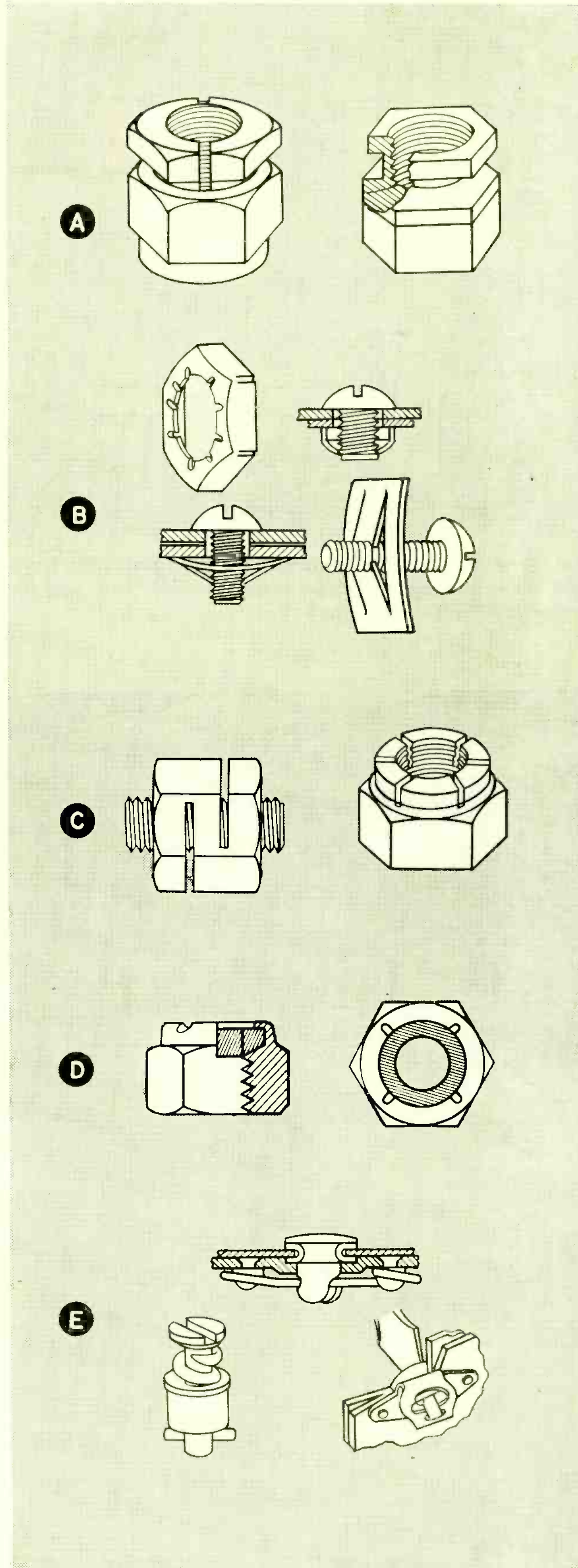


FIG. 10—Special fasteners are widely used in commercial equipment such as television sets and home radios. The several varieties illustrated include: wedge type (A), spring seating fasteners (B), spring stopnuts (C), interference stopnut (D) and quick release fasteners (E)

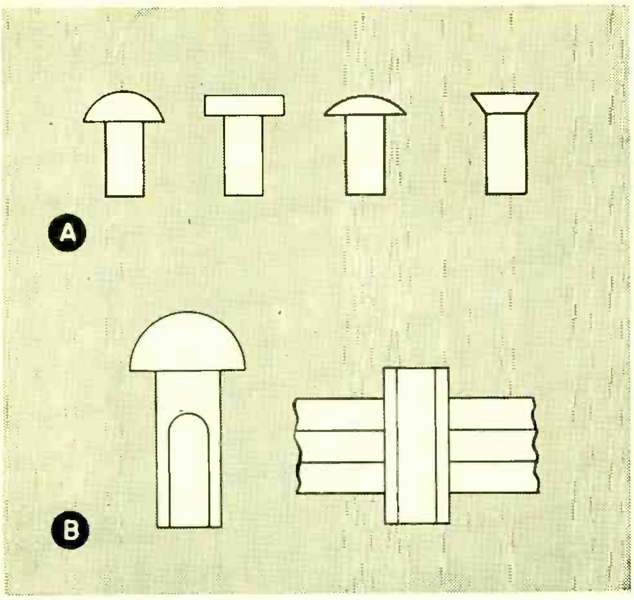


FIG. 11—Rivet types; from left to right (A) shows round, flat, brazier and countersunk heads. Tubular rivets (B) include solid head with hollow shank and tubular type

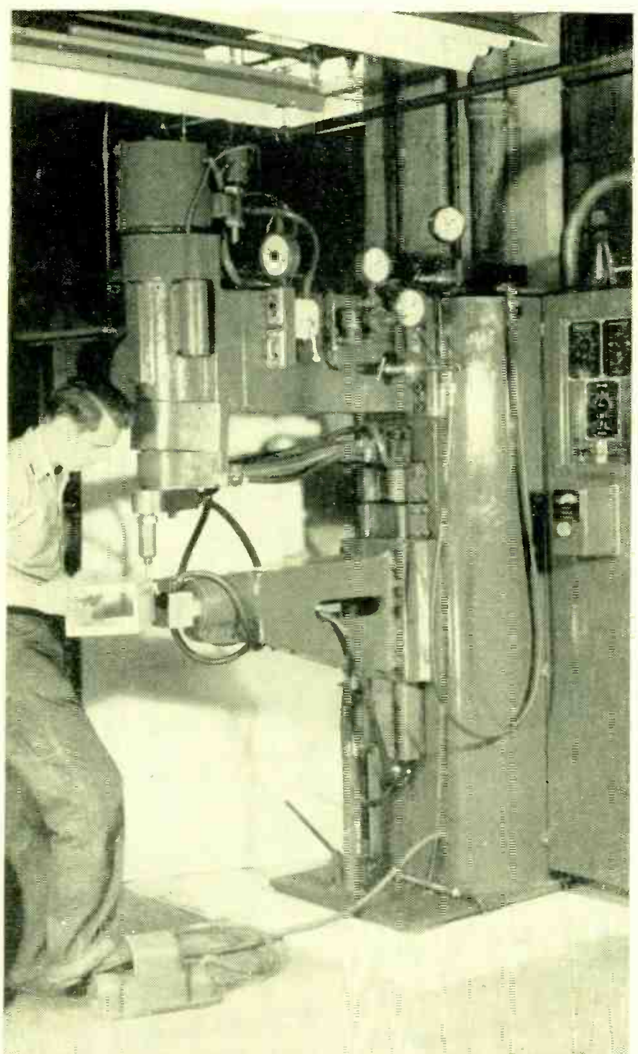


FIG. 12—Chassis work with resistance welding equipment

coating which is corrosion resistant and a good base for paint. Another offers a coating which can be used as a final finish or is a good base for paint. Another provides excellent corrosion resistance and is electrically conductive. It offers protection without interfering with electrical grounding of components.

Phosphatizing is an economical chemical treatment for aluminum. It consists of immersion of the part in a 5-10 percent solution of phosphoric acid. It is a good preparation of the surface for paint.

Electrolytic oxide finishes of aluminum (anodizing) are important because they offer a hard, inert, durable protective film. Anodic films, however, have high dielectric strength and interfere with electrical grounding. Anodizing takes its name from the fact that the aluminum is made the anode instead of the cathode as in electroplating. An electrolyte capable of yielding oxygen is used.

When current is passed, an initial oxide film forms on the aluminum surface and progressive oxidation takes place beneath this film. Hence, the film formed last is next to the metal and the oldest part of the film is on the surface. This outer part of the film is less dense and is softer than at the metal interface, since it has been subjected to the most severe solvent action. The aluminum oxide film produced is minutely porous. Thus current is able to pass through the electrolyte in the pores to the metal without too much resistance and heavy oxide films can be built up.

After formation, the film is treated with boiling water, which closes the pores and destroys the absorptive characteristics of the coating. This is known as sealing. Chromic acid and sulphuric acid are commonly used in anodizing processes, although other acids can be used.

The chromic acid method produces an absorptive film which can subsequently be colored by dipping in dye baths. Assembled parts can be anodized without the corrosion resistance being effected by acids that may be trapped in the joints. The film also offers a good base for paint.

Sulphuric acid anodizing is an economical process. It is not ordinarily used in an assembled or spot-welded part where acid may be trapped under a lap or joint. Such retention of acid would cause deterioration of the aluminum.

electroplating

The deposit of metal on the surface of another metal by electrolytic process is called electroplating. Steel can readily be electroplated after degreasing and cleaning. Where corrosion resistance must be provided but electrical conductivity maintained for grounding of components or soldering, zinc or cadimum plating are common methods. Plating may oxidize on prolonged exposure to the atmosphere. To protect the plating from oxidation and increase the adhesion quality, a subsequent dip in a chromate solution is recommended.

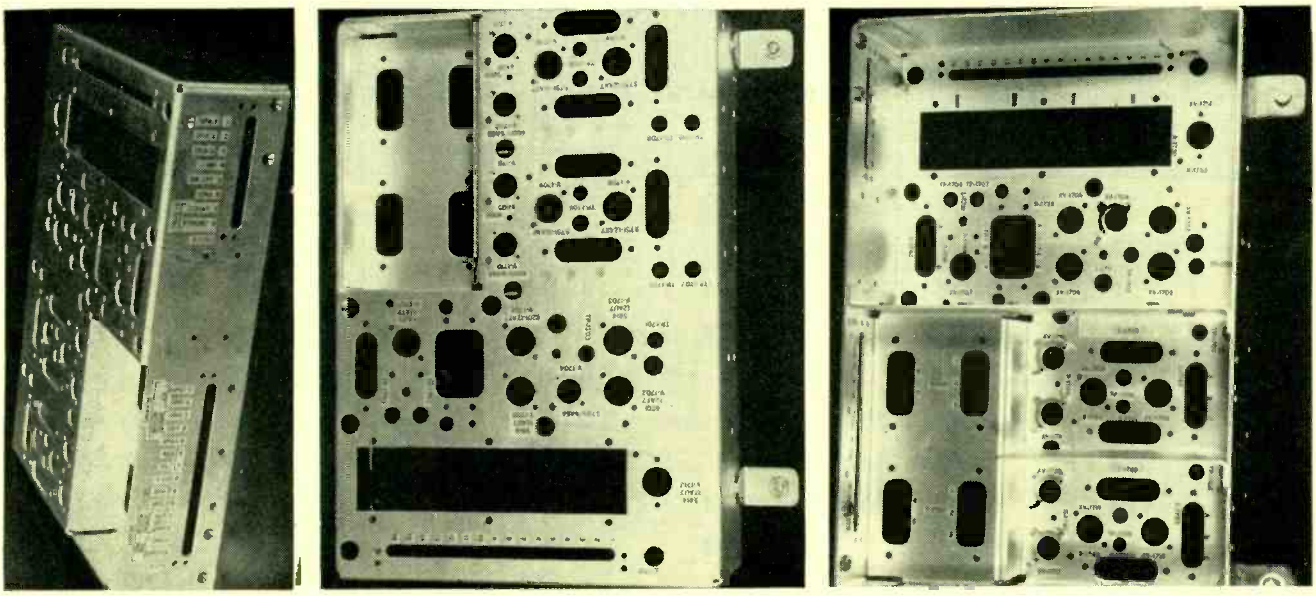


FIG. 13—Three chassis with nomenclature imprinted by silk-screen process

Steel surfaces can be made more electrically conductive by plating with copper or the noble metals, silver, gold, etc. The material should be copper-plated prior to the latter platings.

Chromium plating is used when a hard abrasion resisting surface is required. It is also used as a decorative finish. The high polished appearance of chromium is based on buffing the surface underneath the chromium plating. Aluminum can be electroplated after the part has been zinc coated. This process is an immersion type coating. The material is chemically cleaned and dipped into a solution of caustic soda and zinc oxide. This coating provides excellent adhesion for subsequent electroplatings. Both copper and brass plating on aluminum are used for applications requiring joining with soft solder. Aluminum in its natural state does not solder easily because of its natural oxide film and high thermal conductivity. Aluminum can be plated with chromium, nickel, cadimum, silver, to provide specific decorative or corrosion resistant finishes.

paint, varnish and enamel

Paint is a general term covering lacquers, varnishes and enamels. Lacquer is usually a cellulose nitrate or acetate base that can be pigmented if desired. In its clear state, it is used as a protective film over plated surfaces to prevent tarnishing. These films are economical to apply, because they air-dry and become hard without baking. Lacquers are water resistant but will not withstand salt water. They may also become brittle and discolor upon exposure to sunlight.

Varnishes can be formulated to provide special protection such as moisture, mildew or fungus resistance and are used for this purpose in electronic equipment.

Enamels, sometimes called synthetic because the resins are manufactured rather than natural, are produced in a variety of textures and appearances.

Wrinkle enamels have a crinky appearance which has the chief advantage of covering minor surface imperfections in the base metal such as scratches and nicks. They are also widely used as a finish for sand castings because they cover the porous surface and have great hiding quality.

Hammer finishes have the appearance of hand-hammered metal. They are pigmented in a variety of colors, including the metallic.

Paints are classified by the degree of gloss desired. This can range from lusterless to a high gloss approaching mirror quality. Lusterless finishes tend to show fingermarking. Semigloss materials are desirable since the high-gloss paints can cause eye fatigue to the operator. Paints can be applied by brush, dipping and sprayed. Spray painting is acceptable because the resulting surface is even and smooth without brush marks.

In dipping, the paint drains off the piece and sometimes leaves an unsightly buildup at the lower edges. Spray painting must be done in a booth suitably ventilated and with an exhaust that will draw the excess sprayed material away from the work. Spraying is accomplished by a spray gun with a cup containing paint thinned to spraying consistency.

graphic processes

Electronic equipment must be labeled to instruct the operator in the use of controls, identification of the power requirements, identification of the manufacturer and for labeling the components. Marking must be legible and permanent. It must be easily read and understood; lettering should not be too small.

Engraving is a technique in which the characters are cut into the base material and filled with paint to

Table I—Weight of Materials Used in Chassis Fabrication (lb per sq ft)

Gages USS	Gages B&S	Thickness (in.)	Carbon Steel	Aluminum	Brass	Stainless Steel	Copper
26	25	0.018-0.020	0.80	0.28	0.89	0.82	0.93
24	22	0.023-0.025	1.0	0.35	1.12	1.05	1.18
22	21	0.028-0.029	1.25	0.40	1.26	1.3	1.32
21	20	0.032-0.033	1.38	0.45	1.41	1.4	1.48
20	19	0.036	1.5	0.51	1.58	1.57	1.67
18	16	0.047-0.050	2.0	0.72	2.24	2.1	2.36
16	14	0.060-0.064	2.5	0.90	2.83	2.62	2.97
14	12	0.078-0.080	3.13	1.14	3.56	3.28	3.75
13	11	0.090	3.75	1.28	4.0	3.9	4.21
11	8	0.125	5.1	1.81	5.66	5.25	5.96

B&S (Brown & Sharp), aluminum, brass and copper   USS (U.S. standard), carbon steel and stainless steel

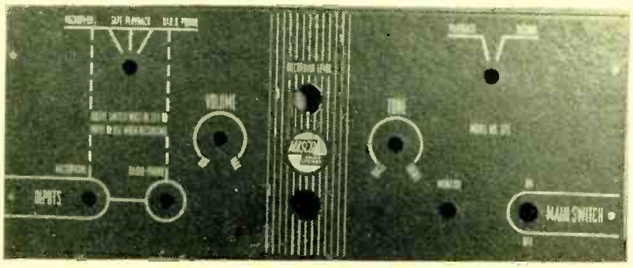


FIG. 14—Screen printing on hammer-finish background.

increase the contrast.

Etching is a good method of producing production quantities of nameplates. They are manufactured by imprinting the required design in reverse on aluminum or brass using a lithographic process. The printing ink is resistant to the etching solution. The etchant eats away the surface of the material not covered by the ink. The material is removed from the etching solution and neutralized. The nameplates are then sprayed with paint of the desired color and baked. The tops of the plates are then scraped down to the printing ink.

Since the etched areas are depressed, they retain the sprayed finish, resulting in a plate that has raised characters with a painted background. Entire front panels can be etched. All fabrication must be done after etching because the etchant would undercut holes pierced into the material. Small nameplates are etched in sheets containing many plates and sheared to size.

The use of rubber stamps is common for marking of nomenclature on chassis or parts. The inks used must usually be covered with lacquer or varnish.

stenciling

Stenciling requires a mask, cut with the required characters and held against the work while paint is applied either with a brush or by spraying. The marking can then be protected with an overcoat.

Silk-screen process printing is an efficient method of applying nomenclature to electronic equipment. A film positive with the desired nomenclature is placed against a bichromate gelatin film with a vinyl backing and an exposure to light made.

The bichromate emulsion becomes solid and insoluble when exposed to light. The areas of the film not affected by light are soluble and the emulsion is washed away. The bichromate gelatin film is then adhered to a tightly stretched silk or mesh stencil and the vinyl backing removed. By placing this stencil on the surface of the part to be printed, pressing paint of the desired color through the openings of the silk will give an imprint of the desired nomenclature.

Figure 13 depicts chassis which have been imprinted using the screen printing method. Screen printing inks and paints are formulated of synthetic baking enamels which when correctly cured offer excellent adhesion to metals and resistance to abrasion and corrosion.

The printing on the panels illustrated has been overprinted with clear fungus resistant varnish to give additional protection. Screen printing is also used extensively in marking front panels.

There is also technique of screen printing on wrinkled enamels in which the printed character is inlaid and embedded into the background and gives the appearance of engraving. Figure 14 shows screen printing on a hammer-finish background and illustrates how design can be introduced to enhance appearance.

Much of the material and some of the illustrations for this article were prepared by the engineering staff of Multi-Metal Wire Cloth Co., New York.

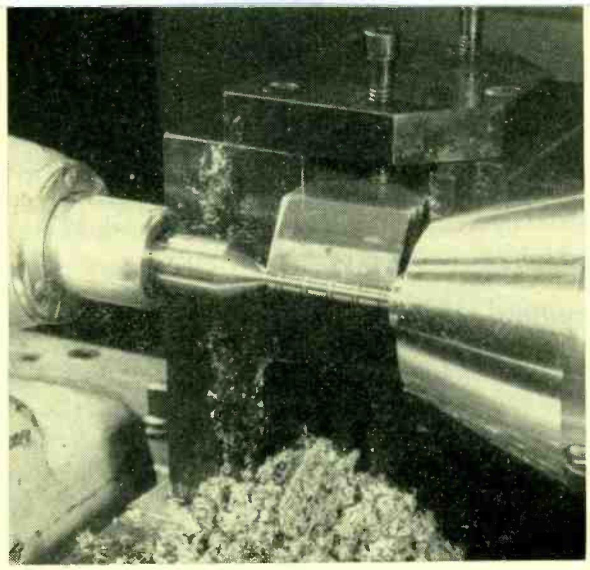


FIG. 1—Ten special grooves are machined in tuning-pin support, using Stellite skiving tool and 10-in. power-feed lathe

Making Small Parts . .

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Brackets, mounts, insulators, meter cases and other small parts of metal and plastic must be rugged, economical and have close dimensional tolerance. Fabricating processes include machining, casting, brazing and welding

TURNING IS ONE of the primary machining operations used in parts manufacture. It offers the advantages of single-point tooling for maximum metal removal and good finish accuracy, with production speed equal to the fastest processing equipment. Turning equipment includes the basic engine lathe and automatic lathes such as turret lathes and automatic screw machines, also tracers or shape turners that use templates.

lathes

The lathe removes material by rotating the work against a cutting tool. Parts are held between centers, attached to a face plate, supported in a jaw chuck or held in a draw-in chuck or collet. The machine is adapted to cylindrical work but may also be used for other purposes. Plain surfaces can be obtained, or workpieces centered, drilled, bored or reamed. The lathe can also be used for cutting threads, turning tapers and milling or grinding operations. In mass production, lathework is done on turret lathes and automatics.

Use of the lathe as a production machine is illustrated by the manufacture of a tuning-pin support. It was necessary to machine 10 angular radial convolutions in oxygen-free, high-conductivity copper rod to tolerances of ± 0.001 on a 0.248-in. diameter. Production requirements were too high to justify machining the grooves individually on a lathe and too low to justify the cost of providing automatic equipment.

As shown in Fig. 1, a skiving tool of modified design with a special tool holder did the job. The skiving tool cutting member was made from nonferrous alloy and the work put on a 10-in. power-feed lathe. The large end of the part was held in a collet and the small end supported with a revolving center in the tail stock. This center was used to eliminate any possibility of the center spinning out due to friction and tool pressure. The skiving tool was clamped, adjusted in the holder and mounted on the front cross slide. The tool was power fed tangentially across the top of the part to machine the grooves. No trouble was encountered in holding specified dimensions. Tool life was about 24 hours between sharpenings. An operation that may be considered the inverse of turning, milling is the process of cutting metal by feeding it into a rotating cutter whose edges are successively brought against the work.

milling machines

A milling machine consists of a power-driven spindle or arbor to which the cutter is attached. The part is cut by moving the table toward the tool by hand or power until the tool has bitten into the work a specified distance.

Milling machines are made so that the table will raise or lower, move right or left, in or out or swivel at an angle. The cutter may be mounted so that it is horizontal or vertical to the table or any angle. With indexing attachments, straight or helical cuts may be made on cylindrical pieces. Standard cutters are made in widths ½ to 8 in. and in all shapes and styles.

Milling machines may be classified as plain, universal, hand and vertical. Plain milling machines have the cutter revolving about a horizontal axis and the table traveling past the cutter at right angles to its axis. A hand miller is one type of plain milling machine. A universal milling machine has a table moving in a swivel carriage which allows it to travel past the cutter at different angles with its axis. Vertical milling machines have the cutter revolving about a vertical axis.

An operation indicative of the adaptability of the milling machine is the milling of 32 cooling-fin slots in a copper electron-tube shell as shown in Fig. 2. A horizontal-type milling machine is used. The machine is equipped with a fixture designed to hold two parts located at the specified angle. Sixteen slots are cut

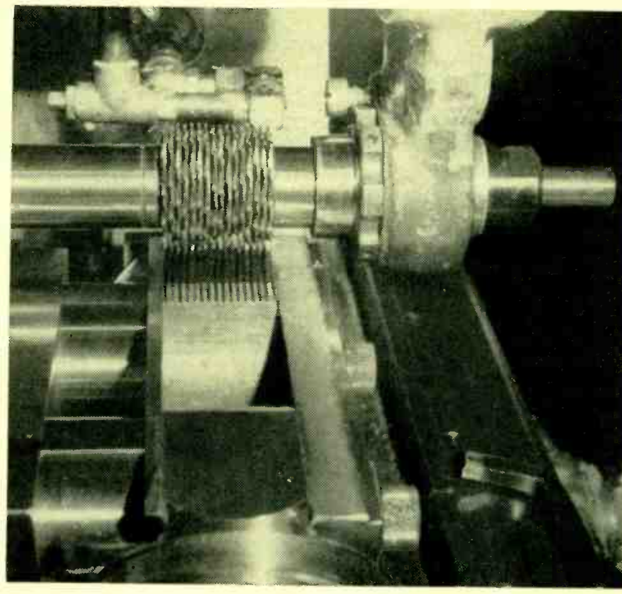


FIG. 2—Ganged carbide-tipped cutters mill 32 cooling-fin slots in magnetron shell. Sixteen slots are cut at a time. Tolerance is on width +0.002, −0.002 and ±0.005 for depth and location

simultaneously on one side of each part using carbide-tipped cutters arranged in a gang and mounted on a single-spindle arbor. When this operation is completed the parts are turned 180 deg, located in an alternate position in the fixture and the slotting is completed. The tolerance of the width of the grooves is +0.002, −0.002 and ± 0.005 for the depth and location.

Table I — Presses for Forming Small Parts

Type of Press	Size	Operation
Inclinable	4-90 tons	Blanking, bending, stamping, forming and assembling light gage sheet metal
End-wheel gap	Small to 50 tons	Blanking, forming, notching, piercing and cutting long, narrow strips
Double-crank overhanging	Small	Blanking, cutting and piercing large pieces of sheet metal
Straight-side high-speed	10-400 tons	Blanking and stamping for high production rates
Dieing machine	Small	Progressive die operations on small parts
Oscillating die	Small	Blanking and cutting light gage material
Multislide	Small	Combined operations—blanking, forming and bending light gage metal
Double-action	Small, medium or large	Blanking and drawing applications requiring two related operations

automatics

Automatic screw machines are essentially turret lathes designed to use only bar stock. They produce parts automatically and without constant attention. Screw machines are usually provided with an automatic feed. They are classified according to the type of turret used or the number of spindles on each machine. Multispindle machines, however, are spoken of as multispindle automatics.

Some single-spindle automatics use a cross slide for carrying tools both front and rear and have a turret mounted in a vertical position on a slide with a longitudinal movement. The two disk cams controlling the cross slide are driven by the front drive shaft. Mounted on this same shaft are three disk-shaped carriers, which have dogs to engage various trip levers that control the machine operation. One carrier controls the indexing of the turret, the center one, the collet and feeding of the stock and the remaining one, the rotation and speed of the spindle. Different tools are mounted around the turret in line with the spindle. Operations such as turning, drilling, boring and threading can be done on these machines. The kind of bar stock used—round, square, hexagonal or special shape—is fixed by the cross section desired in the end product.

Swiss automatic screw machines are often used in precision turning of small parts. The single-point tools

FIG. 3—Multispindle automatic machine drills, reams, chamfers, faces and taps 750 telephone-dial frames per hour. A 12-position die is used. Tolerance on center hole is +0.003 in., −0.000

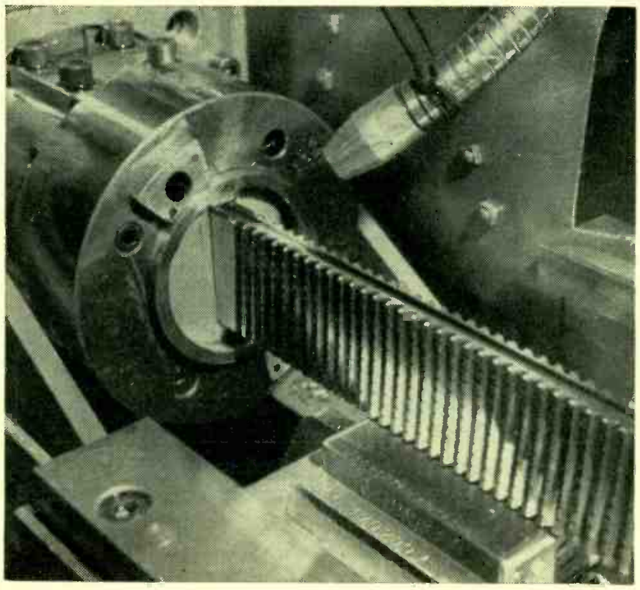


FIG. 4—Rectangular opening in magnetron shell is broached in two operations. Grooves running the length of the broach fit into keys and guides on fixtures to insure concentricity

used are placed radially around the carbide-lined guide bushing through which the stock is advanced. Most diameter turning is done by two horizontal tool slides while the three other slides are used principally for operations such as knurling, chamfering, cutting off and recessing. Diameters can be held to tolerances of 0.0002.

Multispindle automatics are fully automatic and are made with two, four, five, six or eight spindles. All spindles operate simultaneously and one piece is completed each time the tools are withdrawn and the spindles indexed. Attachments can be added that increase the range of cutting conditions or make possible special operations that otherwise could not be performed. Frequently, multispindle setups eliminate secondary operations with considerable savings in direct labor and overhead. Production materials in all shapes and up to $7\frac{3}{4}$ inches in diameter can be worked.

Almost any machine operation is available. Both solid and self-opening dies and taps may be applied. Taper turning, combined taper turning and boring or recessing attachments are applied to the end tool slide. A spindle-stopping mechanism can be arranged for such operations as milling, slotting and cross drilling. The multispindle automatic in Fig. 3 drills, reams, chamfers, faces and taps 750 telephone-dial frames per hour. It uses a 12-position die and drills the center hole to a tolerance of +0.003 in., −0.000.

broaches

Broaching is the removing of metal by an elongated tool having a number of successive teeth of increasing size which cut in a fixed path. A part is completed in one stroke of the machine, the last teeth on the cutting tool conforming to the desired shape of the finished surface. In most machines the broach is moved past the work, but effective results are also obtained if the tool is stationary and the work is moved. A broach consists of a work-holding fixture, tool, drive mechanism and a supporting frame.

Broaching machines are of horizontal or vertical design. Vertical machines are adapted for surface broaching although both pull and push internal broaching machines are made. Horizontal machines pull the broach and are often used on internal broaching in small and medium sized work. However, they too have many surface broaching applications. Broaching machines have been adopted for mass manufacturing because of their exceptionally high rate of production.

An application of broaching is seen in Fig. 4. The parts are cored forgings of vacuum-tube shell inserts and waveguide parts made of oxygen-free, high-conductivity copper and to fairly close tolerances. The forgings are machined such that the excessive stock is removed to insure pure oxygen-free, high conductivity material.

The shell insert blank is first turned in an automatic turret lathe by chucking in the rectangular opening using specially designed centralizing jaws mounted on an air chuck. Turned diameters and the rectangular hole are concentric within 0.004 of center.

The rectangular opening in the shell insert is broached in two operations. The narrow width is first machined to size using a guided broach. Grooves located on the narrow side and running the length of the broach fit onto keys and guides mounted centrally in the work-holding fixture and thus maintain concentricity regardless of previous hole location. Broach shift is prevented and any existing eccentricity between the rectangular hole and turned diameters corrected.

The long axis of the hole is then broached to size

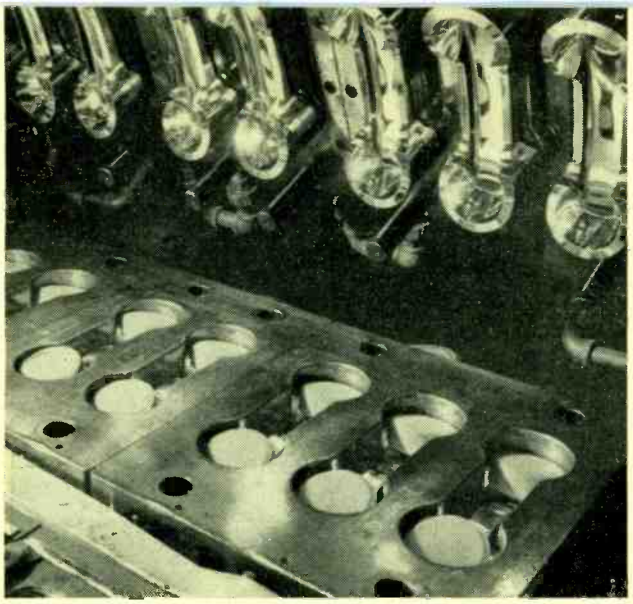


FIG. 5—Compression molding eight telephone handsets at a time. Preformed shapes of thermosetting plastic are fed directly to heated metal mold

FIG. 6—Joining magnetron cathode structures by high-frequency induction brazing. Bell jars maintain controlled atmosphere 90 percent nitrogen and 10 percent hydrogen to prevent oxidation

by rotating the work-holding fixture 90 deg and using a guided broach as in the previous operation.

metal forming

Cold-forming processes are used in making end-use products because of their economy in producing the desired shape. For most cold-forming operations a press is used. Although some presses are better adapted for certain types of work than others, most of the forming, punching and shearing operations can be performed on any press if the proper dies and punches are used. A list of presses commonly used in making small parts in the electronics industry is given in Table I. Other cold-forming processes of importance include bending, extruding, deep drawing and spinning.

Bending is a plastic deformation as performed on a brake, in contrast to forming which is a process making one or more bends about a linear axis by making the metal conform to a die shape. The inner radius of curvature in forming is generally specified. The machine commonly used in bending operations is called a press brake. It is suited for long bending or forming operations not adapted to regular presses.

Extruding is causing metal to flow through a shaped opening in a die to impart that shape to the metal. Extrusion can be worked by impact or continuous pressure. Both methods are commonly limited to nonferrous parts. In impact extrusion the pressures required and consequent tool duty are severe compared to stamping and deep drawing. However, this method offers unique possibilities in the manufacture of cups, shells or tubular shaped parts. Common applications include cams, cases, tubular parts with straight or tapered walls, capacitors and shielding cans.

Spinning is the operation of shaping thin metal by pressing it against a form while it is rotating. The nature of the process limits it to a symmetrical article of circular cross section. This work is done on a speed lathe similar to the ordinary wood lathe except that in place of the usual tail stock it is provided with some means of holding the work against the form. The forms are usually turned from hard wood and are attached to the face plate of the lathe although smooth steel chucks are recommended for production jobs.

Parts are formed by blunt hand tools which press the metal against the form. The cross slide has a hand or compounded-tool rest in front and some means for supporting a trimming cutter or forming tool in the rear.

casting

Resin-bonded shell molding is a sand-casting technique which uses, in place of the clay to bond the sand as in conventional practice, a plastic resin. This provides a strengthened bond which permits the mold to be made as a thin shell. After the plastic binder is cured, two mating halves of the mold are clipped together and placed in a pouring flask backed up with sand or steel shot for support. As the metal solidifies, the mold and the casting are drawn from the flask and the shell stripped off. Special venting is not required as the gases readily escape through the shell mold. Production tolerances of 0.002 to 0.004 in. per in. are readily obtainable and large castings have been made with less than 0.0015 in. per in. deviation. Metals cast include brass, bronze, aluminum, iron and steel.

Plaster-mold casting uses plaster as a casting investment. It has recently been accepted as a production casting method. Compared with sand molds, it has a higher molding cost but close tolerance, fine detail and good surface finish make it economically practical for short and medium production runs. The molds are destroyed by removal of the castings.

Patterns are made of free-machining brass and are held to close tolerance. They are assembled on bottom plates of standard-size flasks and before receiving the plaster are sprayed with a parting compound. The plaster is poured over the patterns with vibration used to insure filling the cavities. The plaster sets quickly and is removed from the flask by a vacuum head. Moisture is removed by baking. Plaster molds are used for

Table II — Plastics Used in Parts Fabrication

Material	Applications	Properties
Phenol-formaldehyde	Wire-spring relays, jack mountings, insulators, plug shells, handset handles	High resistance, dimensional stability, low cost
Resin solution (phenolic varnish)	Insulators, spool heads	High resistance, dimensional stability, low cost
Cast polyester	Terminal strips, cable terminal blocks, encasements	Good aging, adherence
Reinforced glass fiber	Wiring supports	High resistance, mechanical strength toughness
Polyvinyl chloride acetate	Loading-coil cases, wire insulation, capacitor coverings	High resistance, flexibility, toughness and abrasion resistance
Cellulose acetate	Coil interleaving, coil wrappers, relay and jack bushings	High resistance, film strength, close dimensional tolerances
Cellulose acetate butyrate	Combined-set housings, number plates	Impact strength, light weight, good surface finish
Polystyrene	Crossbar frame dust covers	Transparency, low cost
Polyethylene	Cable sheathing	High resistance, flexibility, chemical inertness, light weight, ductility
Polymethyl methacrylate	Wire-spring relay dust covers	Transparency, mechanical strength, good aging properties
Polyamide	Message register gears, combined set dial cam and pawl	Toughness, abrasion resistance, high resistance
Polyethylene terephthalate	Aluminum-foil capacitor dielectric	Film strength, dielectric strength, moisture resistance
Polytrifluoro-chloroethylene	Deposited-carbon resistor sleeves	Nonflammable, heat resistant, almost transparent
Polytetrafluoro-ethylene	Relay armature stops	Nonsticking, wear resistant

nonferrous alloys having casting temperatures up to 2,100 F. While plaster has proved an excellent mold material for yellow brass, certain bronzes, aluminum and magnesium may also be used.

Permanent mold casting utilizes molds machined from cast iron or tool steel but in some cases ceramic or refractory material is used. The mold must withstand high temperatures. Because of high cost, permanent molding should be used only for large-run production of small and medium nonferrous castings.

Castings produced by gravity in permanent molds are free from sand and have good finish and surface detail with tolerances of 0.0025 to 0.010 inches.

other casting techniques

Investment casting is used when dimensional control is important, such as in making waveguide components. It uses patterns of beeswax, frozen mercury and polystyrene plastic. Molds are made with an investment of silica and clay. As it is not necessary to open the mold to remove the pattern or to use cores, the process is used to cast complicated shapes. Variations of this basic process include the lost-wax process and frozen-mercury casting. In the former, a wax object is covered with a plaster investment. When the plaster hardens, the mold is heated to melt the wax while further drying and hardening the plaster. The remaining cavity is then filled with molten metal. Upon cooling, the plaster investment is chipped away leaving the desired casting. Thermoplastic polystyrene resin is sometimes used in place of wax.

A casting process using frozen mercury has been developed for production of precision castings. A metal mold or die is made of the part to be cast. When assembled and ready for pouring, it is partially immersed in a cold bath and filled with acetone which acts as a lubricant. Then mercury is poured into the mold, displacing the acetone. Freezing takes place in a liquid bath held at around —76 F in about 10 minutes. Patterns are removed from the mold and invested in a

FIG. 7—Seam welding. This resistance-welding process can provide a liquid-tight joint

cold ceramic slurry by repeated dippings until a shell about ⅛ inch thick is built up. Mercury is melted and removed from the shell at room temperature and after a short drying period, the shell is fired at a high temperature resulting in a hard permeable form. The shell is then placed in a flask, surrounded by sand, preheated and filled with metal.

In die casting, molten metal is formed under pressure in a metallic mold. Pressures vary from 80 to 40,000 psi and are maintained until solidification is complete. Die-casting machines consist of a press and an injection mechanism and are designed for speed so the cycle of operations resulting in a casting can be as brief as possible. The die halves are bolted to opposing platens of the press in perfect register and other moving parts are integrated with the press such that they operate automatically in proper sequence as the press opens and closes. Die casting is done by both the hot-chamber and cold-chamber methods. In the former, a melting pot is part of the machine and the machine injection cylinder is immersed in the molten metal at all times. The process is normally confined to relatively small parts. The advantages of die casting include rapid production, good finish, close tolerances and minimum machining. The high production rates result in low-cost parts providing the rate is sufficient to offset a high initial tooling cost. Die casting as a production process is limited to zinc, aluminum, copper and magnesium-base alloys.

plastics

Characteristics of plastics, such as ease and speed of forming into desired shapes in large quantities, moisture resistance and electrical resistivity have led to their increasing use in the electronics industry replacing materials such as wood, metal, ceramics and natural fibers. One company is currently using polyethylene at the rate of 6 million lbs per year, replacing lead as cable sheath with considerable cost savings. Tables II and III give applications for plastics and their more important properties.

Plastics can be divided into thermoplastic and thermosetting types. Thermoplastics are heat softening. After heating, forming and cooling they can be remelted and molded again. The thermosetting plastics are heat-hardening and, once having been heated under pressure, the synthetic polymerizes and will not become plastic upon reheating.

Thermosetting plastics include: phenolics, ureas, melamines and polyesters. Thermoplastics include: acetates, butyrates, ethyls, vinyls, acrylics, polystyrenes, nylons, polyethylenes and nitrates. Plastics are further subdivided according to the processes by which parts are produced: molding, laminating or casting. The molding methods include compression, transfer, injection, extrusion or jet molding.

production processes

Compression molding uses powder or preformed shapes fed directly into a heated metallic mold where under heat, (250-400 F) and pressure (100 to 20,000 psi) it becomes plastic and fills the mold. The mold remains closed until the piece is cured and hardens into its final shape. Compression molding is largely used for thermosetting materials. The telephone handset in Fig. 5 is made by this method.

Transfer molding is used for thermosetting materials and makes use of a pressure chamber, separate from the mold cavity, in which the compound is plasticized by high-frequency current and pressure prior to being injected into the heated, closed mold cavity where it is cured and hardened. Transfer molding was developed for intricate-insert and slender-core parts not easily molded by compression.

Injection molding is used for molding thermoplastics and uses chilled dies to solidify liquid plastic material. Powdered material is fed into heating cylinders where it becomes molten. A plunger forces it through a nozzle under pressure (10,000 to 30,000 psi) into mold cavities. The chilled mold after a short cooling period hardens the material into final shape. No curing time is required.

Jet molding is an adaptation of injection molding for thermosetting materials. The plastic is forced by ram or screw through a heated jet where it is softened before entering the closed die. The method is particularly applicable to good flowing materials with long flow periods.

Extrusion molding is used to produce continuous rods, tubes, strips of almost any cross section from thermoplastic material. Granulated material is fed by hopper into a heating cylinder through which it is forced by a screw into a shaping die. Continuous lengths are usually produced by this method at a rate of 500 to 1,000 ft per hour, the hot material cooling and hardening on takeoff belts. Die requirements are relatively inexpensive and equipment is much simpler than for other methods of forming plastics. Generally, thermoplastic materials are extruded.

Casting is often used when the number of parts desired is not sufficient to justify making die equipment. It is usually used with phenolic resins in lead molds. The molds are hand-filled with the prepared resin in a liquid state and baked until the material reaches the required hardness. Casting is recommended for preparing short rods, tubes and various shapes to be used in later machining operations. Machined surfaces have a dull white appearance which may be removed by tumbling with wood blocks and abrasive particles or by buffing. Cast products include terminal strips, instrument cases, and terminal blocks.

Laminated plastics consist of sheets of paper, fabric, asbestos, wood or similar material impregnated or coated with resin and combined under heat and pressure. These materials are hard, strong, impact resisting and unaffected by heat and water and have desirable properties for numerous electrical applications. They may consist of a few sheets or over a hundred depending on the thickness and properties desired. Although most laminated stock is in sheet form, rods, tubes and special shapes are available. The material has good machining characteristics which permit its fabrication into many types of small parts.

In manufacture the resinoid material, usually thermosetting, is dissolved by a solvent to convert it into a liquid varnish. Reels of paper or fabric are then passed through a bath for impregnation. This is a continuous operation and as the sheet leaves the resinoid bath, it goes through a dryer which evaporates the solvent leaving a fairly stiff sheet impregnated with plastic.

welding and brazing

Welding includes pressure, nonpressure and brazing processes. In pressure welding both pieces of metal are forged together while in a plastic state; actual melting may or may not occur. In nonpressure welding the metal is fused or melted together. In brazing, a filler metal of lower melting point is used to join the parts; no forging action is present nor do the parts melt. Brazing, resistance welding, arc welding and gas welding are of primary importance to the electronics industry in the manufacture of small parts.

Brazing is similar to soldering but in brazing parts are joined by copper, zinc or silver alloys having melting points below that of the parent metal but above 800 F. The filler metal is introduced in a liquid state between the surfaces of the joint by capillary attraction. Temperatures range from 1,100 to 1,983 F. Four types of filler are commonly used: copper, copper alloys, silver alloys and aluminum alloys.

The melting point of copper, 1,982 F, limits its application to ferrous metals and other high-melting-point alloys including high-speed steel and tungsten carbide. Copper is frequently used in furnace brazing at 2,000 to 2,100 F with a protective atmosphere. Joints in steel parts brazed with copper have high strengths resulting

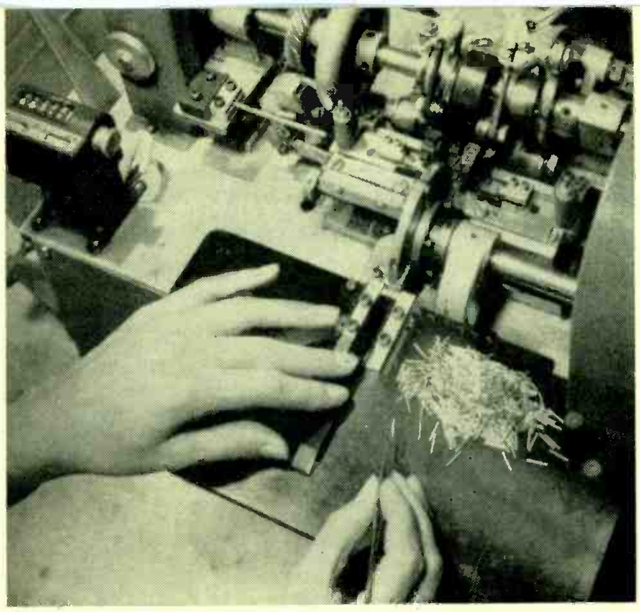


FIG. 8—Miniature welding machine used in making miniature tubes. Wire tabs 0.006 × 0.002 in. are welded to 0.25-in. diameter cathodes

from copper penetration and grain flow. Copper alloys for brazing are brass and bronze alloys having melting points ranging up to 1,980 F.

Silver-alloy brazing employs melting temperatures from 1,165 to 1,550 F. Pure silver is seldom used because alloys of silver such as silver and brass have a lower melting temperature and better melting and flowing characteristics. The silver brazing alloys are intended for use where higher physical strengths are required than are obtainable with soft solder or brazing spelter. Silver-brazed joints may be subjected to temperatures up to 425 F without appreciable loss in strength or to temperatures up to 200 F below their melting points if used only for sealing.

Aluminum alloys have melting temperatures ranging from 1,025 to 1,785 F and are used for brazing aluminum. The filler metal is usually applied in the form of wire or sheet-metal washer. The brazing temperature is above the recrystallization temperature so that cold-worked alloys are annealed.

There are four methods used in heating the metal to complete a joint: dipping in a bath of filler metal or flux, furnace brazing, torch brazing and electric brazing—resistance, induction or arc. The magnetrons in Fig. 6 are having their cathode structures brazed by the high-frequency induction technique.

The joint must first be cleaned of all oil, dirt or oxide and the pieces properly fitted together with appropriate clearance for the filler metal. Mechanical or chemical cleaning may be necessary in addition to the use of flux. Borax, either alone or in combination with other salts, is commonly used as flux and is applied as a thin paste. Borax and boric acid mixtures are suitable above 1,400 F. Commercial fluxes are available for use with lower flow point alloys for brazing stainless steels and for aluminum bronze.

The filler metal is frequently prepared in rings, washers, rods or other special shapes to fit the joint being brazed. Joints may be of the lap, butt, sleeve or scarf type or of various shapes obtained by curling, upsetting or seaming. Brazing is important in vacuum-tube appli-

Table III — Comparative Properties of Plastics

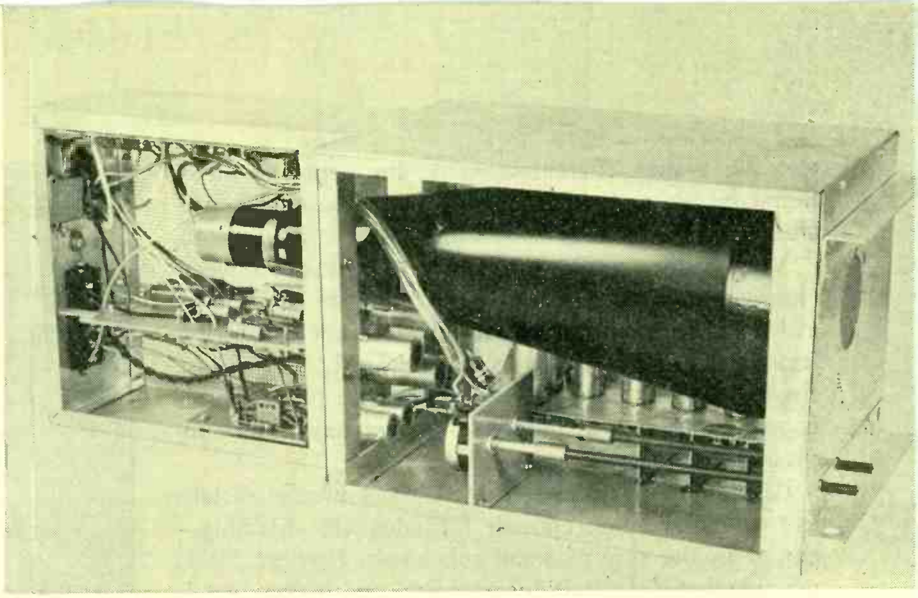
Material	Tens Str (psi ×1,000)	Flex Str (psi ×1,000)	Compr Str (psi ×1,000)	Izod Impact (ft-lb per in.)	Dielectric Str (volts per mil)	Resist. (ohm-cm × 10^n)	Arc Resist. (sec)	Water Absorp. (per-cent)	Therm Expan Coeff (× 10^{-5} per deg C)
Phenol-formaldehye	7	14	20	0.3	350	12	5	0.2	4
Urea-formaldehyde	9	12	30	0.3	350	13	125	1.9	3
Melamine-formaldehyde	7	14	40	0.3	350	13	145	—	5
Cast phenol-formaldehyde	7	14	15	0.3	375	11	225	0.4	7
Cast polyester	6	13	20	0.3	450	14	125	0.4	9
Cast epoxy	12	19	15	0.5	400	14	115	0.1	6
Polyvinyl chloride	8	14	—	0.5	600	16	—	0.4	—
Polyvinyl chloride-acetate	8	14	10	0.5	425	16	70	0.1	7
Polyvinyl butyral	6	10	10	0.8	400	14	—	2	15
Polyvinylidene chloride	5	16	—	2	350	15	—	0	19
Cellulose acetate	6	12	25	2	275	12	180	4	13
Cellulose acetate butyrate	5	7	15	3	325	11	—	2	14
Ethyl cellulose	5	8	15	5	425	13	175	1.3	15
Polystyrene	7	9	15	0.3	600	18	100	0.4	7
Polyethylene	2	2	—	—	450	14	135	0	17
Polymethyl methacrylate	7	15	15	0.4	475	15	—	0.4	9
Polyamide	10	12	15	1	400	13	140	1.5	10
Polyethylene terephthalate	20	—	—	—	—	19	—	—	2
Polytrifluorochloroethylene	6	8	50	4	400	18	360	0	6
Polytetrafluoroethylene	2	2	2	4	475	16	700	0	10

cations, manufacturing magnetrons and for special uses where high ductility and malleability are required.

Resistance welding is a production process adapted to joining light-gage metal that can be lapped. Spot welding is a form of resistance welding. It is the welding of two or more sheets of metal held between metal electrodes, applying pressure and then passing high current between the electrodes and through the work. The current is on just long enough to melt the metal under the electrodes so that the pressure of the electrodes will forge the metal together. The current is high, the voltage is low and there is no danger of shock from the welding current. In an average job the current is on only about 2/10 second and the pressure is about 500 lbs. The electrodes must be in firm contact with the work before the current comes on and the current must go off before the electrodes leave the work to avoid dangerous arcing.

Spot welds are really forge-welds, so usually there will be marks left by the electrodes that exert the forging pressure—at least on one side. Spot welds in steel up to 0.078 in. can be made relatively free of marks on one side if a flat electrode is used on that side. To make a markless spot weld requires that the material be welded without heating the surface opposite the weld. Markless spot welding can be made with special equipment for which capacitor discharge power is required. This welder makes a spot weld so quickly that only the surface of the metal right in the weld reaches welding temperature.

Seam welding is used in making liquid-tight joints. The work is put between two large but thin copper rolls and the seam is passed between these roll edges. As the seam rolls through, this current is turned on and off rapidly making a series of overlapping spots. For a tight seam in 0.031-in. material, the electronic timer would keep the current going at 3 cycles on and 2 cycles off making ten welds per inch at the rate of 72 in. of seam per minute. A seam-welding operation is illustrated in Fig. 7.



Cathode-ray storage tube for large digital computer requires magnetic shielding to exclude stray fields. Shield is fabricated from magnetic alloy by sheet-metal development

Shielding and Potting . . .

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RCA Victor Division, Radio Corp. of America, Camden, New Jersey
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Fabrication of electrostatic and electromagnetic shielding for optimum electrical performance and potting, embedding and encapsulating techniques required to guard against moisture, fungus or accidental short circuits are discussed

A SHIELD is a metallic barrier to attenuate or decrease radio-frequency energy (either electric or magnetic fields) passing through it. Shields are either electrostatic or electromagnetic. The electrostatic shield is used primarily against interference or fields of the electric type, such as those produced by a charged capacitor.

Electrostatic shields are normally of high-conductivity material such as aluminum, brass or copper (Table I). The thickness of the material to be used may be determined from an equation giving the energy absorbed by the material[1]

$$\text{Loss} = 3.34S\,(f\mu_r\sigma_r)^{1/2} \tag{1}$$

Where S is thickness of material in mils, μ_r is relative permeability, σ_r is conductivity relative to copper and f is frequency in mc.

Another method of expressing the penetration loss is to define the thickness which reduces the voltage at the shield barrier to 37 percent of its original value

$$d = 1{,}980\,(R/\mu f)^{1/2} \tag{2}$$

Where R is the resistivity in ohms per cubic centimeter, f is the frequency in cps, μ is the permeability and d is the skin depth in inches.

Therefore

$$\text{penetration loss in db} = \frac{8.686}{d}\left(\frac{f}{R}\right)^{1/2} \tag{3}$$

Thus calculation of the thickness of material for a given loss is greatly simplified.

There is also associated with the metallic material used, a reflection loss

$$\text{reflection loss in db} = (f/R)^{1/2} \tag{4}$$

The combination of these losses (Eq. 3 and 4) is the total loss for a given field offered by the solid sheet of metal.

electrostatic shielding

In most cases of shielding against electric fields, however, the mechanical engineer must consider other factors such as rigidity of the chassis for the purpose of meeting shock and vibration specifications. Conse-

[1] Electrostatic and electromagnetic shielding
[2] Potting, embedding and encapsulating

quently, a sufficient thickness of aluminum or other nonmagnetic material is usually provided which precludes the field energy's radiating from the equipment.

Very often a mesh material must be used between chassis to permit the flow of air for cooling. So long as the flange mounting the screen does not permit the leakage of energy, the screen material will offer almost the same loss as a solid sheet. Normally a No. 20 mesh copper, aluminum or bronze screen will suffice for suppressing frequencies above 150 kc.

Rigidity requirements of the chassis usually dictate use of metal thick enough for adequate shielding—except in the case of small subchassis. However, it is possible that if the unit does not have continuous metal-to-metal contact at all seams and joints, serious leakage can result. Fastening screws spaced a maximum of two inches apart on centers will provide a good contact. The mating surfaces must be clean and free of paint and any other insulating material.

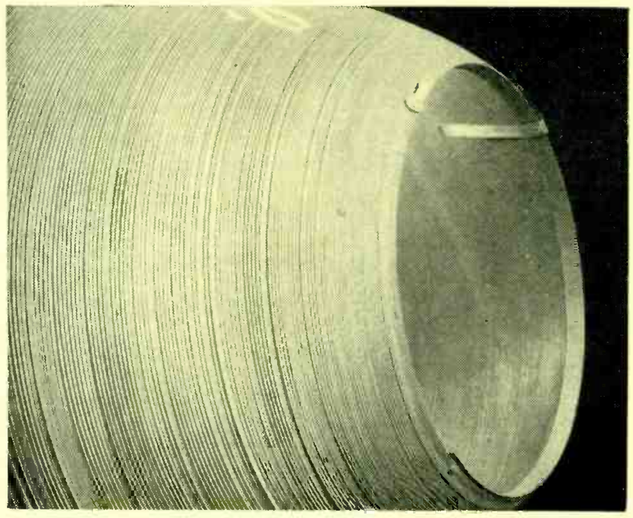

FIG. 1—Wire-mesh gasket around top of cabinet is compressed when lid is closed and forms radiation-proof electrostatic shield

metal gaskets

Many times, metal-to-metal contact of surfaces is insufficient to contain the fields generated within an equipment. Here metal gaskets or spring fingers find wide use. Beryllium copper fingers are utilized primarily on flat rectangular surfaces for sealing doors or small chassis such as radar receivers or i-f strips.

Conductive metal gaskets find use in almost all sealing applications whether the assembly is a sheet-metal cabinet, heavy casting or waveguide flange. One good type of gasket has as a base material a knitted wire mesh that can be made from any metal or alloy that can be drawn into wire. Being metal, the mesh is conductive; being knitted, it is flexible and resilient. A monel gasket is especially resilient and corrosion resistant. Where shielding and sealing both are required, metal gaskets are combined with neoprene or a similar material.

Figures 1 and 2 illustrate how use is made of the resiliency of a metal gasket. Figure 3 shows its application on a flange joint. The joints may be roughly machined with the gasket supplying the necessary complete surface-to-surface contact. In this type of application the gasket should be higher than the depth of the flange groove to insure good contact and should be located inside the bolt hole when possible to prevent leakage through the holes.

Figure 4 shows a compression curve as height relative to nominal height versus applied pressure in psi for a gasket of flattened 0.0045-in. monel wire. Figure 5 shows the shielding effectiveness of the monel metal gasket in decibels versus applied pressure. Frequency is 30 mc.

A new application is being tried in which knitted mesh provides flexibility under vibration, air flow for cooling and at the same time shielding against an intense electric field.

Problems in magnetic shielding occur primarily in the low-frequency range—60 cps to 30 mc. Usually ferromagnetic materials are employed for shielding against magnetic fields.

magnetic shielding

Magnetic fields are generally produced by transformers and coils. Nonmagnetic materials find little utilization in shielding against such low-frequency fields, since the reflection and penetration losses are low at low frequencies. In designing against magnetic fields the induction or near field is the energy source to be shielded against even though external fields may be present due to other equipment radiation.

The parameters useful in defining depth of penetration and relative electric thickness of materials[1] are σ = conductivity, μ = permeability, $\omega = 2\pi f$ = angular frequency of the field, d = thickness of shield, P = relative electric thickness, d_o = depth of penetration and $\beta = 1/d_o$

$$P = d\beta = d\,(\omega\mu\sigma/2)^{1/2} \quad (4)$$

The depth of penetration as previously defined is the distance, from the surface of the shield, at which the field is attenuated to 37 percent of its surface value. Shields where $d/d_o = p << 1$ are called electrically thin shields. Shields where $p >> 1$ are electrically thick. The delineation between an electrically thin and electrically thick shield occurs at the critical frequency f_c. At this point $d = d_o$ or $p = 1$

$$f_c = \frac{1}{\pi\mu\sigma d^2} \quad (5)$$

Quantity p may be calculated for any frequency.[2] It is essential however in all cases to know the effective permeability and conductivity at the frequency of interest. At present, an attempt is being made to develop a standard technique for frequency and attenuation evaluation of ferromagnetic materials.

In general, the problem of shielding against internally generated magnetic fields by transformers and coils requires either shielding the source or shielding the com-

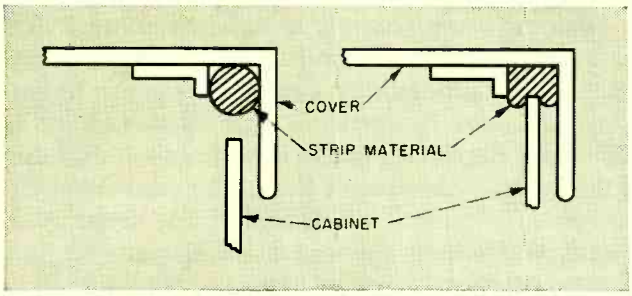

FIG. 1—Wire-mesh gasket around top of cabinet is compressed when lid is closed and forms radiation-proof electrostatic shield

ponent or chassis which can be most affected or both.

In the case of cathode-ray tubes, mesh shielding protection against power-line frequencies must be effected to preclude modulation of the beam current by the fields produced by transformers. Much effort has gone into the fabrication of such shields. A typical example is shown in the photograph.

In some cases multiple shields are required to extend the shielding into a higher frequency range such as 30 mc. Here laminates of mumetal and copper are used with excellent results.

materials for shielding

Electromagnetic shielding materials depend for their shielding action upon their high magnetic permeability and low remanence. The alloys used are based on the elements iron, nickel and cobalt. Iron alone does not give a high enough permeability in many cases but alloys of iron, nickel and cobalt with proper heat treatment yield permeabilities as high as 100,000. The basic phenomenon which is controlled by alloying and heat treatment is the aligning of the magnetic domains. The energy necessary for this alignment process is so great that dimensional changes in the metal are caused by the magnetizing forces. This dimensional change is termed magnetostriction.

Metallurgical variables which control the tensile strength of a material also control the permeability. These metallurgical variables are grain size and orientation, alloying elements and impurities. Grain size controls the ease of magnetization in the same manner as it controls yield and tensile strengths. The larger the grain size the less the hardness and the greater the permeability. Grain orientation is important because crystallographically magnetism is anisotropic in nature.

Silicon serves another purpose inasmuch as iron alloys containing more than $3\frac{1}{2}$ percent silicon do not exhibit the allotropic transformation which causes recrystallization to occur in some iron alloys during cooling. Thus the large grains formed at high temperatures are maintained. Just as a larger grain size means a lower yield point in tensile testing so also does a larger grain size mean that less energy is required for magnetization. For maximum permeability, the rolling direction must be kept nearly parallel to the direction of the magnetic field. Increased efficiency may be had by making duplicate or triplicate shields of thin material and orienting each shield so that the magnetic field in all three axis is absorbed.

Another important alloying element used with iron is nickel. The characteristic of nonnickel alloys that gives them such high permeability is the difference of the directions of the magnetostriction of nickel and iron. Iron has a positive magnetostriction; nickel a negative one. Thus by proper alloying, less magnetostriction occurs with concomitantly less energy necessary for maximum permeability. Important iron-nickel alloys are around 50 percent nickel and 80 percent nickel. Minor amounts of other alloying elements are added to commercial alloys.

The addition of silicon in iron, followed by proper cold reduction and annealing, causes an alignment of the $< 100 >$ or family of 100 planes parallel to the rolling direction. This crystallographic direction is also the direction of easy magnetization for body centered cubic crystals. Thus a minimum of energy is needed to align the domains.

manufacturing processes

Shielding devices are made largely by sheet-metal techniques with little or no machining. There are, however, instances where machining is necessary. Machining of magnetic-shield materials employs techniques similar to those developed for nickel [2] and monel [3]. Lubrication

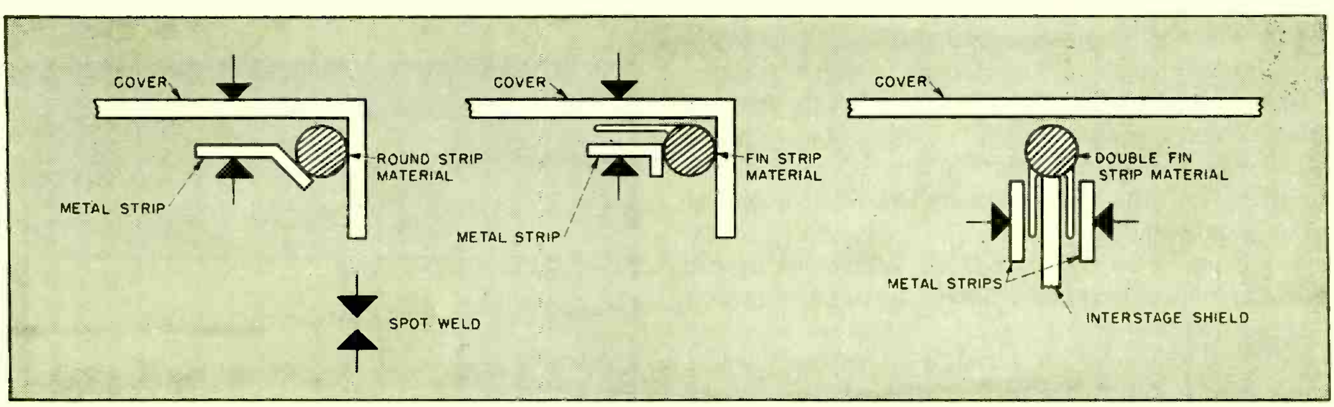

FIG. 2—Three ways to design electrostatic shielding. When shields are spot welded metal gaskets are compressed forming a tight radiation seal

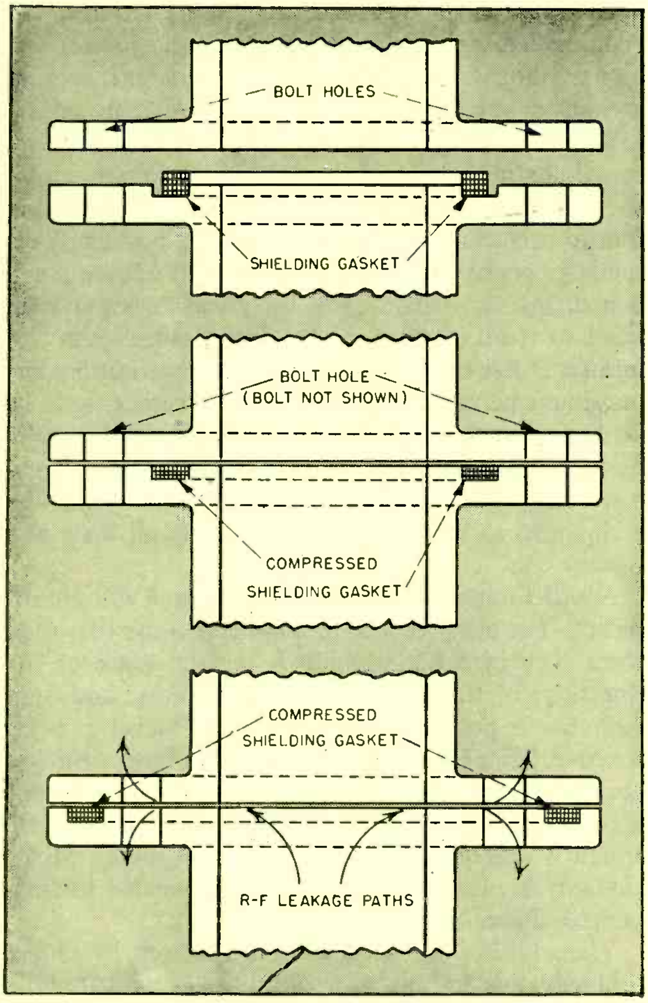

FIG. 3—Sealing a flange joint against radiation. For best results metal gaskets should be located inboard of bolt holes

is necessary during machining but must be removed prior to heating so as not to allow free sulfur to embrittle the nickel alloys.

The materials can be stamped and formed into simple shapes but not without a great deal of caution. Generous curves should be allowed during forming. Each manufacturer has his own tooling and equipment problem and must shape the material accordingly. A successful way of producing c-r tube shields of both silicon and nickel alloys is sheet-metal development. Normally the shield is made of three parts, front ring, cone and yoke shield. The conical piece is developed from sheet material. Normal practice is to blank out a semicircular sheet. The curved sides are serrated by V notches the roots of which have a generous radii. Lands between these notches are later bent to form the flange over which the front ring and the yoke shield are slid. The developed cone is spot welded together. The spot welding schedules are similar to those for steel. When making the shield of grain-oriented silicon-iron, the rolling direction and the direction of the magnetic field must be nearly parallel for maximum permeabilities. A magnetic shield for a color tv tube is pictured. This form is developed by winding a thin ribbon of magnetic material.

There are two different types of heat treatment given to both iron-silicon and iron-nickel alloys: for formability and for permeability. One thing common to both alloys and heat treatments is that all parts must be thoroughly degreased prior to heat treatment. Not only is this necessary because of the carbon present but also because of the sulfur which could cause severe grain-boundary attack in the iron-nickel alloys. Also, heat treatments must be carried out in a reducing atmosphere—usually hydrogen. The recommended temperature for formability annealing both silicon and nickel alloys is 1,400 to 1,600 F.

heat treatment

The heat treatment for magnetic permeability is performed after all fabrication operations. Any forming, bending or sandblasting after the magnetic annealing will necessitate a reanneal. If the parts are to be in contact with each other in the heat-treating furnace they should be powdered with dried calcined alumina, 400 mesh or finer, to prevent sticking. The normal safety precautions for working in a reducing (hydrogen) atmosphere must be observed.

Iron-silicon alloys fall into two groups, the oriented and nonoriented material. The former material is annealed at 1,350 to 1,400 F since higher temperatures result in breakdown of the preferred orientation. The preferred orientation and enlarged grain size already exist in the material by virtue of a mill anneal after cold rolling. The nonoriented material is usually annealed at 1,850 F. The usual holding time is two to four hours.

The annealing of the iron-nickel alloys to develop their full permeability properties must be closely controlled. They must be annealed in a sealed retort in the presence of dried electrolytic hydrogen (dew point, —60 F at 2,000 F for times of saturation plus two-four hours). The cooling rate must not exceed 100 F per hour to 1,100 F; below that temperature the cooling rate is not important. The parts must be loaded with care to prevent distortion since any cold adjustment of the distortion after annealing will immediately impair the desired magnetic properties.

In many instances simultaneous electrostatic and

Table I — Nonmagnetic Metals for Electrostatic Shielding

Metal	Relative Conductivity	Minimum Thickness (mils)
Aluminum	0.61	13
Brass	0.25	20
Copper	1.00	10
Zinc	0.29	18.5

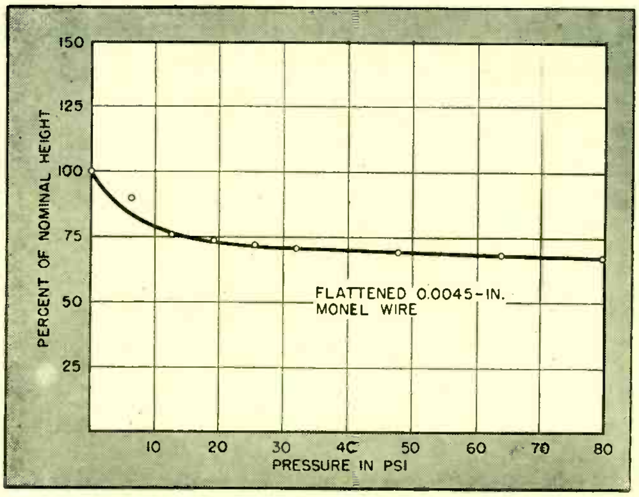

FIG. 4—Deflection characteristics of wire-mesh gaskets (Metal Textile Corp.)

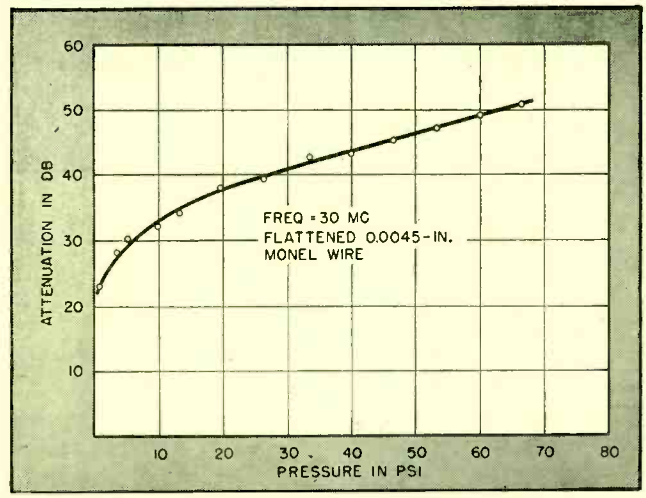

FIG. 5—Shielding properties of metal gaskets are improved by compression

electromagnetic shielding is desired. A common installation is a trilayer construction with the electromagnetic material as the top and bottom surfaces.

The proper material to use is a function of the protection needed. An efficient material is the 80 percent nickel-iron type alloys. There are instances, however, where even ingot iron will give adequate protection from magnetic fields. Should nickel become scarce, many shielding devices using alloys of high nickel content, especially those in commercial equipment such as color tv might substitute a trilayer construction of grain-oriented silicon-iron.

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(3) "Metals Handbook", ASM, 1948.

Potting, Embedding and Encapsulating

SEALING MATERIALS may be used for encapsulating, embedding or potting. Encapsulating involves coating the part by dipping or brushing. Embedding means creating a self-supporting structure of the part and its resin jacket, while potting entails placing the part in a shield can or other enclosure.

Bituminous compounds are used to obtain high efficiency from power transformers and chokes by providing good heat transfer from the windings.

Bituminous compounds for potting have low stain and a high softening point—265-275 F. The compounds should also have low viscosity at a convenient pouring temperature—about 425 F.

One of the first compounds for potting components such as audio transformers and tuned circuits was beeswax. The part was wrapped in kraft paper to prevent shorting to the case and molten beeswax poured in. Microcrystalline waxes produced in petroleum refining have been found an economical and adequate substitute for beeswax and are more widely used today. Microcrystalline wax can be poured at 133 F.

thermosetting resins

Polyester resins are unsaturated alkyds combined with a reactive monomer such as styrene or diallyl phthalate. They can be solidified by use of an organic peroxide catalyst with or without heat. When the catalyst is added the reaction proceeds slowly at room temperature but after a period called the tank or pot life solidification or gelation occurs. The process then continues more rapidly and with the evolution of heat until the plastic is fully cured. During curing the resin shrinks 7-10 percent. Ordinarily polyester resins are cured at 225-250 F to reduce cure time. Production cycles vary with the type of resin, proportion of catalyst and temperature but cycles for potting and embedding electronic components can be in the order of minutes.

Epoxy type polymers solidify upon addition of a curing agent and, in most cases, application of heat. Pot life of 4 to 6 hours is not uncommon. The curing temperature varies widely but some epoxies can be cured by temperatures of about 150 F in a few hours. Some curing agents used with epoxy resins are toxic and the precautions suggested by the manufacturer should be followed. Shrinkage can be as low as 2 percent before gelation and 2 percent after. Shrinkage of both epoxy and polyester resins can be reduced by adding filler material such as glass fibers, asbestos, silica or alumina.

techniques

Embedments are made by pouring the resin into removable shells. Mold materials and release agents often

Table II—Mechanical and Electrical Properties of Typical Sealing Compounds

	Microcrystalline Wax	Bituminous Compound	Polyester Resin	Epoxy Resin
Specific Gravity	--	1.45-1.55	1.22	1.19
Hardness (Barcol impressor)	--	15-22	45-50	36
Tensile Strength (psi)	--	--	7,000-8,000	8,000
Compressive Strength (psi)	--	--	21,000-23,000	18,400
Notched Izod Impact Strength (ft-lb /in.)	--	--	0.17	0.36
Heat Distortion Point (264 psi)	135 F (melts)	245-300 F (softens)	190 F	189 F
Linear Coefficient of Thermal Expansion per deg C	--	--	$7.2\text{-}9 \times 10^{-5}$	6.7×10^{-5}
Dielectric Strength (v/mil; ⅛-in. thickness)	--	--	480	400-500
Dielectric Constant				
at 1 kc	2.3	2.66	3.15	3.8
at 10 mc	2.3	2.57	3.03	3.8
Loss Factor				
at 1 kc	0.0006	0.0035	0.011	0.0023
at 10 mc	0.0004	0.0010	0.054	0.019
Arc Resistance (seconds)	--	--	125	240
D-C Volume Resistivity (ohm-cm)	--	--	3.3×10^{8}	8.7×10^{14}

must be selected with care. Both metal and plastic molds are used—plastics used include Teflon and polyethylene. Release agents used include carnauba wax, cellulose acetate and silicone greases. However, some resins may react with certain release agents or the use of some agents may create problems if the embedment is subsequently to be painted. The advice of the manufacturer of the resin should be sought.

When parts are encapsulated, curing is sometimes done in ovens or under banks of infrared lamps. In pouring embedments or in potting it is important that no air bubbles be trapped. This can be avoided by careful pouring which includes tilting the mold. In some cases a centrifuge may be employed. Some mechanical and electrical properties of representative sealing compounds from each of the four groups discussed are given in Table II.

steps in sealing

Steps to be followed in potting, encapsulating and embedding may now be summarized.

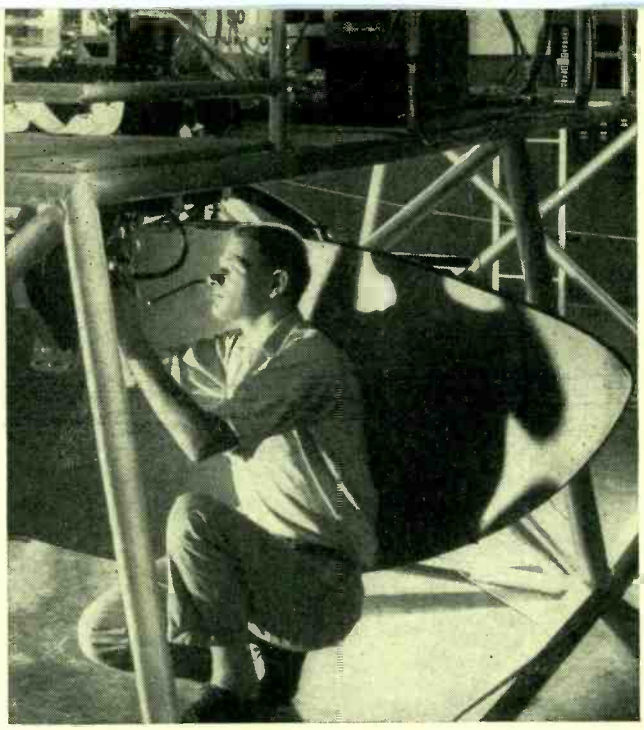
(1) Select the proper compound and determine if a filler is needed. Fillers and plasticizers may be used if shrinkage is a factor. Fillers may also be used for coloring, varying the coefficient of expansion, improving high frequency characteristics, changing viscosity and improving low-temperature operation.

(2) Where two or more ingredients are used, measure carefully the portions. The ratio of hardener or catalyst to resin is particularly important.

(3) Make sure that the coils, transformers or other components are free from moisture by preheating them; keep moisture from resin compounds.

(4) Do not use air-drying varnishes except for surface impregnation. Use internal curing varnishes for impregnation only, not for hermetic sealing.

(5) Check the adhesion of the resin to be used to the metals of which the leads, bushings and shield cans are made. Where leads are to be brought out of the assembly, it is often best to use bare metal. Some resins may react with copper or other metals and care also must be exercised to prevent this type of corrosion.



Kinematic systems used in field of electronics range from antenna drive system of giant airborne radar equipment (left) to tiny computer elements (right) used in ground-position indicator

Moving Parts...

By ELLIOTT GUTTMAN
W. L. Maxson Corp., New York, N. Y.

Input and output systems of electronic equipment almost invariably involve moving parts. Mechanical design of such systems is particularly important in radar, computers and automatic control devices

BASICALLY there are two modes of motion, rotation and translation. The former of these is in much more widespread use, possibly due to the comparative ease in containing the motion. Included in the field of pure rotary parts are pulleys, gears, bearings and universal joints, while there are but a few cases of pure translational movement.

shafting and remote control

Probably the most commonly used component in the field of moving parts is the shaft. It is used in practically all cases of rotation and in many instances involving translation. Basically, there are two types of shafting, rigid and flexible. The former of these is used quite extensively, especially the round shaft, which is a component so common that it is often taken for granted. There are many shapes of shafts, but costs (especially those of mating parts) dictate the use of the round shaft. Fabrication is relatively simple since stock is available in all standard sizes and simple turning can usually result in any desired shape. In using solid round shafting, the basic design problems are tolerances and materials. Tolerances are usually determined by the shaft supports or by the components that mount on the shaft. All grades of shafting are commercially available, even accurately ground stock, so that final determination can be made on the function versus cost basis.

rigid shafting

Nonround shafts are being used more and more, especially in cases where the elimination of keys, set screws etc is desired. However, it should be pointed out that this design is usually more costly unless

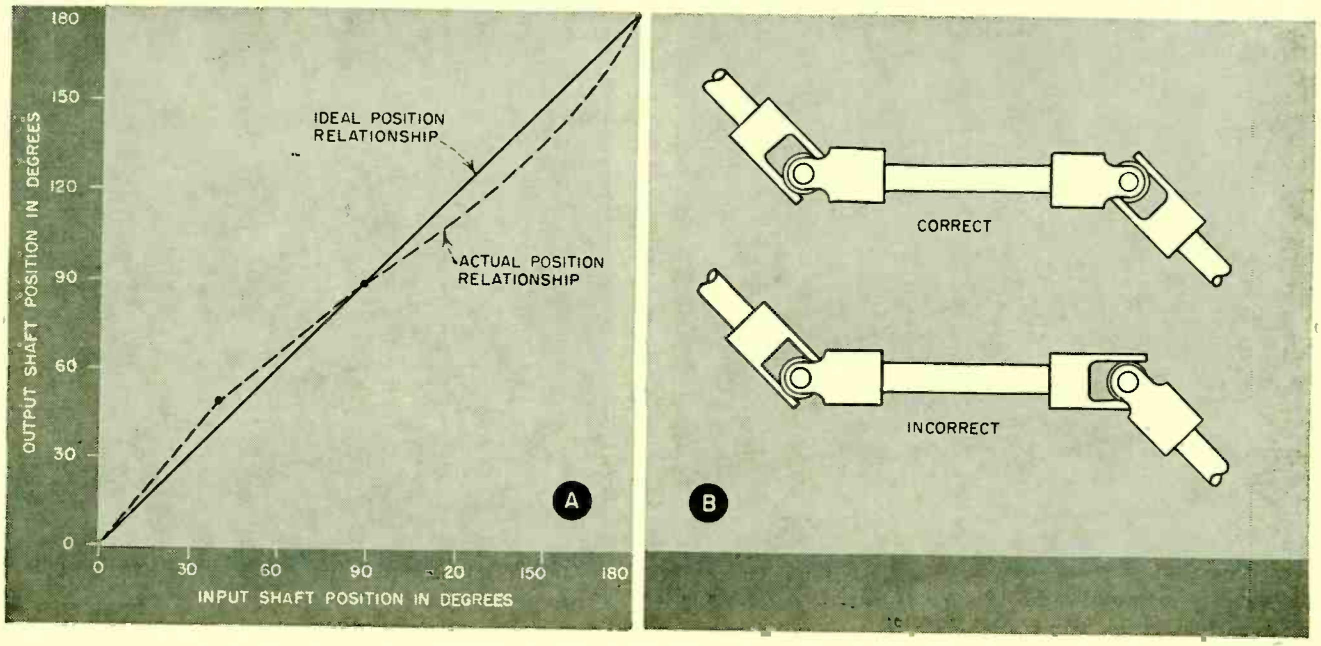


FIG. 1—Universal joint joining two shafts. Typical curve for input-out put shaft position (A) and method of positioning shafts (B)

stamped parts are used extensively in mounting components on the shaft.

Of course, in the precision field there may be many cases where a nonround shaft is the answer to the design problem, especially where positioning is important.

Round shafting is also used for transmitting translational movement. Actually any solid link could work equally as well, but designers have used the round rod since round bearings are readily available and it is easy to turn or drill mating parts. However, in cases where stampings can be used and no turning of the shaft is desired, a nonround shaft is used. Actually, in cases where stamping is either not available or not desired, keys on a round shaft solve both the support and rotational problems quite well.

Another variation is that of the hollow shaft, which is designed to meet the same basic demands to which the solid shaft is subject. It can be used in cases where weight is of extreme importance or where the space inside of the shaft is needed for a fluid, wiring or even another shaft. This design, being used in mechanisms where compactness is the key to the design, necessitates care in insuring proper supports for each shaft.

flexible shafting

In contrast to rigid shafting, flexible shafting is used extensively for transmitting both rotational and translational movements. Flexible shafts can be used to take up misalignment between shafts, to allow for relative movement between parts, or to connect two shafts without using gearing. In precision designs, care must be taken since there is some inherent backlash in using a flexible shaft for transmitting rotation. Most manufacturers' catalogs are fairly complete and should be consulted in reference to the dos and don'ts of flexible shafting. For the best results, it is usually better to contain the shaft within a sheath, protecting the moving member and giving greater support in general.

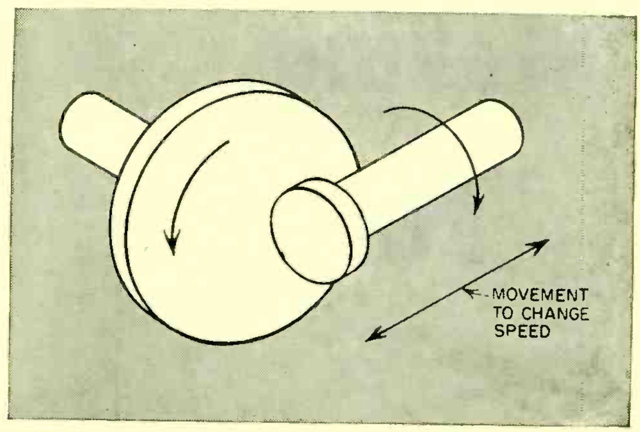


FIG. 2—Disk and wheel friction drive mechanism

supports and bearings

When considering shafting, it follows that supports and bearings are topics that are closely allied. Actually there are many types of bearings whose use are dictated by the precision versus the cost criterion. The simplest support is a hole in the mating piece that is large enough to contain the shaft. Of course precision is poor, cost is little and the friction is high if the piece be made from common materials.

The next refinement is to bore the hole accurately and to keep closer tolerances on the shaft. This approach results in a lapped hole and a finely polished shaft that afford good precision, moderately high costs and a moderate amount of friction.

Another approach is the use of a bearing material that is usually either a soft, ductile material or a harder material that is self-lubricating.

For cases where both precision and friction are the important factors, there is the ball bearing with all of its many extensions. Sizes of ball bearings are quite varied and there are several different grades of precision that are available.

small bearings

At this point it would be well to make mention of the subminiature and inch bearings, a field that has sprung up in recent years. There are commercially available small, precise, radial ball bearings with o.d.'s as small as 0.0100 in. and bores as small as 0.0197 in. Pivot bearings are available with o.d.'s of 0.043 in. and widths of 0.028 in.

Bearings of this type have helped immensely in the field of instrumentation and should be used in the precision field wherever possible. When using bearings with very small bores, it would be well to be careful with the shaft design, since these shafts are extremely delicate and can be damaged by common handling.

Most small bearings have their outer races pressed into the supporting pieces. However, this practice is not too good when loads get high or when bearing sizes get too large. For such cases, the designer should rely on bearing supports or pillow blocks that are marketed by the bearing manufacturers. These supports are especially designed to take the larger torques prevalent between the outer races and the housings. The designer, of course, can design his own housing if the problem warrants it. However, he must be careful not to rely on press fits when this torque gets too high.

Another consideration in bearing design is that of maintenance. To obtain satisfactory operation, the bearing must be kept free from dirt and properly lubricated. Sealed and shielded bearings are available to take care of this problem, but when an open bearing is used, the design must contain provisions for keeping the bearing clean and properly lubricated. The latter problem is especially difficult if the bearing will be operated at elevated temperatures.

A device that should be considered with shafting and supports is the universal joint. In the use of this component, care must be taken in the design, since the relative position of the input shaft with regard to the output shaft is not fixed. See Fig. 1A.

This is an important consideration in the design of a precision positioning device such as a servo gear train. However, a universal joint is an excellent device for transmitting rotation between two nonparallel shafts and if position is desired, the designer should use two joints, having them properly positioned with respect to each other. See Fig. 1B.

belts, chains and friction drives

This category of components has a somewhat limited use in the electronic equipment field, being better suited for power equipment. There are, however, several instances where they have been quite useful.

One particular case is that of controls such as tuning dials, where the transmission of rotary motion is desired, with no regard to slippage and where costs

Table I—Materials Used in Fabricating Gears

	Cast Iron	Stainless Steel	Heat-Treated Steel	Brass	Aluminum	Nylon	Plastic	Fiber
Strength	Fair	Good	Good	Fair	Fair to Good	Fair	Poor to Good	Poor to Good
Wear	Fair	Fair	Good to Excellent	Fair	Fair	Fair	Fair to Good	Poor to Fair
Machinability	Good	Fair to Good	Fair to Good	Excellent	Good	Good	Poor to Good	Fair to Good
Weight	Heavy	Heavy	Heavy	Heavy	Light	Light	Light to Heavy	Light
Dielectric Strength	Poor	Poor	Poor	Poor	Poor	Good	Fair to Excellent	Good to Excellent
Resistance to Heat	Good	Good	Good	Good	Good	Poor	Poor to Good	Fair to Good
Resilience	Poor	Fair to Good	Fair to Good	Good	Fair	Poor to Fair	Poor to Good	Poor to Good
Corrosion Resistance	Poor	Good	Good	Good to Excellent	Good to Excellent	Good	Poor to Good	Poor

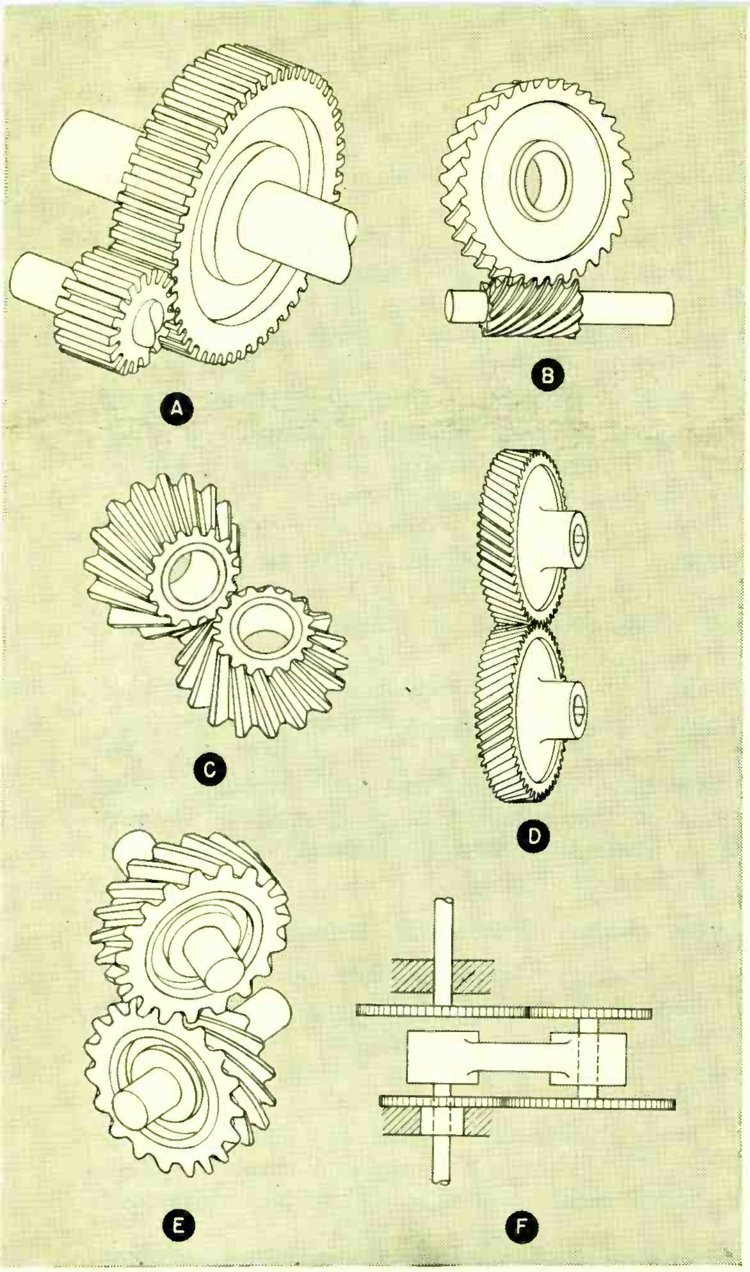


FIG. 3—Types of gears used in electronic equipment: spur (A), worm (B), bevel (C), helical (D) and spiral gears (E). Also shown is planetary or epicyclic gear train

should be kept low. If slippage is not desired, chains and timing belts can be used; however, there is an increase in costs due to more complex belting and sprockets.

Belting is best used in transmitting power from the prime mover, but this is done usually in cases where more than 1/5 horsepower is involved. In these cases a V belt is usually used and again if slippage is not desired, a timing belt or the like can be used.

Chain drives have not been used too extensively since they are somewhat heavy and fairly costly. There are cases however, where the interference of other components presents problems that the use of chains and sprockets can easily solve.

The principle of friction drives has been used to a greater extent. The majority of clutches use this principle to transmit power, since a drive of this type is the easiest to engage and disengage. This article will not attempt to start to mention the many possible designs using a friction type clutch.

A characteristic of the disk and wheel friction drive shown in Fig. 2 is its ability to multiply two inputs together with very simple controls. This feature is often used for mechanical integrators, or simpler still, a reversible, variable speed drive.

gears

Probably one of the most versatile items in the field of moving parts is the gear. The primary purpose of the gear train is to transmit power or position from one shaft to another. This can be accomplished with a change in speed, whether or not the shafts are parallel, and without slippage between the driver and the driven members. Gear trains can also combine inputs algebraically by using combinations of mating gears.

There is no limit to the number of materials that can be used for gearing. The major requirements are those of hardness and ability to absorb wear. Gear trains are usually used to transmit relative position.

If the gear train is one designed primarily for positioning, the wear factor is usually small and material consideration is based on material and fabrication costs tempered by the design criteria.

For the transmission of power, the factor of tooth strength becomes important since there is considerable bearing of one gear upon the other with resulting wear and local heating problems. Metals have been widely used for gearing and for the most part have proved very satisfactory. However, in recent years, plastic and other nonmetallic gears have been used in increasing numbers. In many cases, the latter have proved as good, if not better, than the metallic gears.

types

The simplest form of gearing is the spur gear, Fig. 3A. Because of its comparative ease of manufacture and its versatility, it is the most widely used of all of the forms of gearing. Spur gearing is used extensively in small precision devices since the smallest gears are now available in this form.

The form of gearing which is probably the second most widely used is the worm gear and worm wheel illustrated in Fig. 3B. The worm and worm wheel are capable of large reductions in speed with but one stage of gearing. This reduction is done between two nonintersecting shafts that are perpendicular to each other. This form of gearing has the feature of nonreversibility since it is difficult and at times impossible to drive the worm by turning the worm wheel. The effectiveness of this feature depends on the design of the lead angle of the worm gear.

Other forms of gearing include bevel gears, helical gears, spiral gears, differential mechanisms, rack-and-pinion gears and planetary or epicyclic gear trains. Bevel gears, Fig. 3C are used for the transmission of rotation between two intersecting shafts. They have the disadvantages of cantilever type shaft supports, noninterchangeability and difficulty in assembly and disassembly.

Helical gears portrayed in Fig. 3D are used to transmit

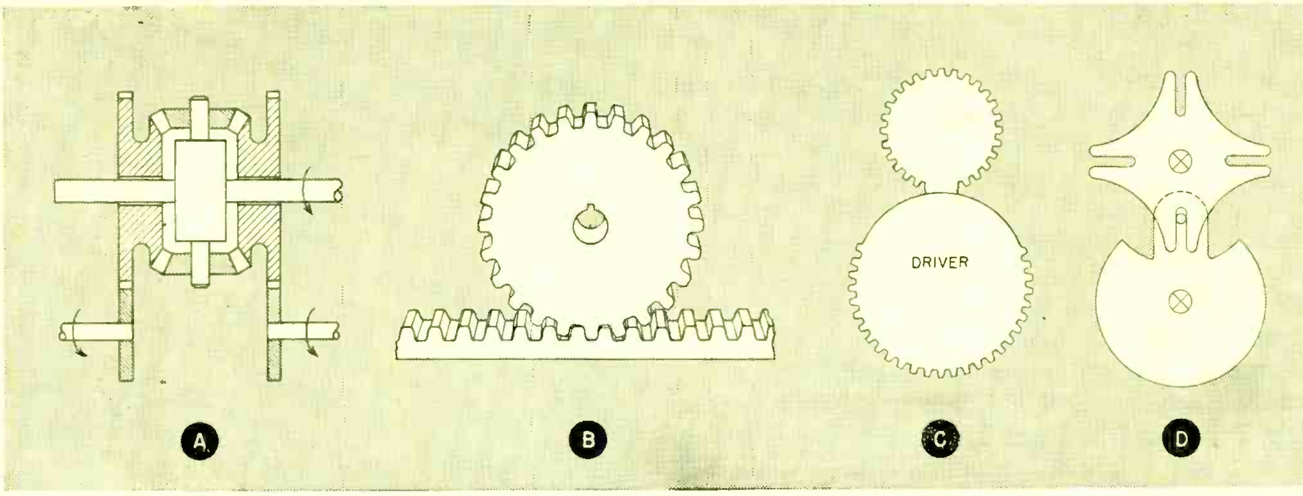


FIG. 4—Special gearing systems: differential gears (A), rack and pinion (B), intermittent gears (C) and Geneva mechanism (D)

heavier loads at higher speeds with quieter operation. They are capable of transmitting rotation between two parallel shafts. Their disadvantage lies in the transmission of axial thrusts to the gear shafts and inherently high fabrication costs.

Spiral gears, Fig. 3E, allow for the transmission of rotation between two nonintersecting, nonparallel shafts. Planetary or epicyclic gear trains shown in Fig. 3F are used for small or large speed changes where the input and output shafts are in line and where no fixed idler shaft is required.

Differential mechanisms, Fig. 4A, are widely used in electronics. They consist of combinations of bevel and spur gears. Actually a differential mechanism is an epicyclic gear train in which the fixed gear is now allowed to move, giving the effect of a double epicyclic train. The purpose of an ordinary differential is the algebraic combination of two inputs.

Rack and pinion gears, Fig. 4B, transform rotational motion to translation and vice versa by the use of gearing. Spur, bevel and helical toothforms can be used for this type of mechanism. The latter has the advantage of being able to vary the angle between the shaft of the pinion and the line of action of the rack.

Another series of components that should be considered in this section are the noncontinuous types such as the intermittent gears and the Geneva mechanism. These components are capable of changing constant speed rotation to intermittent rotation. There are many variations in the design of these devices and Fig. 4C and 4D show typical designs of each of these types. These components have found much use in computer mechanisms and counting devices, but their use is somewhat limited since, unless large quantities are made, the design and fabrication costs are quite high.

toothform

The most important factors in the design of gears are those involving the toothform and include the type of teeth, the pressure angle and the pitch. Some degree of standardization has occurred in recent years, with the result that both the pressure angle and the type of teeth have been more or less tied down.

At the turn of the century, there were many forms of gearing which included conjugate, cycloidal and composite toothforms. However, at present, in electronic devices, the involute toothform is almost the only one used. The major reasons for this evolution of this standard are the inherently superior rolling contact of the teeth, the comparative ease in manufacture and the fact that inaccuracies and wear can occur without seriously damaging gear action.

Of course there are variations of the involute system such as extended addendums or shortened teeth such as those found in stub-tooth systems; however, these

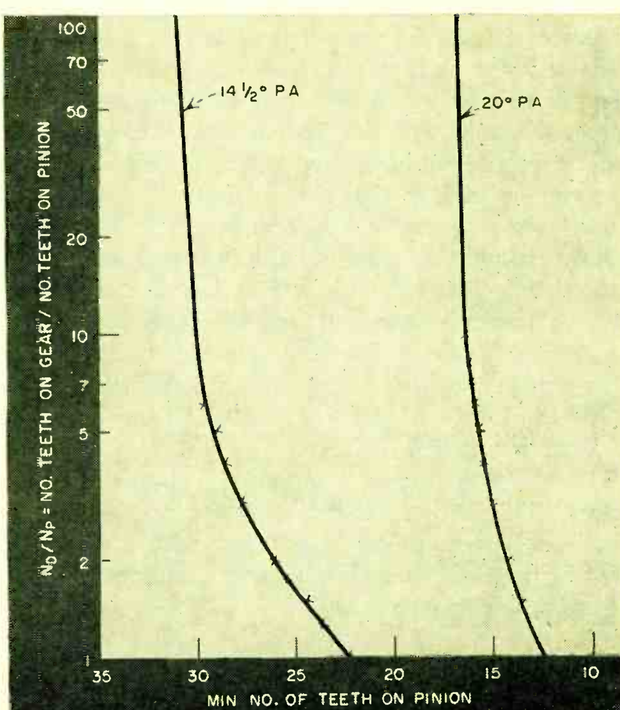


FIG. 5—Interference effects in gears

are used in electronic mechanisms primarily to avoid interference.

Two pressure angles, 14½ and 20 deg, have been used as standards. The former has been widely used and is present in most commercially available stock gears. In recent years, especially in electromechanical devices, the trend has been for smaller parts and naturally smaller gearing. This has caused a demand for gears with a 20-deg pressure angle since a pinion with fewer teeth can be used without fear of interference. See Fig. 5. Another advantage of the 20-deg pressure angle is its greater tooth strength since the increase in the angle of obliquity results in a tooth a little broader at the base. This author feels that we are now in a transition period and that in time, the 20-deg pressure angle will become the only standard.

pitch

The pitch of a gear can be greatly varied. A long time ago when gears and gear teeth were large, the circular pitch was used to specify the pitch. Since the circular pitch is the distance in inches on the pitch circle between corresponding points on adjacent teeth of a gear, it is easily seen that for large gears this number is an integer and for small gears it becomes fractional.

To keep the pitch a whole number, the parameter diametral pitch was evolved, which is the number of teeth on the gear per inch of pitch diameter. Thus a gear with a diametral pitch of 24 and a 2-in. pitch diameter would have 48 teeth. This same gear would have a circular pitch of 0.131 in. Since gears used in electronic mechanisms are usually small, the diametral pitch is primarily used to denote pitch.

For use in instruments, stock gears with diametral pitches of 20, 24, 32 and 48 have been commercially available for some time. In the quest for smaller, more accurate gearing, gears are now being stocked with diametral pitches of 64, 72 and 96. Although not stocked, gears have been used whose diametral pitches have gone as high as 120, 144 and 200.

The advantages of a high diametral pitch are the obvious reduction in size and the inherent decrease in backlash which is primarily a function of the circular pitch. The disadvantages of large diametral pitches are the increased difficulty in manufacturing and the necessarily weaker tooth. For a gear with a diametral pitch of 200 the height of the tooth is 0.0108 in. while the thickness is only 0.00785 in.

The designer has to compromise between these factors. This author believes that for precision, it is usually not necessary to have a gear with a diametral pitch higher than 96, and only in very rare cases, would it be advisable to exceed 120.

interference

The final problem of gearing is interference. As can be seen in Fig. 5, if the pinion gets too small, interference will occur when the upper part of the addendum of a tooth on the larger gear contacts the addendum of a tooth of the pinion gear. If the designer finds it necessary to work in this interference range, he has several methods of eliminating the trouble. If this problem occurs with gears whose pressure angle is 14½ deg, change to a 20-deg pressure angle. See Fig. 5.

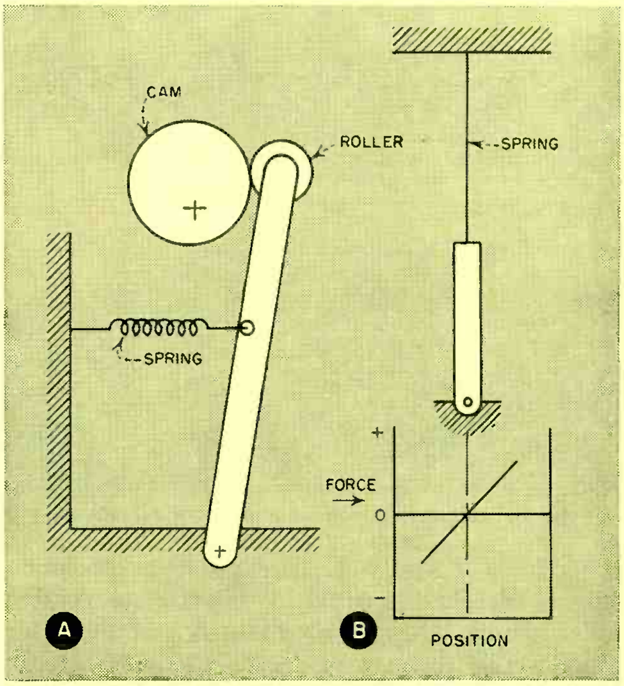


FIG. 6—Use of springs in electronic equipment: to keep roller in contact with cam (A) and as a self-centering device (B)

A second solution would be to relieve the addendums of the teeth on the larger gear, but this is not easily done in a shop. The same results could be obtained by undercutting the dedendum of the pinion gear, but this weakens the strength of the teeth.

Continuing along this approach the designer could use a stub toothform which is a modification of the tooth profile achieved by decreasing the tooth height while leaving the diametral pitch and the number of teeth on the gear unchanged. Another solution is the modification of the toothform by increasing the addendum and decreasing the dedendum of the pinion while decreasing the addendum and increasing the dedendum of the larger gear. The effect of this is to make the pinion's teeth stronger and the large gear's teeth weaker. The designer will have to decide which course to follow, basing his decision on the design criteria and the capabilities of the manufacturing plant.

springs

Springs are used extensively throughout electronic equipment, most notably in relays, limit switches, contact arms, vibrators and solenoids. There are two basic design functions for a spring, both of which are used in electromechanical devices. The first, and possibly the more common of the two, is the use of a spring to give return action to a unidirectional device. This can best be shown in a cam mechanism where the spring

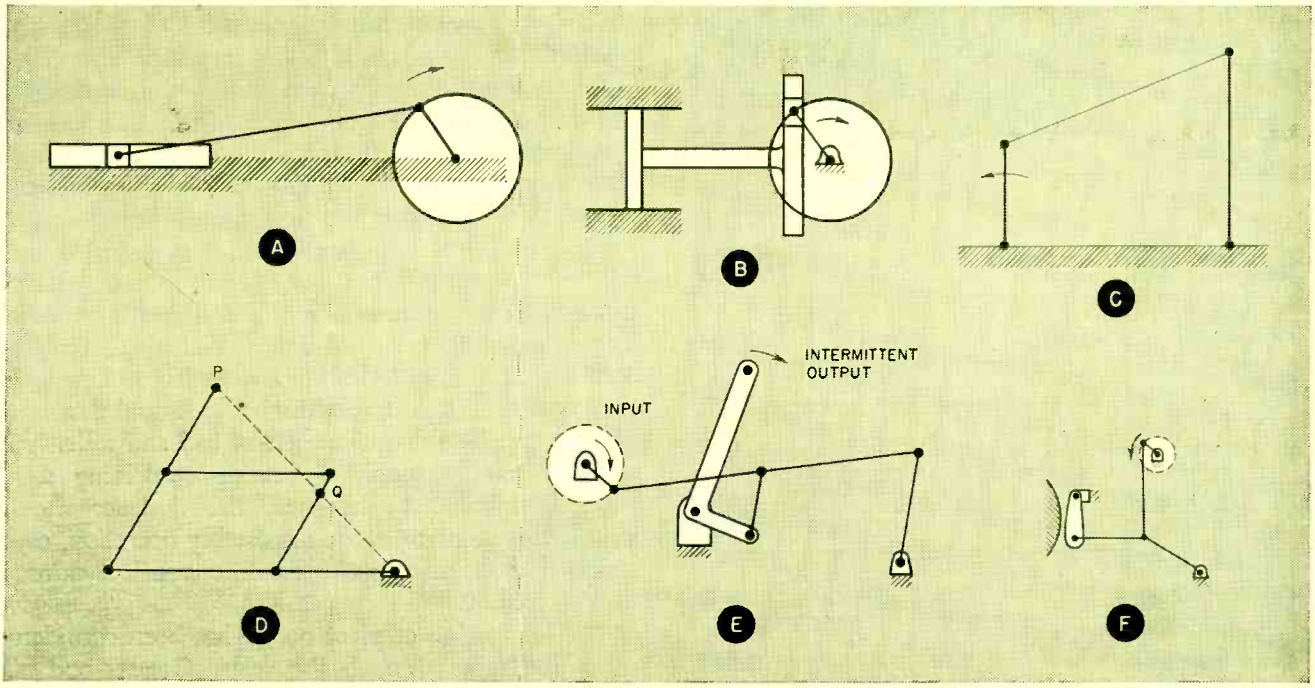


FIG. 7—Various bar linkages: slider-crank mechanism (A), Scotch yoke (B), four-bar linkage (C), pantograph (D), wrapping-paper mechanism (E) and stone-crusher mechanism (F)

keeps the roller in contact with the cam surface as shown in Fig. 6A.

The second basic function of a spring is to provide a displacement that is proportional to the applied force. Secondary features of this function are that with comparative ease, it is possible to have the displacement directly proportional to the applied force and that this displacement can be both positive and negative about a determined mean point. A self-centering device is shown in Fig. 6B demonstrating this basic function.

There are innumerable uses involving both these functions and it would be impractical to attempt to discuss them in this article. Springs have been used in many different forms, among these are helical, leaf, flat, spiral and many more. Several of the larger spring manufacturing companies have available a jointly prepared book concerning the design and use of springs. Included in this book are discussions of the various cross-sections that are available for springs along with all of the formulas necessary to design the spring properly. This book also includes a section on materials. However, a designer may find the data given in Table II useful. If the spring is to experience stresses close to the elastic limit, it would be wise to test a sample of that material to be used to see if it will withstand those stresses for the specified life of the parent device.

cams and bar linkages

One of the most useful components and yet probably the least used in electronic devices in proportion to its capabilities is the cam. Fundamentally, the cam converts reciprocation and rotation to reciprocating motion, multiplying the input by some predetermined factor. Evidently, this type of device can impart innumerable complicated motions to the driven elements. This feature makes a cam quite useful since special mechanical movements can easily be obtained.

The design of cams is not too difficult and all basic machine design and kinematics textbooks are fairly adequate on the subject. The main problem in cam design is to have the driven element capable of following the driving element. This is a function of the design criteria since rapid accelerations and decelerations are difficult to follow, and if the parent device demands this, it would be better to go to linkages to obtain the desired motions.

Most cams have to be designed with a spring to enable the follower to have return action. In some cases, the force of gravity is sufficient to do this. Cams can be double-acting using a groove to contain the follower instead of having the follower ride upon the cam surface. This is done to control motions in both directions without the use of a spring.

Another type of mechanism, similar in function to the cam, is the bar linkage. This mechanism has the advantage of supplying positive action at all times, not relying on a spring for return action, and the disadvantage of occupying a larger space for its operation. Its uses are also innumerable since it is possible to achieve many different kinds of motion using rotating or reciprocating inputs. Several different types of linkages will be illustrated in this article to illustrate a few of the many possibilities. Figure 7A shows a simple slider-crank mechanism where rotary motion is converted into reciprocation. The Scotch-yoke, shown in Fig. 7B, converts rotary motion into simple harmonic reciprocation. Figure 7C is an example of a 4-bar chain where rotation is converted to rotary motion modified by a

Table II—Spring Materials				
Material	Young's Elasticity ($\times 10^{-6}$)	Shear Elasticity ($\times 10^{-6}$)	Rockwell Hardness	Elastic Limit (psi)
Spring Brass	15.0	5.0	B91	80,000
Nickel Silver	16.0	5.5	B96	100,000
Phosphor Bronze	15.0	6.0	B100	100,000
Monel	26.0	9.5	C28	100,000
Chrome Vanadium Steel	30.0	11.2	C47	140,000
Beryllium Copper	19.0	6.2	C38	150,000
Type 17-7 Stainless Steel	29.5	11.0	C42	160,000
Music Wire	30.0	12.0	C44	160,000
SAE 1095 Steel	30.0	...	C46	185,000
Type 302 Stainless Steel	26.5	10.0	C45	190,000
Type 304 Stainless Steel	26.5	10.0	C45	190,000
Type 420 Stainless Steel	29.0	11.0	C48	230,000

predetermined function. Figure 7D, 7E and 7F show various mechanisms that can be obtained from bar linkages.

lubrication

The subject of moving parts cannot be completely covered without some discussion of friction and lubrication. In general, there are four conditions that prevail between surfaces moving relative to each other. These are dry surfaces, greasy surfaces, thin-film lubrication and thick-film lubrication.

The condition of dry surfaces is usually avoided since the coefficient of friction is high resulting in extra expended energy that eventually is turned into heat at the rubbing surfaces. The first refinement is the condition of greasy surfaces that still have metal-to-metal contact, but give a much lower coefficient of friction.

The next refinement is the condition of thin-film lubrication that provides a film of lubricant between the moving surfaces at all times that there is relative motion. This condition and that of greasy surfaces cover the vast majority of lubrication examples.

The final condition of thick-film lubrication covers the few cases where the parts are always separated by the lubricant. It is used for cases where the function need be very low. The most notable example of its use is the mounting of the Mount Palomar telescope where a 1/12-horsepower motor is all that is required to turn the giant unit weighing over 500 tons. The coefficient of friction for this installation is 0.000004.

lubrication points

The main points of lubrication in moving parts are in bearings and pivot points. In the former cases, the self-lubricating bearings usually take care of themselves. Regular sleeve bearings, although not used extensively in electronics, are usually cases of thin-film lubrication, requiring a pump to supply fluid to the acting surfaces.

Ball and roller type bearings should be packed with some sort of grease or oil to give a condition between greasy surface and thin-film lubrication to their moving parts. The actual coefficient of friction of these antifriction bearings is quite low and should not be confused with the condition of lubrication that is intended. Too often a designer will forget that these bearings need some form of lubrication and neglect the grease in their designs. This can result in hot spots and shortened bearing life. The manufacturers of ball and roller type bearings usually supply a bearing containing some form of lubrication; however, the designer should stretch this point to insure satisfactory operation, especially under severe operating conditions such as extreme heat or cold.

The lubrication of pivot points has been considered more and more through the years. Greases and oils have been used with the difficulties of maintaining the lubrication at the critical areas.

More recently, oils containing graphite have been used. In these, the graphite is deposited on the working surfaces, giving the effect of greasy friction as found in a bearing material.

Another innovation in recent years is the use of silicone oils as a lubricant. These oils have proven quite versatile since they can withstand large pressures and operate through a wide temperature range. Another interesting use of high viscosity silicone oil is on instrument pivot points where flutter and transients are filtered out while slower movements are transmitted through the junction.

conclusion

This article has been prepared to give the electronic designer a summary of the various components used in the field of moving parts. It is also meant to provide the electrical engineer a better insight into the design problems that the man on the board faces, enabling the engineer to work more closely with the designer during the basic concept phase of the design. At best, this article is a summary and for more precise information the designer or engineer will have to resort to a library or to the various manufacturers in the particular field of interest.

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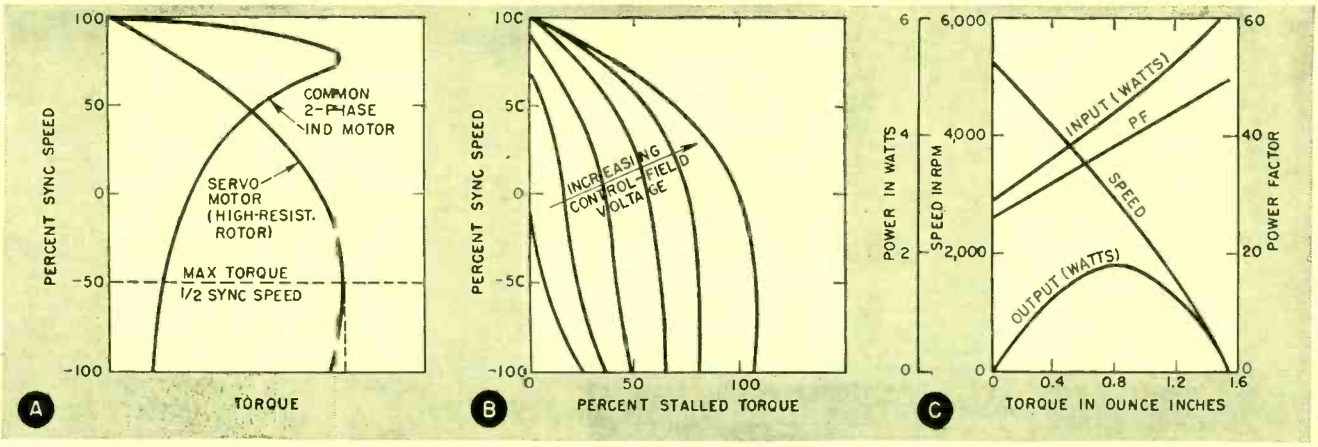

FIG. 1—Servo motor characteristics. Speed-torque curves illustrate effects of rotor resistance (A) and control field voltage (B); (C) shows typical motor performance

Power Devices

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Electronic control instrumentation requires use of motors and associated devices such as clutches, brakes and damps. Several of these are discussed and selection criteria given

Inspecting instrument-motor chassis. This device forms part of a supervisory control system by which heavy equipment such as oil-refinery pumps can be regulated by signals from a central location

One of the popular motors for control application is the two-phase induction servo motor.

The servo motor is normally operated on unbalanced terminal voltage. One phase, called the main field, is excited by constant voltage while the other, called the control field, is excited from a variable source such as a high-gain amplifier. The control field may be varied from rated value of one polarity through zero to rated value of the opposite polarity. Thus the command signal can control speed, torque and direction of rotation.

Performance requirements are: high torque at speeds near zero; negative slope of the speed-torque characteristic around zero speed; and, when the command signal is reduced to zero, the servo motor should not run as a single-phase motor. These are met by a high-resistance rotor designed so that maximum torque is developed at a reverse speed of approximately one-half synchronous speed. Figure 1A shows the effect of rotor-resistance on the speed-torque characteristic.

parameters

An important figure of merit for the two-phase induction motor is the ratio of stalled torque to rotor

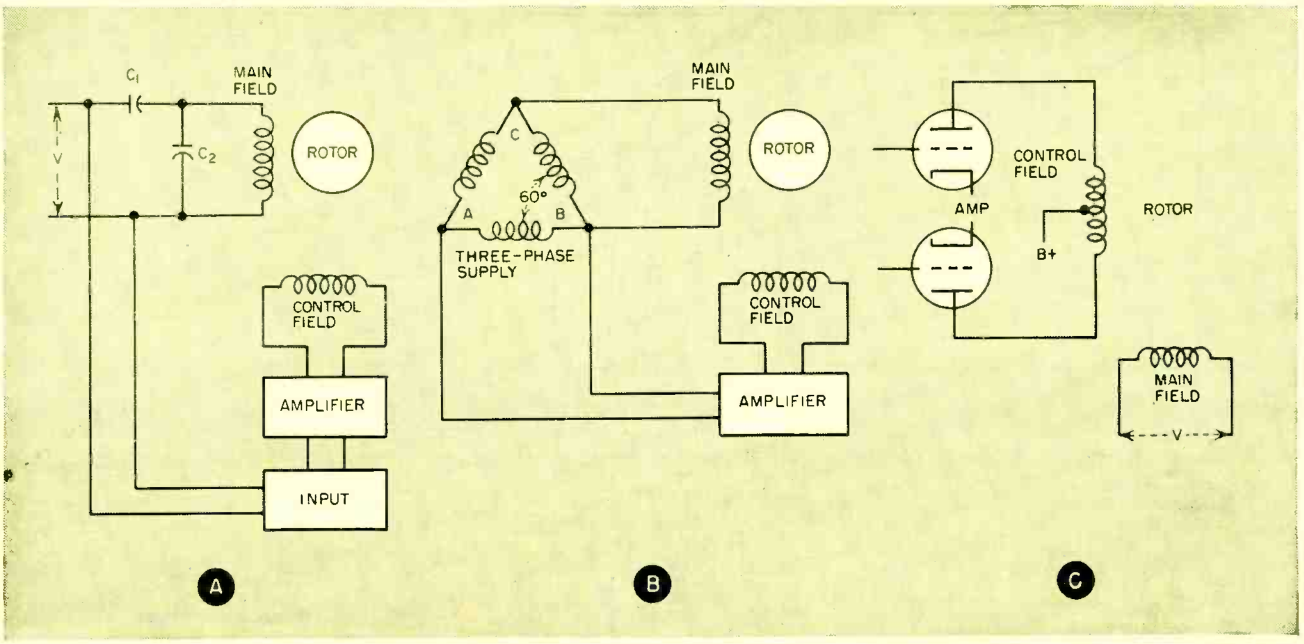

FIG. 2—Servo motor connections. Phase shift may be obtained with capacitors (A) or by using two phases of three-phase supply (B). Split-field motors are available for plate-to-plate operation (C)

inertia. To achieve low inertia a small diameter rotor is necessary. The highest torque-to-inertia ratios are obtained for minimum diameter rotors. The simplicity of a die-cast squirrel-cage rotor lends itself to small diameter design.

The negative slope of the speed-torque characteristic contributes to the stability of a servo. As seen from Fig. 1A, as the speed increases the torque decreases almost proportionally. This internal motor damping is referred to as the viscous motor friction. The magnitude is equal to the reciprocal of the speed-torque curve. Figure 1B shows a family of speed-torque curves for various values of control-field voltage. In the region of low control-field voltage viscous friction is about half that obtained in the high-voltage region. Typical motor performance is illustrated in Fig. 1C.

The capability of a motor to respond to rapidly varying inputs is determined by its time constant expressed as the ratio of rotor inertia to viscous motor friction. This time constant is important in closed-loop stability.

Maximum starting voltage is a measure of the static friction of the motor. In a positioned servomechanism, a sufficient break-away voltage must be developed to overcome static friction. Static friction includes bearing friction and slot effect. Slot effect is caused by varying reluctance torque with rotor position due to magnetic nonuniformity of the slot openings.

In critical applications, slot effect can be eliminated using a drag cup-type rotor if the accompanying decrease in torque can be tolerated.

With rated voltage on the main field, starting voltage is the minimum control-field voltage necessary to cause the motor to rotate

Starting Torque = (Control Field Starting Voltage/Control Field Rated Voltage) × Stalled Torque

The determining limitation is the maximum operating temperature the motor can withstand. This includes the temperature rise within the motor plus the ambient temperature. The temperature rise depends on the heat conduction of the mounting, radiation of the exterior finish, type of cooling and average power input.

Proper mounting on a metal surface can reduce the temperature rise approximately 50 percent. If radiation is the main source of heat dissipation, a motor with a brightly polished finish may run 10 C hotter than one with a dull black finish. Cooling with fans can increase the power rating 2 or 3 times.

applications

The temperature rise above ambient is directly proportional to the average power input. If the temperature rise for a given power input and mounting is known, the temperature rise for a new power input is

Temp Rise = Average Power Input × (Known Temp Rise/Known Power Input)

Table I is a guide to maximum operating temperature obtainable with various classes of insulation. The range of class A insulation can be extended by potting motor windings instead of using varnish impregnation. The potting material is a thermosetting resin which adds to the individual wire insulation and helps dissipate heat.

Voltages impressed on a two-phase motor should be 90 deg out of time phase. The main field voltage may be shifted 90 deg from the command signal by a series capacitor. The quadrature voltage that will appear across the motor terminals will be Q times the line voltage. It is, therefore, necessary to reduce the Q of the motor to unity by inserting a shunt capacitor

C_2 (Fig. 2A) across the motor and readjusting C_1 for 90-deg phase shift.

Where three-phase voltage is available, any two of the three phases may be used for two-phase excitation with a 15-percent reduction in torque (Fig. 2B).

advantages and disadvantages

The two-phase induction servo motor has no brushes to require inspection and replacement. Quiet operation is characteristic. A high torque-to-inertia ratio is possible and low starting torques can be obtained with drag cut-type rotors.

The principle disadvantage is the inherent inefficiency of a squirrel-cage motor running at a high slip (low speed). The efficiency is lowered further by operating with unbalanced voltages. The standby condition, main field constantly excited with rated voltage, increases the heating problem.

The conventional polyphase motor, of which the two-phase motor is a type, develops a smooth nonpulsating torque and is essentially a constant speed motor. It finds use for driving such things as gyro wheels and blowers. The running speed is less than the synchronous speed, Speed = 120 f/p.

As seen from a typical speed-torque curve, Fig. 1A, stable operation takes place where the slope is negative. Although speed is proportional to frequency, some blower motors will run at constant speed over range of input frequencies from 400-2,000 cycles.

The starting performance of a squirrel-cage induction motor is characterized by low torque and high starting current. Wound-rotor motors with slip rings are used where frequent heavy starting with low current is required. As can be seen from Fig. 1A, as rotor resistance is increased the starting torque can be increased. However, this is not common for small sizes and requires an external controller.

The advantage of the squirrel-cage polyphase induction motor is its reliability, simplicity, absence of commutator sparking and economy. The disadvantages are difficulty in obtaining polyphase power, poor speed control, low starting torque and high starting current.

Single-phase motors are more numerous than any other factional horsepower motor because usually only

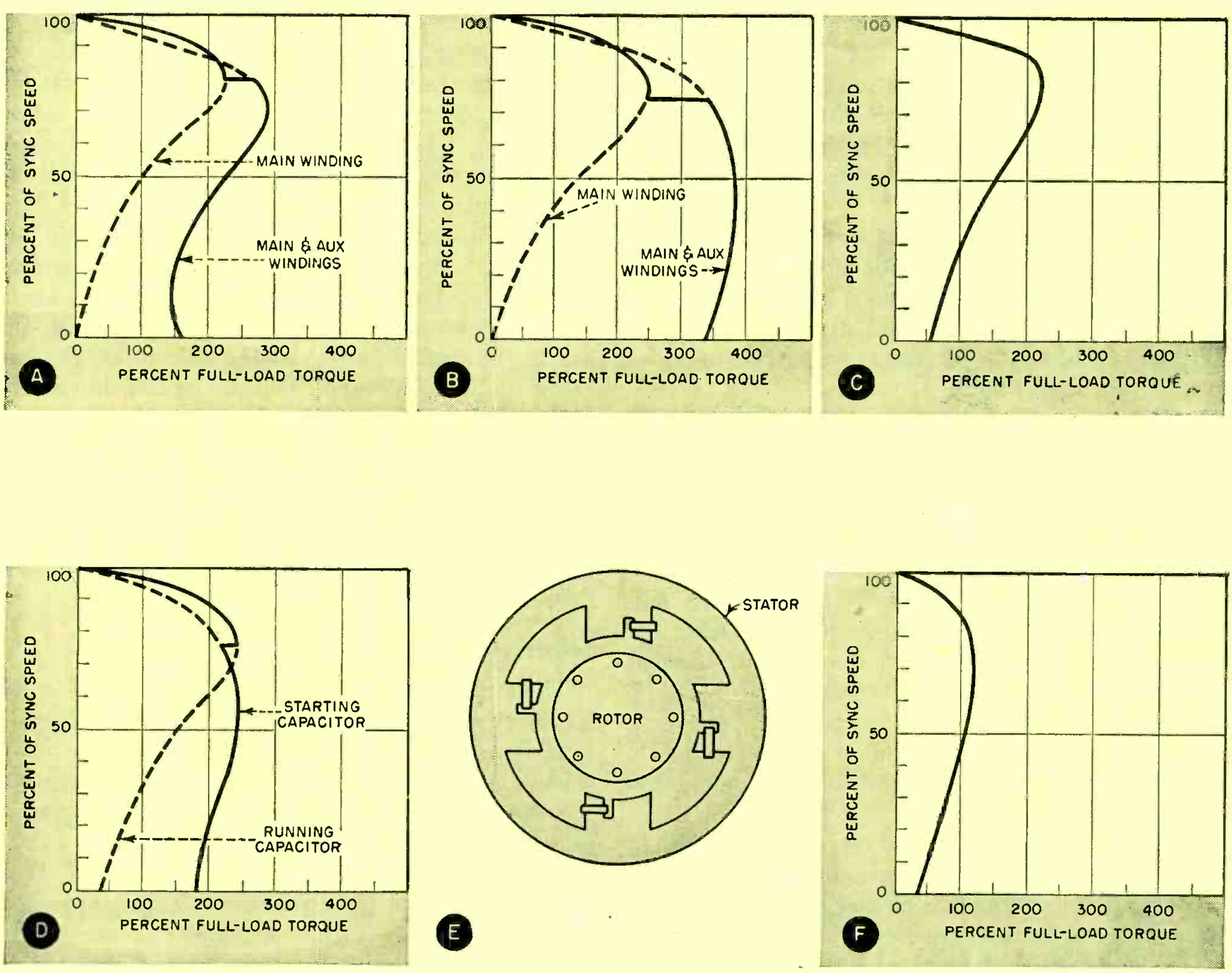

FIG. 3—Single-phase motor characteristics. Curves illustrate split phase (A), capacitor start (B), permanent split (C) and capacitor start-capacitor run (D) motors. Configuration and characteristics of shaded-pole machine are given in (E) and (F)

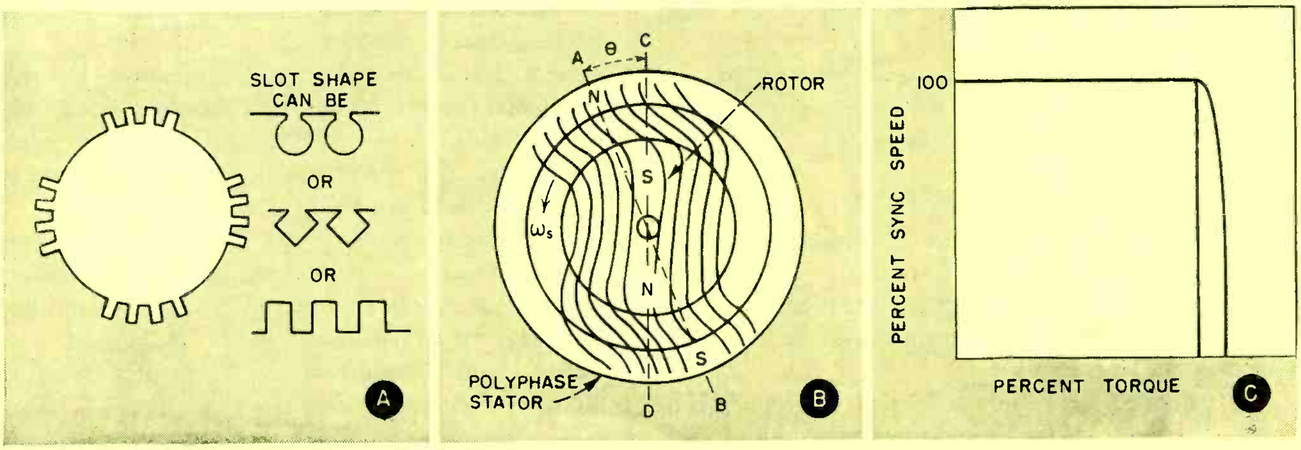

FIG. 4—Rotor lamination of four-pole reluctance motor (A), magnetic field (B) and speed-torque curve (C) of hysteresis motor

single-phase power is available. The single-phase induction motor is probably most common.

single-phase motors

The outstanding problem of a pure single-phase motor is that it is not self-starting. Single-phase induction motors are usually referred to by names descriptive of starting methods.

To produce a rotating field, a starting winding in the stator is necessary. The axis of the starting winding must be displaced from the main winding and the current in it must be out of phase with the current in the main winding.

The single-phase motor is characterized by relatively poor efficiency, low power factor, noisy operation and poor reversibility characteristics. A single-phase motor must be brought to rest before it can be reversed. Reversal is achieved by reversing connections to either main or auxiliary winding.

motor types

Split-phase motors have the auxiliary winding displaced 90 deg. The auxiliary winding has a higher resistance-to-reactance ratio than the main winding so that the two currents are out of phase. This is equivalent to an unbalanced two-phase motor, and the rotating field causes the motor to start. After the motor starts, the auxiliary winding is disconnected by a centrifugal switch that operates at about 75-percent sync speed.

Connection of a split-phase motor for plate-to-plate operation is given in Fig. 2C while operating characteristics are shown in Fig. 3A.

The capacitor start-induction run type is also a split-phase motor, but the time-phase displacement between the two currents is obtained by a capacitor in series with the auxiliary winding. The auxiliary winding is disconnected after the motor has started. The outstanding feature is high starting torque. Its performance data are given by Fig. 3B.

In the permanent split or capacitor motor the auxiliary winding of a capacitor-start motor is not cut out and the motor operates essentially as a two-phase motor. The power factor and efficiency are improved and the reduction in torque pulsations makes the motor quiet. Starting torque is sacrificed as the capacitance is a compromise between the best running and starting values. Figure 3C shows operating characteristics.

Capacitor start—capacitor run motors (Fig. 3D) use two capacitors. The permanent capacitor is the best for running. The shunt capacitor for best starting is cut out by a switching device after the motor is started.

The shaded-pole method is essentially a split-phase method with power supplied to the auxiliary winding inductively. A shading coil, made of a heavy copper loop, is placed about a portion of each of the salient poles as shown in Fig. 3E. Induced currents cause the flux in the shaded portion of the pole to lag the flux in the unshaded portion. This produces a shift of the field axis across the pole face that acts like a rotating field. See Fig. 3F for performance data. Starting torque is very low. Because of poor efficiency this motor is used for small fans and for starting clock motors. Bidirectional control may be achieved by using two shading coils on each pole and remotely shorting the desired coil.

reluctance motor

The squirrel-cage induction motor can be converted into a self-starting synchronous motor of the reluctance type by salient pole effect in the rotor. This is achieved by removing some of the teeth from the rotor and leaving the remaining bars and end rings intact. Figure 4A shows a lamination of such a rotor for use with a four-pole stator. The motor starts as an induction motor and accelerates to a speed approaching synchronous. If the reluctance torque is sufficiently large to bring the rotor from slip speed to synchronous speed, the rotor will lock in with the rotating field and run as a synchronous motor. If

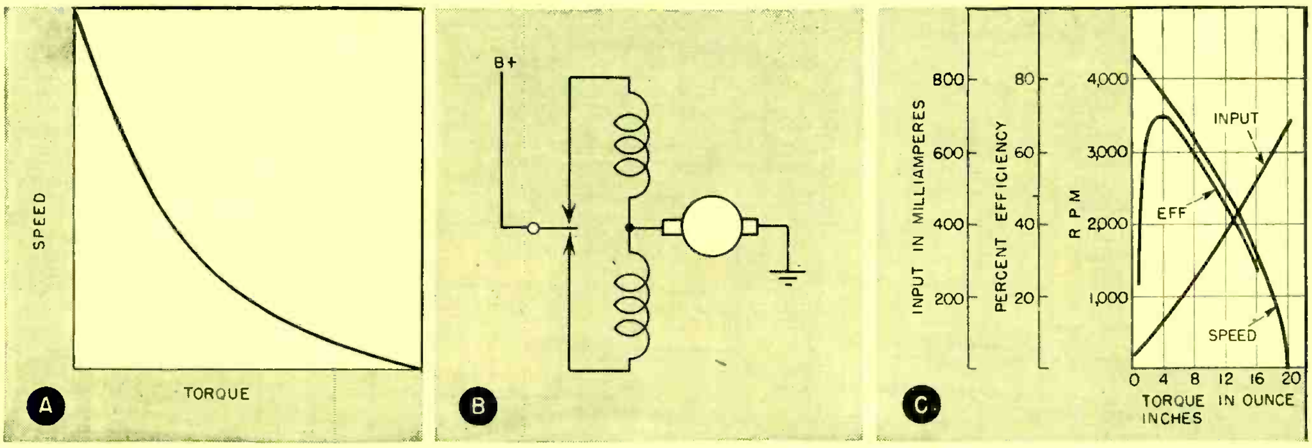

FIG. 5—Direct-current machines. Speed-torque curve of series motor (A), method for reversing rotation (B), and typical d-c motor performance (C)

the inertia of the rotor and its load is too high to be pulled in, the motor can run only as an induction motor. To operate synchronously, a given size reluctance motor must have ⅓ the output of an induction motor.

The main disadvantage of the reluctance motor is that its pull-in characteristics limit its application to light loads. In clock motors, this is overcome by manually spinning the rotor above sync speed. As the rotor coasts down, it pulls into step and continues to rotate.

Another disadvantage is the high starting torque and hunting characteristic inherent in all salient pole synchronous motors.

hysteresis motor

A relatively new type small synchronous motor is the hysteresis motor. It utilizes magnetic hysteresis to produce torque.

The rotor is a simple, smooth, nonsalient ring of permanent magnet material. The stator has a polyphase or permanent-split capacitor-type winding. The magnetic field produced by the stator winding induces magnetic poles of opposite polarity in the rotor. As the rotating stator field slips past the rotor, the rotor tends to retain its polarity of magnetization. Figure 4B shows magnetization in the hysteresis motor. The axis of the magnetic field produced by the stator is along line *A-B* while the rotor axis of magnetization lags behind by the angle ϑ and is along line *C-D*. As a result of this lag torque is produced. The torque accelerates the motor until it pulls into synchronism with the rotating stator field. At synchronism the rotor behaves like a permanent magnet rotor locked in with the synchronously rotating field. The speed-torque curve of a hysteresis motor is shown in Fig. 4C.

The constant hysteresis torque will pull into synchronism any load that it is capable of accelerating. Miniature hysteresis motors are widely used to synchronize gyro wheels. Another feature is reduced hunting due to the absence of salient poles.

The advantages of low noise level, continuous nonpulsating synchronizing torque and reduced hunting make the hysteresis motor highly desirable in phonograph and recording drives.

Where minimum size and maximum efficiency are required, as in miniature gyros, the efficiency of 1 to 2-inch diameter hysteresis motors does not compare favorably with the approximately constant speed induction motor. This disadvantage has been overcome in many miniature applications by overexcitation. This consists of using increased excitation voltage for a short time to overmagnetize the rotor after it has pulled into synchronism.

d-c motors

Direct-current machines are more adaptable to adjustable speed service than a-c machines. Direct-current motors provide a given output power in a smaller volume than a-c motors and have higher starting and reversing torques. Their major application is in aircraft control systems.

Series motors have high starting and reversing torques and poor speed regulation. As shown in Fig. 5A the speed-torque characteristic has a high negative slope. For control applications this contributes to stability as it is equivalent to a high viscous damping torque. The series motor is a nondirectional device unless switching is used. This has led to the development of the split series field motor (Fig. 5B) which has two oppositely poled field windings, one for each direction of rotation. Bidirectional control can be obtained with a single-pole relay.

Series motors are ideal for fans and blowers, step positioning devices and other constant torque loads where speed is relatively unimportant.

shunt motor

The shunt motor has from low to medium starting torque and fairly good speed regulation. With a series field (compound motor) the full-load speed at

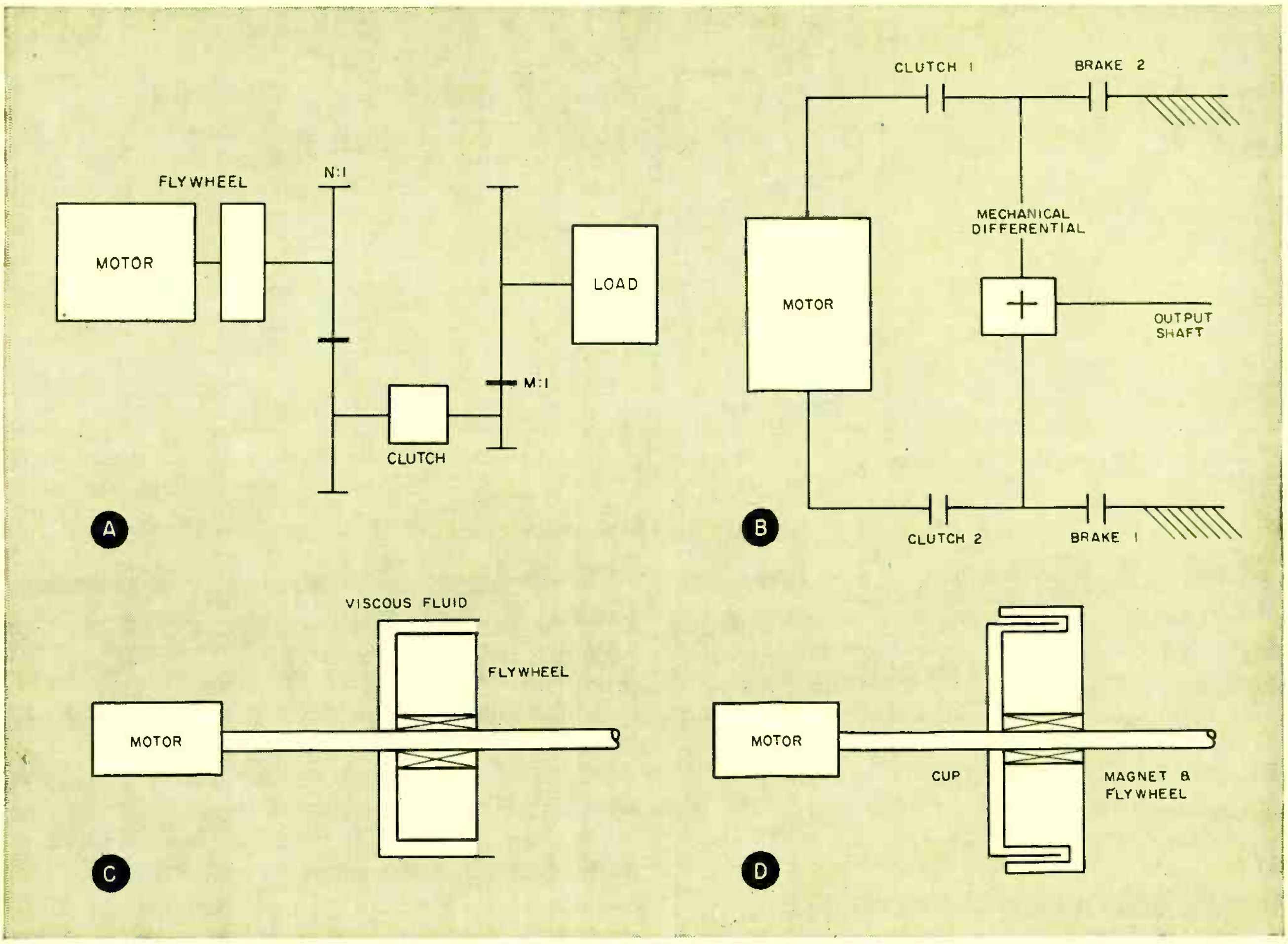

FIG. 6—Associated motor devices. Clutch and brake applications, top, and servo damping devices, below

Table I — Temperature Ratings of Motor Insulation

NEMA Class	Wire Insulation	Impregnation	Max Continuous Total Temp
O	Organics: cotton fiber Formvar	None	80 C
A	Organics: Formvar	Organic resin (varnish)	105 C
B	Inorganics: Teflon mica glass asbestos	Organic resin (varnish)	130 C
H	Inorganics	High temp resin (silicone varnish)	180 C
C	Inorganics	None	Greater than 180 C

can be made to be equal to, smaller than or greater than the no-load speed. Control of speed and torque can be achieved by the armature circuit resistance method, by field control or by armature control.

Field control can be achieved by driving from a d-c amplifier. To prevent time delay between buildup of field current and application of control signal, a current amplifier should be designed. A disadvantage of field control is difficulty experienced at low or zero signal levels by residual flux due to hysteresis.

Armature control utilizes a change in armature terminal voltage to provide an equal change in counter emf and a proportional change in speed. The field flux is constant. If a d-c amplifier is used for the armature, it must be capable of delivering full motor power. This system gives good linearity and operates satisfactorily in high-gain systems.

Permanent magnet motors are similar to shunt motors. They are characterized by light weight, economy, high efficiency and armature control. Their chief disadvantage is that the field may be demagnetized or the pole axes shifted if the motor is badly overloaded. Figure 5C shows the characteristics of a permanent magnet servo motor.

The basic disadvantage of all d-c machines is the prob-

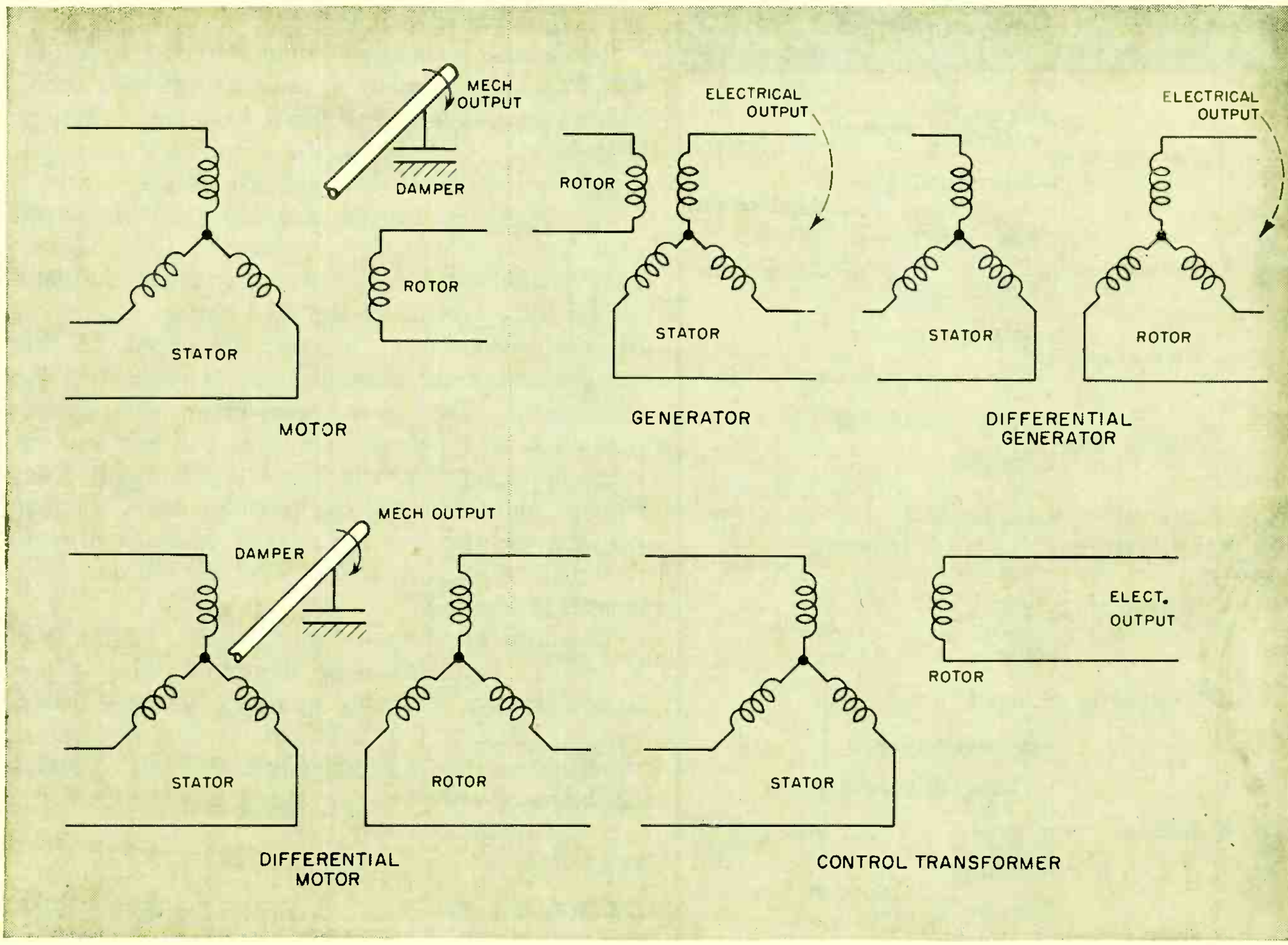

FIG. 7—Five common synchro types used in instrument applications

lem of commutation. Commutation generates radio noise and interference and often requires noise suppressors. Uneven brush wear causes apparent brush axis shift.

clutches

A practical instrument control clutch can achieve torque coupling and control by three methods: mechanical contact between friction surfaces as in an automobile; electrical, generation of eddy currents; and fluid coupling, control of the shear and viscosity characteristics of a fluid between the input and output members. Figure 6A illustrates one typical clutch coupling application.

Fluid couplings of the torque converter type do not generally exist in instrument sizes. A straight fluid coupling offers a convenient answer for open-loop applications where considerable slippage at low speeds can be tolerated and where maximum smoothness in torque pickup is needed.

The fluid magnetic clutch is versatile since it combines the smoothness of the eddy-current clutch with the large torque controlling ability of the friction clutch.

To circumvent the problems in utilizing an inherently abrasive mixture as the high-speed coupling agent in a fluid magnetic clutch the synchronous-induction clutch was recently developed. This clutch is similar to a hysteresis motor with the stator excited with d-c and spun. Its characteristics are much like those of the direct friction clutch, no slip below a certain torque determined by the excitation. After pull-out the clutch slips and behaves like the eddy-current clutch.

Since a clutch need not generate torque, the input power for control can be made a small percentage of the peak capability of the clutch.

The disadvantage of a clutch in servo control applications is that for maximum torque output with zero velocity all the input power to the clutch goes into heat. From the standpoint of heat dissipation there is little basis for choice between the clutch types.

brakes

Brakes are devices for dissipating kinetic energy. Dissipation may be achieved by utilizing the energy for some useful purpose as in dynamic braking or by converting the energy to heat; for instrument units no economy is gained by dynamic braking. Figure 6B depicts an instrument braking system.

Many instrument brakes utilize cork on steel as the braking surfaces since this combines economy with

Table II — Family Tree of Associated Motor Devices

Class	Type	Subtype	Detail
Clutches	Mechanical	Electrically controlled	Fixed coil
			Moving coil
		Self actuating	
	Electric	Eddy current	Synchronous, induction
			Straight slip
		Fluid magnetic	
	Fluid coupling	Torque converter	
		One-to-one torque transmission	
Brakes	Mechanical	Dynamic clamping	
		Parking	
	Electrical	Nonlinear	Dynamic clamping
			Parking
		Viscous	
	Fluid coupling–Viscous		
Damps	Mechanical	Flat	Output damps
		Tuned	Output damps
		Viscous to ground	Output damps
	Electric	Viscous to ground	Output damps
		Tuned	Output damps
		Flywheel	Output damps
	Fluid	Viscous to ground	Output damps
		Flywheel	
	Network	Operation on error signal	

relatively long wear. If extremely longer wear is desired as in sealed units sintered bronze on steel may be used.

Like clutches, brakes may be direct friction, fluid or electromagnetic although the first two are mostly in use today. Fluid brakes are used to provide viscous friction for damping.

damps

The ideal servomechanism damp brings servo velocity and error to zero simultaneously in the smallest possible time with no overshoots. One means to accomplish this is to build some anticipation into the servo controller so that the net driving torque can be reversed sufficiently in advance of null to decelerate the servo to zero velocity at the instant null is reached.

A viscous friction damp offers a good method of improving instrument performance. Viscous friction can cause no static positional servo error and improves following performance at low rates. However, the unwanted energy is still dissipated as heat. A schematic of a fluid viscous coupled flywheel damp appears in Fig. 6C. It consists of a shell and an internal flywheel coupled to the shell by viscous friction of oil in which the flywheel is immersed.

Among the problems of fluid viscous coupled flywheel damps are: sealing of units against leaks over a wide range of ambient conditions, variation of damping characteristics with temperature, and lack of simple means for continuous damping adjustment.

The variation of damping characteristics with temperature has been partially overcome by using silicone fluids instead of oil. To overcome two of the detrimental characteristics of the fluid viscous damps, the electrical viscous damp has been developed. A thin extruded copper or aluminum cup is coupled to the servo motor. The cup is rotated between the circular pole pieces of a permanent magnet and soft iron elements providing a low reluctance return flux path. Eddy currents induced in the cup provide viscous coupling between the cup and the magnet which is flywheel mounted. A diagram of the electrical viscous damp appears in Fig. 6D.

The inherent damping characteristics of most servo motors can be increased by allowing a direct current to flow through the motor windings. For the smaller motors, however, flux paths are usually operated so close to saturation that not much additional damping can be bought by power expenditure.

synchros

Fundamentally synchros consist of a wound stator and rotor which may be cylindrical or have salient pole structure. The windings may be single phase or three-branch wye.

Figure 7 shows the classes of synchros in common use.

The cascading of a synchro generator and synchro motor produces the primary self-synchronizing system.

In any rotor position, the rotor coils and stator coils constitute two windings of a transformer.

When the rotors are aligned and excited with equal voltages in the absence of load torques, the induced voltages in the secondaries cancel, and no stator current flows. If misalignment occurs, voltage is developed causing current to flow through both stators.

Torque synchros in self-synchronism do not amplify. Therefore the energy delivered mechanically at the output of the motor must be supplied mechanically at the generator input.

Because of the inherent transient overshoots and the lack of torque amplification simple transmitter-repeater data systems are generally used to drive only light dials. In driving heavy loads, torque amplification can be obtained by feedback.

Another useful component is the differential synchro which may be either a motor or generator. It can modify the angle indicated between a standard generator and motor or control transformer by adding or subtracting another angle. The differential motor gives mechanical rotation equal to the sum or difference of the signals from two generators.

Assembly Techniques....

By FRED T. SCHICK
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Modern fastening and assembly methods utilizing automatic equipment speed production for the mass market while special fabrication techniques prescribed for military gear enhance reliability and simplify maintenance

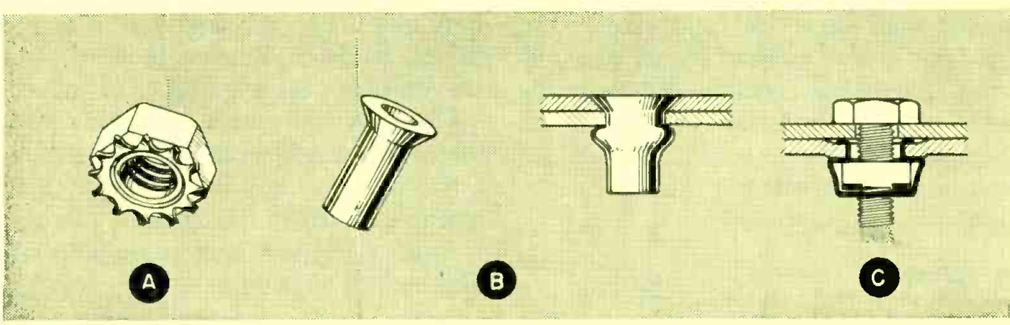


FIG. 1—Keeps (A) combining nut and lockwasher, blind rivets, shown before and after upsetting (B), and nut retainer (C) are useful in inaccessible locations

TO ASSEMBLE the components that make up electronic equipment industry has devised numerous methods and devices.

In television set production the emphasis is on speed and economy. In military equipment, fastening methods are usually delineated by specifications. Fasteners must allow for easy replacement of parts under difficult circumstances.

Machine screws are widely used in military equipment. The machine screws mostly used are ASA coarse thread sizes 6-32 and 8-32, class 2 fit after plating.

machine screws

The most commonly used material is steel. Brass screws are also used, usually where parts must be mounted in a magnetic field such as in mounting the neutralizing coil around the face of a cathode-ray tube.

Small machine screws size 4-40 are occasionally used in fastening small parts. Two uses for machine screws in production of commercial equipment are mounting speakers and fastening heavy parts such as yokes of color sets. For heavy fastening ¼-20 screws are used.

A widely used screw head is the hexagonal head, chosen because of the wide application of screw-driving guns. On military equipment slotted pan-head screws are used for ease of maintenance. When hex-head screws are not specified, industry often uses cross-head screws which avoid tool slippage. Countersunk-head screws are not often used; their use is restricted largely to military equipment.

set screws

In military equipment set screws are frequently used to fasten knobs, collars and couplings to shafts. These screws usually have recessed heads and are designed to be tightened by special wrenches. One wrench has a six-sided stock while another is fluted. Most common set-screw size is ASA coarse 8-32.

In equipment designed for the mass market knobs are usually of the slip-on type held in place by spring fasteners.

A nut commonly used with machine screws is the hexagonal nut, usually the chamfer type. Military specifications often call for nuts having a plastic insert. This nut is self-locking.

An interesting device used where secure fastening is

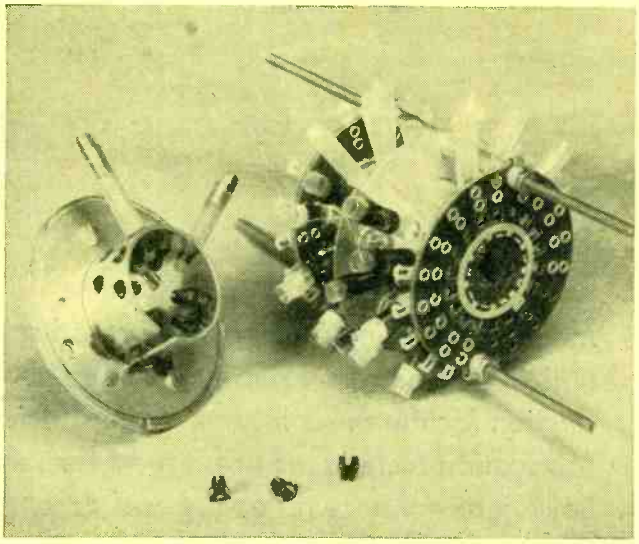


FIG. 2—Construction of multiposition wafer switch illustrates use of eyeleting

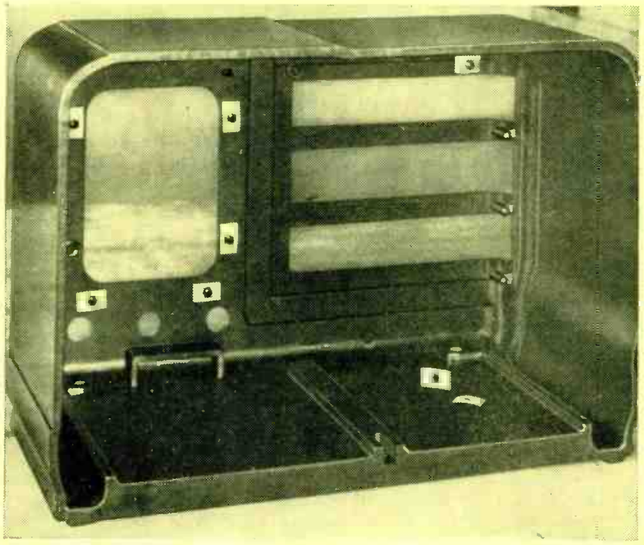


FIG. 3—Spring-steel fasteners used in assembly of portable radio cabinet

desired is shown in Fig. 1A. It combines a nut and lockwasher as one unit; these are called keeps. In building military equipment lockwashers are generally used under screws. Commercial equipment occasionally uses lockwashers, generally under screws holding the chassis to its wooden cabinets.

Fiber washers or plastic inserts are used for insulation.

self-tapping screws

The self-tapping screw is a widely used device. The A type is a pointed sheet-metal screw, easy to insert and used to fasten components and brackets to chassis. Type A screw is used in sizes 6, 8 and 10, depending upon the size and weight of the component.

The type Z self-tapping screw is a multifluted screw resembling a tap shank. It is used in assembling plastic parts and in making connections through extruded holes in sheet metal.

The Type FZ self-tapping screw is also fluted but has a wider thread than the Z type and is specifically designed for assembling plastic parts.

riveting

Riveting and eyeleting are widely used, especially in fastening parts that do not usually need replacement, such as tube sockets, terminal strips, capacitor mounting plates, etc.

A special type of rivet in common use is the shoulder rivet. The connection is made by a shank of smaller diameter than the body of the rivet to provide free-turning mounting of idlers and pulleys, and mounting of springs and spacers.

Blind rivets are used in closed places where bucking is impossible. One type is a hollow rivet with a pin to drive the rivet. The head of the pin exerts a squeezing force. Some blind rivets are of self-plugging type and some of the pull-through type. Designers attempt to avoid closed places in their layouts. Therefore, blind rivets are largely used in putting on trim. Where insulated rivets are required plastic blind rivets are available. See Fig. 1B.

Common rivets are used in subassembly operations such as where a bracket is riveted to mounting strap for a television picture tube. Here riveting is done on a machine similar to the eyeleting machine.

Most widely used eyelets are 0.088 and 0.122 in. in diameter. Eyeleting is usually done by eyeleting machines. These are commonly equipped with automatic feeds; some provide for inserting two eyelets at one time. Figure 2 illustrates use of eyelets in a multiposition wafer switch.

special fasteners

The spring-steel fastener reduces parts handling and speeds production. It consists of a flat piece of spring steel bent in a bow. Basically it is a one-thread holding device that fits over the screw and grips it in place. The spring-steel fastener can also fit over studs, rivets, nails, tubing or wire.

Where ease of disassembly is important, spring-steel fasteners can be slipped over studs of D-shaped cross-section. The stud is gripped on two sides by the fastener and locked in position. The part may be released by turning the fastener one-quarter turn.

When spring-steel fasteners are used with machine or self-tapping screws, the screws can be unfastened just as when they are used with machined nuts. In Fig. 3 use of spring-steel fasteners in assembly of a portable radio cabinet is illustrated. Studs die cast on the dial frame are inserted in holes in the plastic cabinet and the fasteners then slipped over the studs.

Figure 4 illustrates the self-retaining feature of a spring-steel fastener. The fastener is U-shaped and fits over the chassis edge to provide a self-retaining nut for fastening the cover.

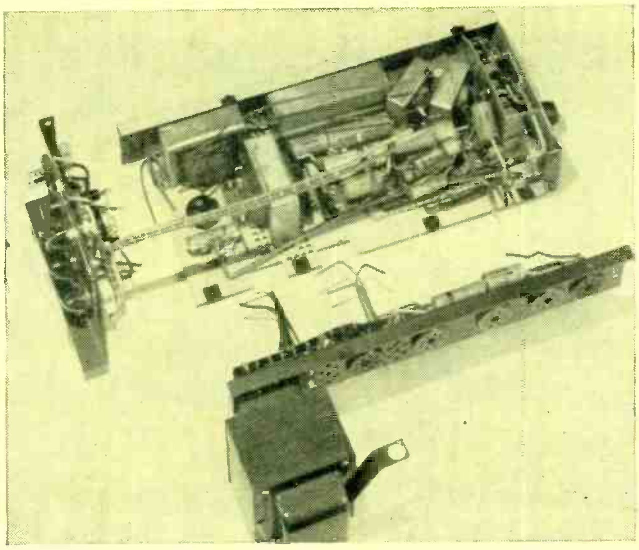


FIG. 4—Self-retaining U-shaped fasteners fit over edge of chassis to permit attaching dust cover

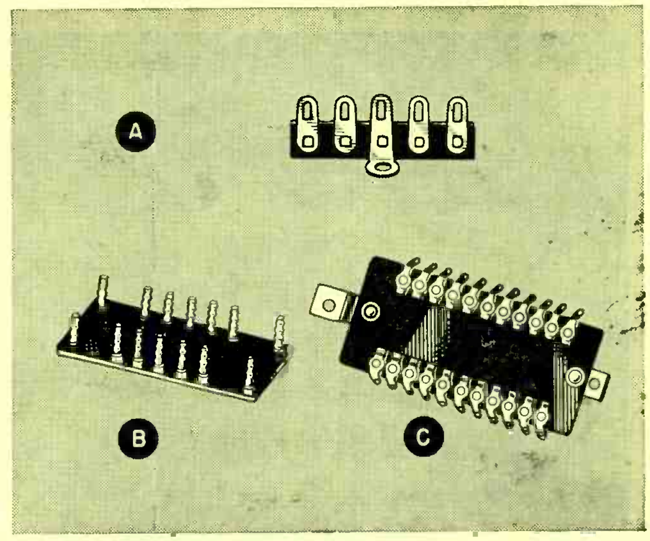


FIG. 5—Component board types include free-standing type (A), turret (B) and pancake types (C)

Spring-steel fasteners are available in several shapes including brackets, tubular fasteners, compression rings, wire and cable clamps. Also included are wood anchors, turning fasteners and a wide variety of clamps, retaining rings and special mounting fixtures.

Another special fastener is the nut retainer shown in Fig. 1C. It can be used for holding nuts in blind locations and requires no welding or clinching. One common application is mounting the television chassis in the cabinet. The nut retainer is housed in a spring-steel cage and provides play to compensate for manufacturing tolerances.

use of Glyptal and cement

Glyptal is a fast-setting liquid compound used to coat critical tuning adjustments to prevent tampering. Cements are used in several assembly operations. Some of these include affixing sound baffling material inside the cabinet and fastening voice coils to speaker cones.

Several cements have been developed to meet special needs. A rubber-base cement is often used. Special cements known as dope have been developed for coating coil forms to help them retain their shape while not affecting the electrical performance.

Cement is not often used in what was formerly its most important application cementing labels to pieces of equipment. Labels used today are largely of the pressure-sensitive type.

fittings and connectors

Where a ground connection must be made to the chassis this is usually done by a ground lug. In military practice the ground lug may be a combination lug and lockwasher. The lug is fitted under the machine screw holding, say, a tube socket and connections made directly to the lug.

In commercial practice, it is customary to lance the ground lug out of the chassis—actually punch a small piece of steel partially out and make the connection by soldering to it.

Terminal strips show a considerable difference between military and commercial practice. A commonly used terminal strip for commercial practice is a thin piece of phenolic resin about $\frac{1}{32}$ in. thick and $\frac{1}{2}$ in. wide. See Fig. 5A. This is equipped with mounting feet at right angles, one or more depending upon the length. Solder lugs are connected to the strip by eyelets forming the lower part of the lug. Solder connections are made directly to the lugs.

In military practice a common terminal board (Fig. 5B) is a $1\frac{1}{2}$-in. strip of $\frac{1}{8}$-in. phenolic resin appropriately fungus proofed and equipped with rows of turret lugs. The terminal boards are usually fastened to the chassis by machine screws. Also used is the pancake component board, shown in Fig. 5C. Figure 6 shows a chassis using eyeleted pancake component boards and wafer-type tube sockets.

plugs and receptacles

The military-type connector consists generally of a die-cast shell inside of which there is an insulator holding male or female metallic parts. The insulator may be phenolic resin or of polystyrene or other materials for better insulation.

In commercial practice plugs consist of thin phenolic resin forms with the metallic connectors fastened directly to them. The so-called phonograph connector lends itself well to connection to shielded leads. The plug contains a center prong which carries the signal. The prong is centered by a disk of insulating material, which is in turn surrounded with a small metal shell that provides ground contact.

high-voltage connectors

Use of voltages of 12,000-14,000 v on cathode-ray picture tubes has brought about the need for carefully

FIG. 6—Eyeleted component boards and wafer-type tube sockets installed on chassis

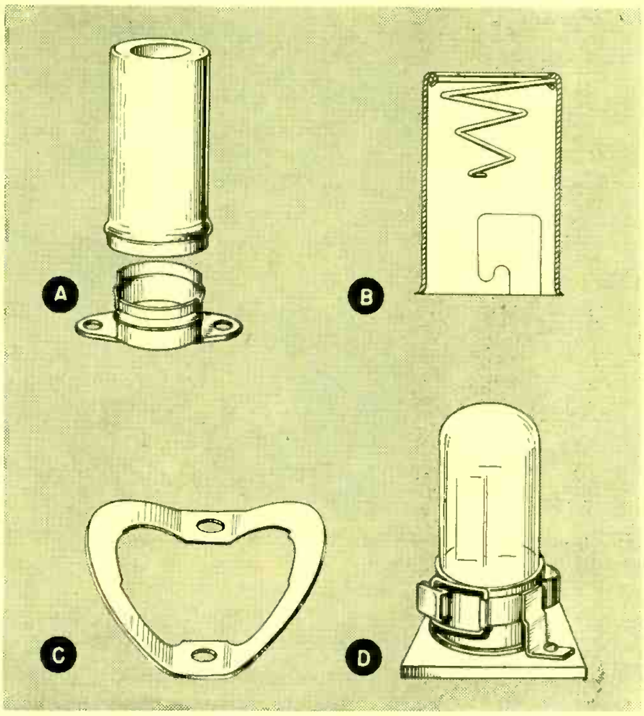


FIG. 7—Bayonet (A) and bead (B) type tube shields; also ring (C) and collar (D) type tube clamps

insulated anode connectors. The connector consists of a plug button designed for corona-free operation, which fits into a small recessed cavity in the cathode-ray tube.

The anode connector is surrounded by a wide circular shield of Neoprene or silicone since the high voltages used in this work have a deteriorating effect on natural rubber.

Anode connector leads are often equipped with polyethylene-enclosed single-prong connectors.

Where electronic equipment is built up of several interconnected chassis, need exists for multiconductor cable and corresponding plugs and receptacles. In commercial equipment for the mass market, multiconductor cable is sometimes terminated in an octal-base tube socket acting as the female receptacle and a corresponding eight-prong male plug. In military equipment, a wide variety of multiconductor connectors is used. These include types having tubular prongs arranged in clusters and knife-like prongs.

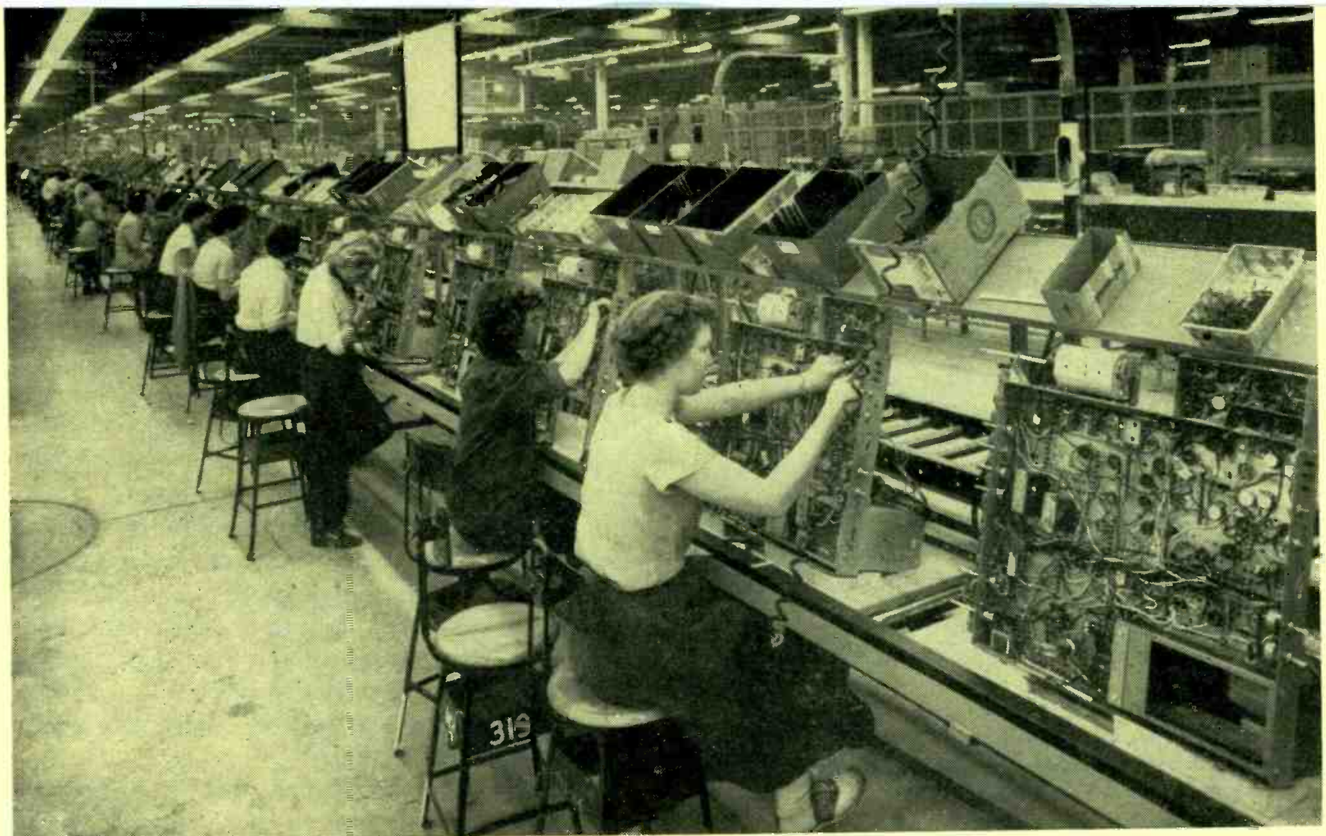
tube sockets

Most common types of tube sockets are the miniature 7, 9-prong and octal-based sockets. Special types include 4-prong, 8-prong, loktal, 5, 6 and 7-prong subminiature sockets, 3-prong transistor sockets, special sockets for the klystron and various transmitter tubes and cathode-ray tube sockets with up to 20 prongs to accommodate new three-gun color tubes.

There are two basic types of sockets, the wafer type, (Fig. 6), usually made of laminated phenolic material, and the molded type made of either plastic or ceramic. The wafer socket is riveted to the underside of the chassis while the molded type is mounted by a metal saddle either above or below the chassis. The saddle often incorporates a ground lug.

Tube shields are often used, particularly on miniature tubes. In one type the saddle of the tube socket forms the base of the shield. See Fig. 7A. The base has a bayonet connection to the upper part of the shield. The upper part of the shield also includes a spring. Another type, shown in Fig. 7B has a spring bead on the lower part, which fits into a rim on the upper part.

Tube clamps or tube holders are used where excessive vibration is encountered or where tubes are mounted horizontally or inverted. One type of tube holder exerts cutting-edge action on tubes having molded bases and may readily be released by slight pressure of fingers on the holder in the direction of the chassis. This holder is of 0.015-in. annealed spring steel in the form of a ring, fastened to the chassis in two places and bent upwards to form two bows. This type of clamp is illustrated in Fig. 7C. Another type, shown in Fig. 7D, widely used in military applications consists of spring-steel collar and buckle welded to an upright post. For octal and loktal-based tubes, the collar is tightened around the plastic base. For miniature tubes, the post is longer and the tube is held by a cap that fits over the top of the envelope and exerts downward spring tension. Subminiature tubes may be held in a cylindrical clamp that fits around the tube and serves to conduct heat.



Wiring and soldering operations, often performed along a moving belt like the one shown, may represent 30 to 40 percent of direct labor cost in manufacturing electronic equipment

Wiring and Soldering . . . .

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Efficient wiring and soldering methods together with choice of proper materials cut direct-labor cost and improve performance in military and commercial equipment. Special techniques point way to fully automatic production

TELEVISION receivers may contain over 90 feet of wire, while a complete radar system may have over 4,000 feet. Although the cost of wire and flux-solder in a television receiver represents only a small fraction of the overall cost, wiring and soldering may represent 30 to 40 percent of direct labor cost.

Both tinned copper wire and insulated wire are used. Figure 1 shows various kinds of wire used in set production. Solid copper wire tinned and bare of insulation is used in sizes ranging from 38 gage (0.003465 in. in diameter) to 6 gage (0.1620 in. in diameter). Wire of 22 gage (0.0253 in. in diameter) is commonly used. Stranded wire is used to provide flexibility where movement may be required in disassembly and reassembly. Occasionally flat woven copper braid or solid flat copper is used where low resistance contacts are required such as common ground connections between chassis. See Fig. 2. Types of insulated wire include plastic covered, cotton covered, lacquered, nylon covered, glass fiber insulated and the film insulated type. Plastic covered wire is in wide use.

insulation

A common type of plastic covering is polyvinyl chloride $\frac{1}{32}$ or $\frac{1}{64}$ in. in thickness. This insulation will resist temperatures up to 80 to 90 C and breakdown voltage to 10,000 v with a usual rating of 600 v. This wire has good resistance to abrasion and humidity and is easy to strip. Glass fiber insulated wire shows

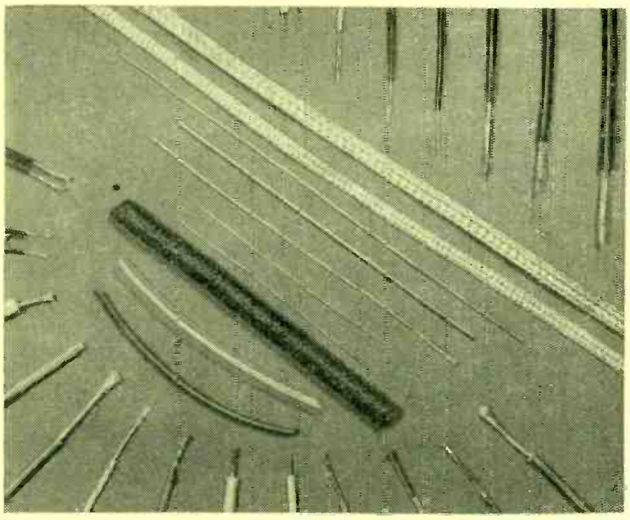


FIG. 1—Wire used in electronic equipment manufacturing. At the top are five examples of solid insulated wire and two of shielded cable. In the center are shown two types of flexible copper braid, five of bare hookup wire and three of sleeving or spaghetti. At the bottom are shown two samples of twin lead and 11 of stranded insulated wire

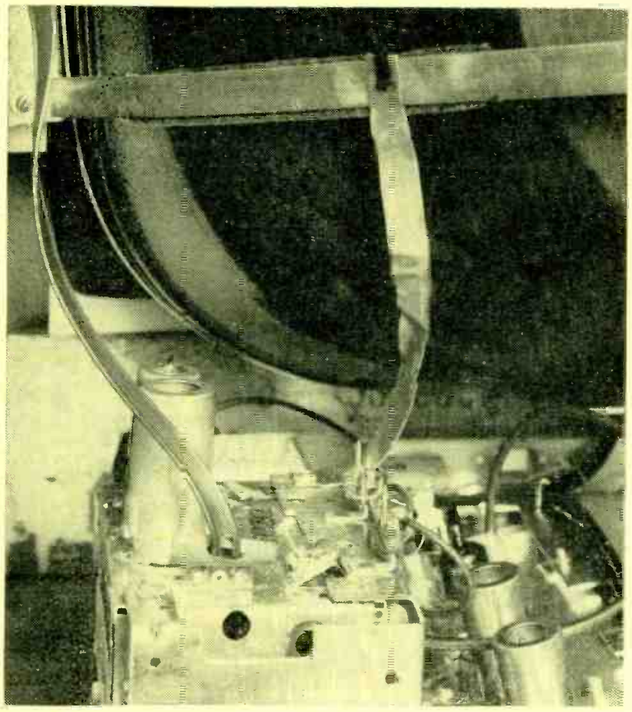


FIG. 2—Detail of television receiver showing use of flat copper strip as a ground connection. Wire at left is twin lead bringing in signal from antenna

the favorable attributes of plastic covered wire and provides great resistance to heat. This wire is fire retardent and is often used in military and airborne equipment.

Cotton covered and lacquered braid wire is still used in some receiver manufacturing. Nylon covered wire is coming into use because it is economical in cost and space due to its insulating qualities. Its resistance to abrasion is good.

Film insulated wire includes enamel covered wire and special coated types. These coatings are tough and durable, will withstand bending and require no additional thickness due to covering. They are used in winding coils, particularly the horizontal size and horizontal linearity coils and deflection yoke coils for the television receiver.

Teflon is made from tetrafluoroethylene resin. Its most outstanding characteristics are high insulation value, resistance to moisture, heat and abrasion. The plastic in dispersion is applied to glass fiber cloth by dipping. It is then dried and fused at elevated temperatures. Glass fabric laminates withstand 250 C continuously and up to 300 C intermittently. Teflon suffers no apparent degradation from oxygen, tends to repel water and has the property of shedding dust. It is used for critical wiring such as high-voltage leads in television receivers where the wire goes through several metal shields incurring abrasion and danger of arc over. High-frequency work in government equipment often requires its use.

Special types of wiring include twin lead used primarily to transmit signals from the antenna to the tv or f-m chassis. Twin lead may consist of two conductors of No. 22 gage stranded copper wire set parallel in a casing of brown polyethlene. This wire has a dielectric strength of 5,000 volts rms for one minute and a capacitance per foot of 5.5 micromicrofarads at one megacycle.

Special purpose shielded cable used for audio and pulse circuits consists of an inner conductor of tinned copper wire 0.0228 to 0.0256 in., an insulated film of polyvinyl chloride and circumferential shield of 32 to 36 strands of 0.0057 to 0.0072 in. tinned copper wire. It may also have a spiral wrap and an outer jacket 0.010 in. thick of polyvinyl chloride. This cable will withstand up to 600 volts rms at 90 C.

Silicone is a relatively new hydrocarbon applied as a varnish or additive to the outside covering of insulation. It is outstanding for its waterproofing properties.

spaghetti

Sleeving insulation known as spaghetti is slipped over tinned copper hookup wire to prevent shorts. One type consists of braided cotton, rayon, nylon or glass sleeving impregnated with an oleoresinous varnish and will withstand 800 v average and 1,500 v short-time dielectric test. It comes in sizes from 24 gage to 1 inch in diameter. A second type is braided glass tubing coated with a continuous film of oleoresinous varnish. This type of sleeving will withstand 2,500 v average, 4,000 v short-time dielectric test. It comes in sizes from 24 gage to $\frac{5}{8}$ in. inside diameter.

wiring

In point-to-point wiring, as shown in Fig. 3, all wiring should be neat, sturdy and as short as possible. In high-frequency circuits it is often necessary that point-to-point wiring be used. Servicing can sometimes be completed in less time with point-to-point

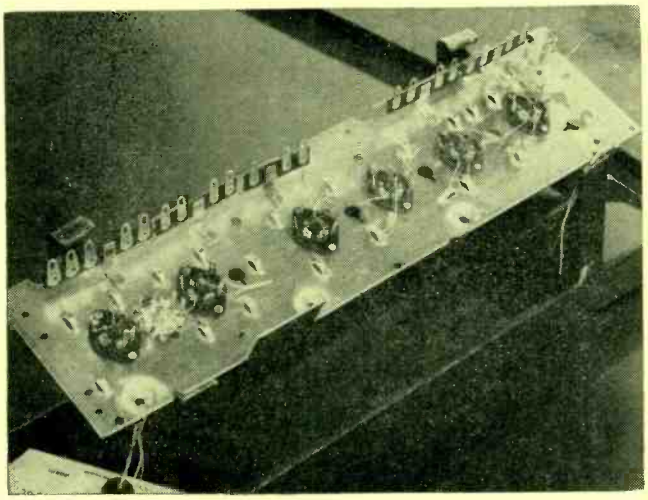
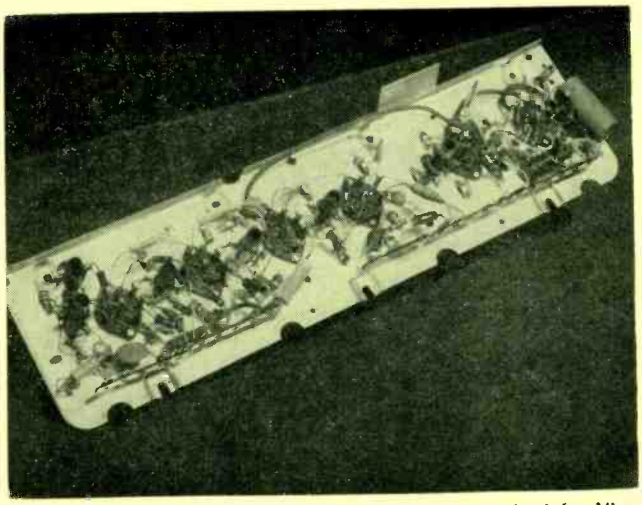
 

FIG. 3—Subassembly illustrating use of point-to-point wiring. Basic wiring composed of bare solid copper wire is shown at the left. View of completed unit, right, shows appearance after components are wired in

wiring because the direct path can be traced easily. Less wire is used and there is no need for identification of wire ends.

Basic wiring, or the connections of tinned copper wire to the chassis after mechanical parts have been assembled, is usually point-to-point wiring. Figure 4 shows use of point-to-point wiring in a tv receiver.

When specifications require it, wires are grouped and laced into a cable. Wires in a cable must be neat and tightly bound. Leads should be of a length to provide slack to prevent stress on individual wires and terminal connections. There must be sufficient slack to enable removal of parts for inspection, adjustment or repair without disconnecting or damaging other parts. The wires are placed separately on a cable board in a predetermined sequence. After all the wires are laid, twine, linen or lacing cord is used to form a solid unit. Cables are almost always made bottom side up so that the lacing knots will not be visible. Figure 5 illustrates use of cabled wiring.

wire stripping

The outer covering of wire such as nylon, cotton or enamel must be separated from the conductor to provide a clean, shiny surface for the soldered connection. Poor stripping will result in poorly tinned copper ends and a poorly soldered or noisy connection.

Wire stripping can be accomplished chemically, mechanically or electrically. Preparations having the consistency of heavy syrup or free-flowing paste are available that can be used to strip lacquer, enamel or other film insulation. These preparations are composed of ingredients such as chlorinated solvents, having good solubility properties, ammonia and phenolic fractions which are excellent solvents for resins. An interval of time must elapse between the application of the stripper and the reaction or blooming time. This time element is a cost consideration.

A common method of wire stripping is mechanical stripping. Precision machines, Fig. 6, have been designed to cut to lengths up to 15 in. and strip 3,000 wires per hour. Stripping length on both ends can be the same or the ends can be stripped to different lengths.

Another mechanical stripping method employs an electric motor and one or two wire wheels. This method can be used on various gages of wire and types of insulation and a long stripping length is possible. A variety of stripping wheels are made, including a fine-gage crimped wire or wire and glass fiber wheel. Insulation is stripped by inserting leads between rotating wheels. The entire unit can be moved to the work position. The wheels must be changed, depending upon the wire to be stripped. In some cases wheels with 50 percent of their useful life remaining must be replaced to achieve satisfactory quality of stripping.

Still another type of mechanical stripper uses a motor to revolve the stripping blades. The wire to be stripped is fed through a hole in the front cover and, by depressing a foot pedal, the two stripping blades, which revolve at a high rate of speed, are brought in contact with the insulation. The blades stop short of the conductor and as the wire is withdrawn the insulation is separated from the conductor.

This type of stripper can be used only on insulation other than the film or plastic type. It must be bolted to the bench and the pedal secured to the floor. Its advantages are that it operates quietly and safely; stripping length adjustment can be made quickly. Blade cost is low and blade life high.

marking and coding

Once the wire is cut and stripped to the required length it is tin dipped, generally in a solder pot containing 50-50 (tin/lead) bar solder. When used in cabling the wires may require identification or coding.

In point-to-point wiring such as that used in radio and television receivers the exterior color of the insula-

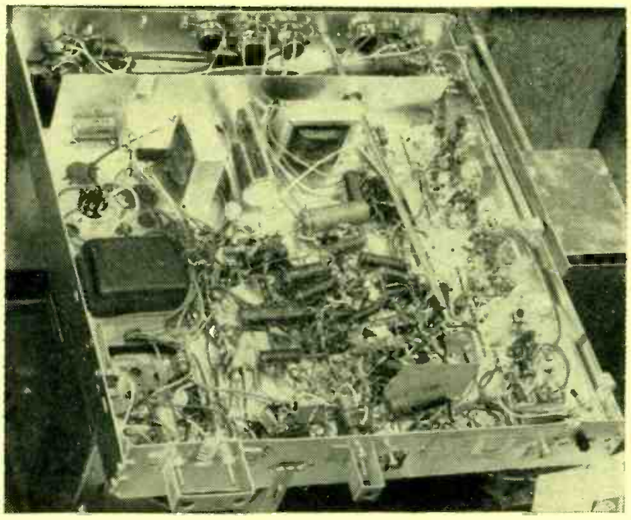


FIG. 4—Use of point-to-point wiring in a tv receiver. Photo, left, shows set with parts assembled to chassis and basic wiring installed. Photo, right, shows a set completely assembled and wired

tion is used for coding. This may be either a solid coloring or a secondary or tracer color along with the principal color.

Recently, printed vinyl tape has been used for identification of wire, cable and conduit. It is composed of a thin printed pressure-sensitive vinyl tape having an efficient adhesive on the back. It is available in rolls of various widths. The ink is sealed into the vinyl backing to provide an abrasion-resisting material. The tape can be fed from a machine or cut to required length by hand.

Insulated plastic tubing is also used on individual or grouped wires. To identify both ends of a large quantity of wires, plastic tubing is purchased in lengths as required. Printing is done on the exterior parallel to the length. In a particular cycle of the operation a length of the imprinted tubing is slipped over the end of the wire before terminating it.

A self-adhesive tape is available in cut-to-size strips or labels from 1 to 6 inches in length and from $\frac{5}{16}$ to 3 inches in width. It can be written on with any dry, blunt point such as pencil or stylus. Writing appears beneath a layer of transparent plastic due to pressure of the writing instrument.

component boards

Component or terminal boards are used as tie points in the circuit of a television receiver. They are usually mounted to the metal chassis by rivets, eyelets or screws. Some have only one or two terminals while others may have eight or more. The material used may be phenolic NEMA grade XP, vacuum wax impregnated, or it may be of phenolic, grade X, chocolate brown surface with a tan core. Table I lists materials for terminal boards.

The material itself is a laminated thermosetting plastic made by bonding together two or more piles of impregnated stock. The base material may be paper or fabric made from cotton, asbestos, glass or synthetic fiber. The binder in most cases is a phenolic in the form of a varnish with which the material is treated in the early stages of manufacture. This material is also available with a binder of melamine or silicone if required.

Standard sheet sizes are 18 × 24, 36 × 67, 36 × 44, 36 × 36 and 39 × 49 inches. Thickness runs from 0.010 in. to $\frac{1}{32}$ in. Terminals fastened to these boards may be of the single-ended type riveted or eyeleted on. By staking and spinning, terminals of a double-ended type may be attached.

Prototype fabrication and short-run production is facilitated by a mounting system that consists of terminal cards, unit planning cards, miniature terminals and tube sockets. The terminal cards are prepunched, multihole cards that have flexibility to take a number of circuit variations.

soldering fluxes

To join metal by soldering, it is necessary that the surfaces be clean and free of all oxides. This is done by employing a flux that will dissolve the oxides on the surface, permitting the molten solder to wet, spread and take. The flux reduces surface tension of the solder and the metal, allowing the solder to penetrate into the pores of the metal, and creates a protective covering to preclude the now clean surface from becoming reoxidized due to the heat required in soldering.

Fluxes are either noncorrosive or corrosive. The degree of corrosion indicates its activity with pure water. Rosin is noncorrosive while hydrochloric acid is corrosive but has great fluxing power.

Rosin consists chiefly of abietic acid and related substances. At ordinary temperatures it is a solid and does not cause corrosion but it reacts mildly at soldering temperatures. Rosin is easily crushed into powder and melts rapidly at about 125 C. The usual solvent for rosin is methylated or denatured alcohol. Powdered rosin is mixed with from two to four parts by weight

FIG. 5—Cabled wiring may often be required in military and commercial equipment. Operator at left is fabricating cable for a communications receiver. She lays wires on harness board, then binds them with linen cord. Operator at right is stripping ends of wires comprising cable for large radar set

of alcohol. In addition to either methyl, ethyl, propyl or butyl alcohol, oil of turpentine or carbon tetrachloride are sometimes used as solvents. Rosin itself is a relatively poor flux since it will take only on relatively clean copper, brass, hot-tinned or tin-dipped surfaces.

Various acid additives are added to rosin to make it a more active flux. In activated solders the active ingredient employed will volatilize upon being heated, accomplish its extra fluxing job and leave only a plain rosin residue.

soldering techniques

To join metal with soft solder the proper flux must be applied and the metal heated to liquify the solder alloy. Tools used for soldering include: electric and gas-fired soldering irons, torches, induction heating machines, oven soldering, radiant heat, electrode soldering, steam heating, resistance soldering and hot-plate soldering. Figure 7 illustrates a soldering operation using a torch.

The tip is the heart of the soldering iron and is generally made of copper because of its exceptional ability to absorb and transfer heat rapidly. Electric soldering irons are available in power ratings of 40, 60, 100, 125, 150, 200, 250, 300 and 500 watts. The higher the wattage the more heat the tip can hold and transfer and, in general, the higher the wattage the heavier the soldering iron. For production soldering, which is often done by women, a frequently used iron runs between 125 and 150 watts.

Irons of 200 watts or more are used where a number of ground lances are to be soldered. On long cycle operations without a temperature-regulation device service life of soldering iron heater elements may be upwards of four months. Use of a heavy soldering iron for parts assembly is shown in Fig. 8.

Much of the bar solder used in industry is used in soldering pots. See Fig. 10. Solder pots are used where the tinning of wires or components is necessary. The electrically heated solder pots make the solder molten. The part is dipped in flux and then immersed in the solder bath.

A soldering pot should be operated at a controlled temperature, generally not in excess of 125 to 150 F above the melting point of the solder being used. Table II gives melting temperatures of various solder alloys. Bar solder is available in 50/50, 60/40, 40/60, etc. Consideration must be given to the amount of heat withdrawn due to parts being dipped. By so doing drossing and scaling on the top of solder in pots will be kept to a minimum and brighter finish obtained on the part. To maintain proper temperature during dipping a thermostatically controlled soldering pot may be employed. Use of virgin tin-lead solders is important for good pot soldering. Virgin metals contain far less impurities than smelted or refined solder.

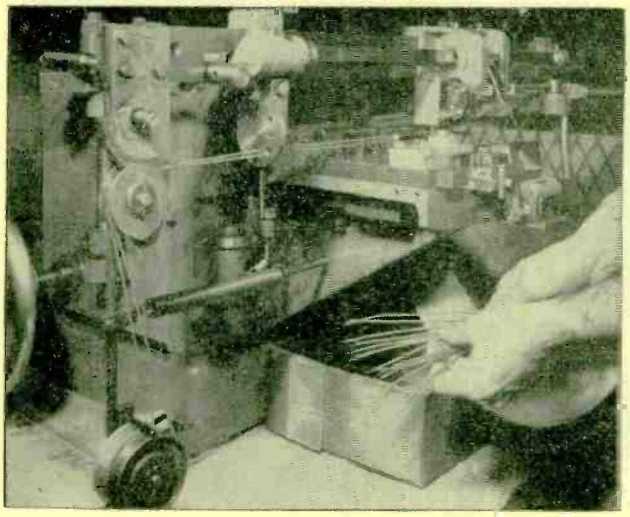
In dipping copper parts into a tin-lead solder bath the affinity between tin and copper results in tin-copper crystals that may form a sludge at the bottom of the pot. This is removed from the bath and deposited upon the surface of the article being tinned. It is good practice occasionally to cool the solder bath to 10 F above melting temperature, remove these crystals from the pot and refill with fresh solder.

other joining processes

Welding involves joining metals with high heat—2,200 F and higher. This results in strong connection but is used primarily in joining very heavy metals to avoid buckling and warping of the basic material.

Silver soldering and brazing are methods of joining metals using hard solders that contain high percentages of silver, copper, etc.

The temperature for silver soldering or brazing runs from 1,150 F upwards and fills the need for a process



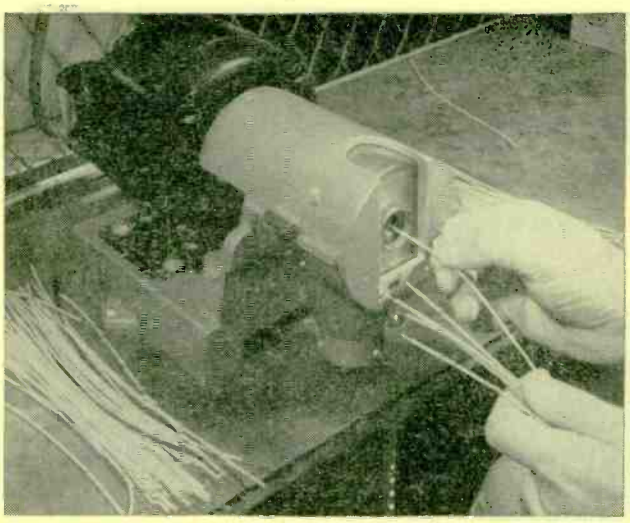


FIG. 6—Mechanical wire stripping methods. Wires can be cut to length and stripped automatically, left, or the ends merely stripped by inserting them in machine, right

FIG. 7—Use of a torch in soldering operation. Operator is assembling variable air-dielectric capacitors

FIG. 8—Irons of 200 watts or more are used in chassis soldering and parts fabrication

of joining of metals at a lower temperature than that of welding. Soft soldering employing tin-lead is the lowest temperature (360 to 600 F) method of joining metals. It permits joining thin metal sheets or delicate parts without buckling or warping.

Tensile strengths of soft solders vary from 17,000 lbs per square inch to approximately 29,000 lbs per square inch. An alloy of tin and lead will melt at a lower temperature than either of the two metals by themselves. Pure tin has a liquidus temperature of 450 F, while pure lead has a liquidus temperature of 620 F. Any combination of the two metals has a lower melting point.

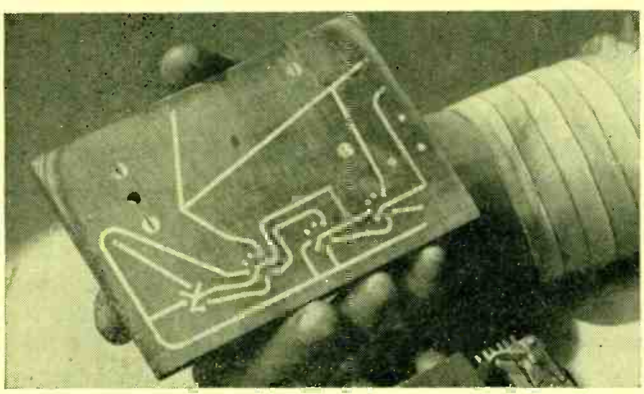
solderless connections

Solderless connectors are available in a wide variety of sizes and types. Tools are available for manual, pneumatic, hydraulic and electric operation that compress the barrel of the connector onto the conductor.

Advantages of solderless connectors include uni-

Table I — Characteristics of Materials Used in Terminal Board Fabrication

NEMA Classification	Colors	Filler	Binder	Application and Description
X	Natural, black, walnut &, brown	Paper	Phenolic	General purpose paper-base grade for panels, contactors and terminal blocks where high mechanical strength, low-cost material is required
XXP	Black & natural	Paper	Phenolic	Excellent insulator; can be machined readily and punched hot. May be used in switches, relays, vibrators and where a low dielectric loss material is required
CE	Black & natural	Medium cotton drill	Phenolic	Best canvas base, electrical grade
AA	Natural only	Asbestos fabric	Phenolic	Has high heat resistance, low coefficient of thermal expansion, low water absorption, fairly high impact resistance and good resistance to wear and chemical corrosion. It has low dielectric strength
XXX	Black & natural	Paper	Phenolic	Excellent electrical grade. Preferred grade where low dielectric loss and stability upon exposure to moisture are of primary importance. Used on equipment involving high voltages at temperatures up to 130 C
XXXP	Black & natural	Paper	Phenolic	Compares favorably to XXX as regards electrical properties. Preferred where a paper-base punching grade of high insulating value is required
XP	Black, natural, walnut & brown	Paper	Phenolic	General purpose paper-base grade of low cost for punching. For use at temperatures up to 100 C and moderate humidity in applications such as spacers, terminal boards and crossbars for knife-type switches



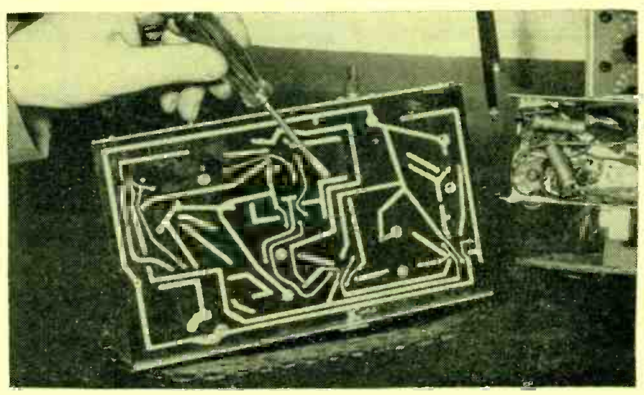


FIG. 9—Printed circuit techniques include use of conductors sprayed on dielectric plate, left, and stamped from metal foil and embedded in plastic, right

formity of installation, simple operation by unskilled operators and optimum rate of attachment. Savings in manufacturing are obtained by elimination of solder, soldering iron with its replacement and maintenance costs and a saving of the electrical power required to operate soldering equipment.

Development of a solderless wire-wrap connection provides a new technique for making solderless electrical connections. The wire is wrapped around the terminal using a specially designed air or electric tool. Sufficient tension is developed so that the resulting bond becomes permanent, both electrically and mechanically. This method not only eliminates all need for solder, but since it is made with a power tool, less time is required than for hand wrapping.

special techniques

Modular design for electronic equipment is aimed at breaking a potential bottleneck that might occur in an all-out emergency and at simplifying equipment. The

Table II — Melting Characteristics of Solder

Solder Alloy percent tin	Composition percent lead	Temp at Which Solder Becomes Plastic in deg F	Temp at Which Solder Becomes Liquid in deg F
0	100	—	620
5	95	522	597
10	90	435	576
15	85	361	554
20	80	361	536
25	75	361	514
30	70	361	496
35	65	361	477
38	62	361	468
40	60	361	460
45	55	361	437
48	52	361	424
50	50	361	414
55	45	361	391
60	40	361	370
63	37	*	361
65	35	361	364
70	30	361	367
75	25	361	378
80	20	361	390
85	15	361	403
90	10	361	415
95	5	361	432
100	0	—	450

*Eutectic alloy is formed having one sharp melting point and no plastic range

FIG. 10—Soldering of leads to octal plug is performed by first fluxing connections then dipping part in soldering pot, rear

heart of one system is a ceramic wafer, $\frac{7}{8}$ inch square and $\frac{1}{16}$ inch thick. After being stamped and pressed, the wafers are oven cured. Notches on all four sides are silver-painted for circuit connection use. After fabrication they are sorted automatically for proper positioning of capacitors or resistors of the required value. Complete assembly of the wafer-mounted parts is done on a single machine. They are then fed into a machine for automatic soldering. The final modules, which may consist of four to six wafers with their associated resistors and capacitors, are assembled, soldered and then connected automatically to a tube base. In turn, connections are made to a base plate produced by a printed circuit process to form the final subassembly.

Another automatic production technique revolves around a machine that solders many joints at one time by dipping an inverted television chassis in a solder pot of sufficient size. Preceding the dip soldering operation, a chassis has ground pins and spring washers installed by semiautomatic machinery. The chassis are then fed into a large press which inserts a large quantity of rivets into pin plates and terminal strips in one stroke. The terminal pins receive the components designed for them and the chassis is dip-soldered.

printed circuits

When a circuit is produced upon an insulating surface by any process it is termed a printed circuit. There are six main classifications: painting, spraying, chemical deposition, vacuum processes, stamping and dusting. In painting, conductive and resistive paint is applied by brush or stencil. Later capacitors and tubes are added. Resistive and conductive paint may also be applied by spraying. In chemical deposition, a chemical solution is poured over an insulating surface covered with a stencil and a metallic film precipitated out to form the circuit. The circuit may also be electroplated. In vacuum processes, the conductors and resistors are distilled onto the surface.

Other methods include die stamping in which conductors are punched out of metal foil and then attached to the insulating panel and dusting wherein conductive powders are dusted onto a surface through a stencil and then fired. The powder may be held electrostatically or by a binder. In addition to these printing processes, photoetched circuits are also referred to as printed circuits.

A printed circuit replacement for waveguides is composed of some base metal which is a fairly good conductor such as aluminum or copper. On to this is securely fastened by pressing, a material such as polystyrene. Next to this insulator is the foil, photoetched in particular a design together with the components, resistors, connections, etc. Sometimes a double arrangement is made resulting in a sandwich. It is used principally in microwave circuits as a substitute for the plumbing generally used.

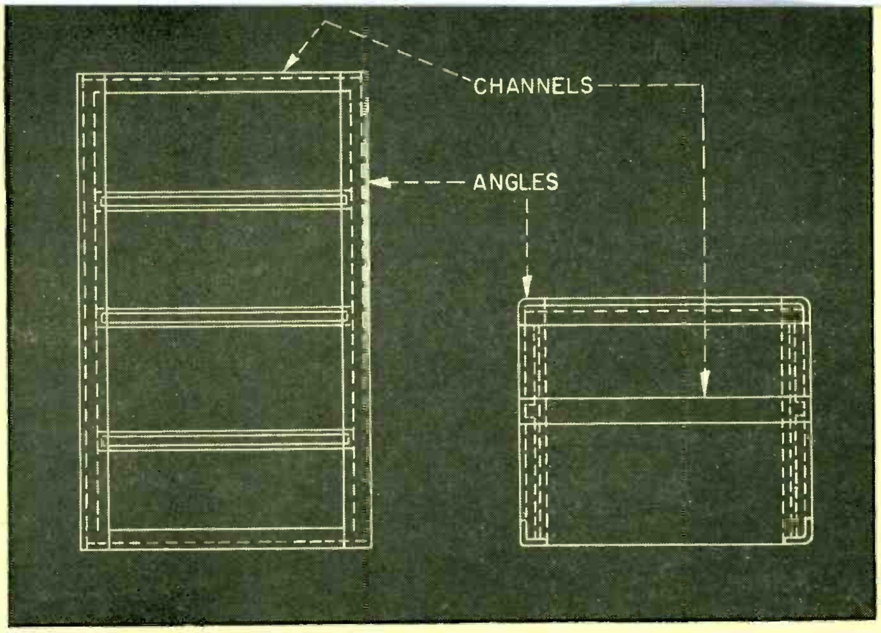


FIG. 1—Plan and front elevation of a Christmas-tree frame. This provides a rigid structure of channels to which panels can be fastened. Chassis are mounted in horizontal drawers

Designing the Cabinet . . .

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Environmental conditions strongly influence design of military and commercial electronic equipment. Some cabinets even permit operation underwater, in explosive atmospheres or while subjected to severe shock, vibration and extreme climatic conditions

MECHANICAL DESIGN of cabinets for electronic equipment depends primarily upon the size and function of the equipment and the environment in which it must operate. Environmental conditions include shock, vibration, extreme temperatures, salt spray and high humidity. Equipment may also be designed for operation at high altitudes, underwater and in explosive atmospheres.

construction

Stationary equipment such as large-scale computers and telephone amplifiers is not ordinarily required to function under conditions of shock and vibration. Such equipment is designed primarily from consideration of static loading.

Equipment built as a single unit, such as the power amplifier of a transmitter, presents an individual design problem. However, heavy components such as power and modulation transformers, filter capacitors and chokes should be mounted near the bottom of the cabinet to reduce static loading of upright structural members.

Heat dissipating components such as power amplifying and rectifying tubes should be mounted clear of other objects to permit convection cooling. A blower may have to be installed to provide necessary movement of cooling air. The air intake should be located near the bottom of the cabinet with the outlet provided by perforated side panels or louvers near the top.

When locating shelves or other functional supports within the cabinet consider their effect as baffles in the air cooling system. The air intake should be furnished with a glass fiber or other filter to avoid dust deposits within the cabinet that may cause short circuits. In many transmitter locations it may be necessary to install ducting connecting the air intake, outlet or both to the

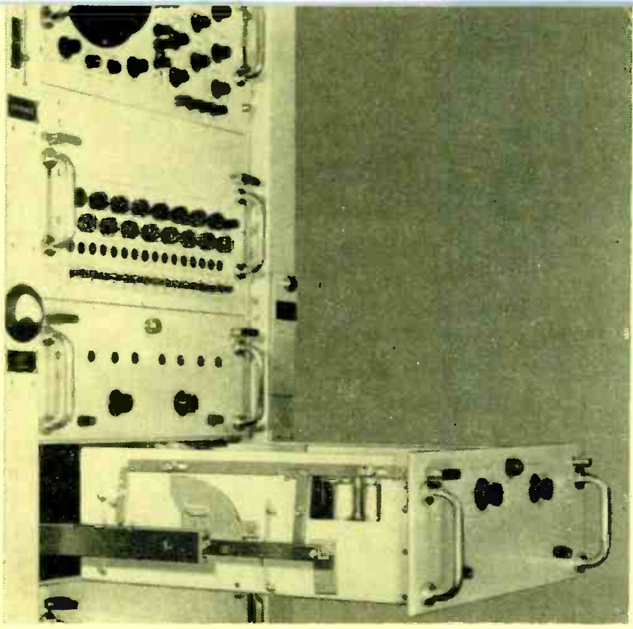


FIG. 2—Drawer type of construction in which broad side of chassis is horizontal

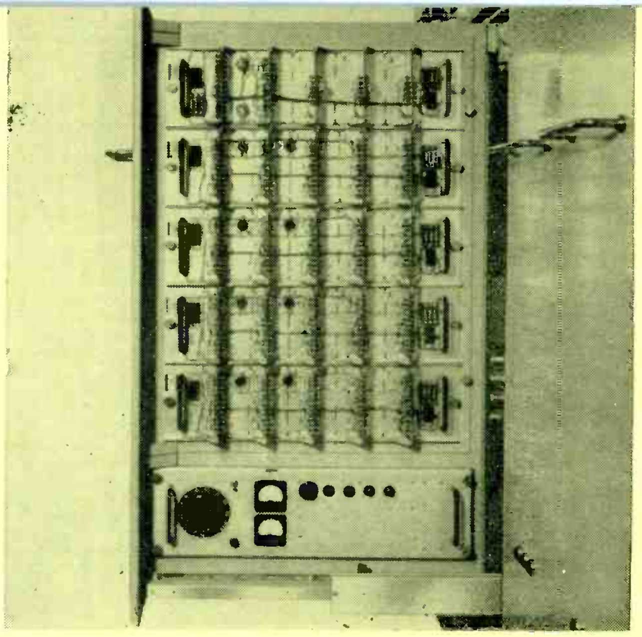


FIG. 3—Drawer type of construction in which broad side of chassis is vertical

outside of the building. Liquid cooling is necessary for some large transmitting tubes but modern practice is to restrict its use as much as possible, especially in military equipment.

relay racks

When equipment is broken down into individual chassis as with telephone amplifiers, diversity receivers, frequency meters and laboratory equipment, relay rack construction is popular. The standard rack stands 76 in. high, is 19 in. wide and 14 in. deep. It has a rectangular framework of welded angle sections. Smallest structural angle is $3 \times 3 \times 3/16$ in. However, for cabinet construction bar angles of mild steel are commonly employed. A list of sizes and weight per linear foot is given in Table I.

Side panels and back panels or doors are pressed from sheet steel. Gages and weight per square foot together with mill tolerances are given in Table II. Mild steel is usually adequate for cabinet work. Where corrosion is a factor, copper-bearing sheet steel may be employed.

Where appearance is important use of galvanized steel may be economically justified by its ease of finishing. Note that in U. S. gages galvanized sheet steel runs 2.5 ounces heavier per square foot. Where additional strength or hardness is required in structural members, steel of higher carbon content may be employed. Use of galvanized steel is commonly avoided in designing government equipment because of difficulties experienced in welding it.

Chassis are mounted in relay racks by either panel or vertical mounting. In panel mounting the chassis is bolted to a front panel and the panel attached to parallel upright members of the rack by countersunk bolts. The broad side of the chassis is supported in the horizontal plane by cantilever action. Heavier chassis may require angle brackets for additional support. Panel mounting has the advantage that the tubes are operated in an upright position.

When subdividing equipment into chassis, functional design is the major consideration. However, mechanically the front panel should be an integral number of inches high. For ease of servicing each unit should weigh no more than about 40 pounds. Military specifications require that chassis or single units weighing in excess of 150 pounds be equipped with hooks for use with mechanical hoisting equipment.

Size restrictions are imposed on marine equipment by hatch and door sizes. Surface vessel hatches are 30×30 in. with round corners on a 7.5-in. radius. Doors are 26×45 in. with round corners on 8-in. radius. Submarine hatches are circles 25 in. in diameter. Doors are 20×38 in. with round corners on 10-in. radius. In both cases the height restriction is 72 in.

In military airborne equipment, panels are usually multiples of 5.5 in. in width and an integral number of inches in height.

One disadvantage of panel mounting aside from the difficulty of servicing is heat dissipation. Often each heat dissipating chassis must be equipped with its own blower. In equipment where more than one relay rack is to be employed, install rectifiers and other heat dissipating units in one rack, mounting the units vertically, and provide an adequate blower if such a layout does not make the cabling too complicated.

vertical mounting

In vertical mounting each chassis is provided with a flange along its narrower dimension. The chassis is bolted to parallel upright members in the rack so that its broad dimension is in the vertical plane. This has the advantage that both the tubes and the components and base wiring are available for adjustment and servicing without removing the chassis from the rack. This type of construction is commonly used for television video equipment.

Single blowers can be installed for a whole relay rack or the front and rear panels left off and cooling equip-

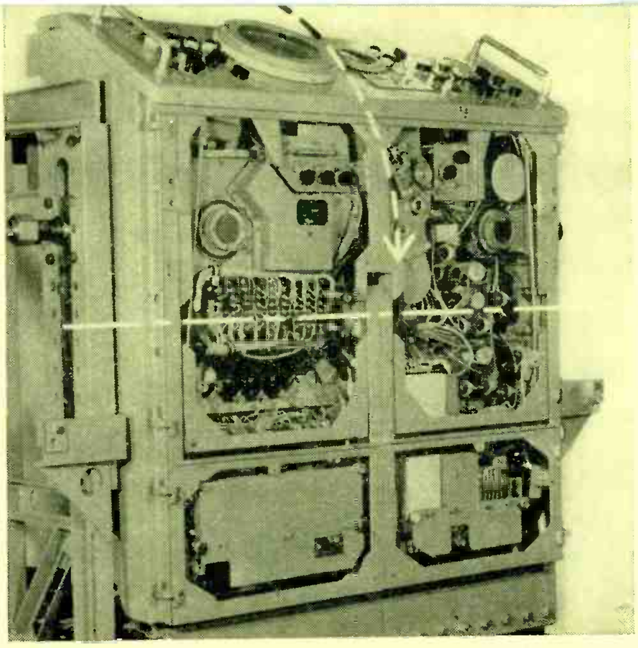


FIG. 4—Hinged chassis pivots about axis indicated. Arrow illustrates how chassis is swung forward and down

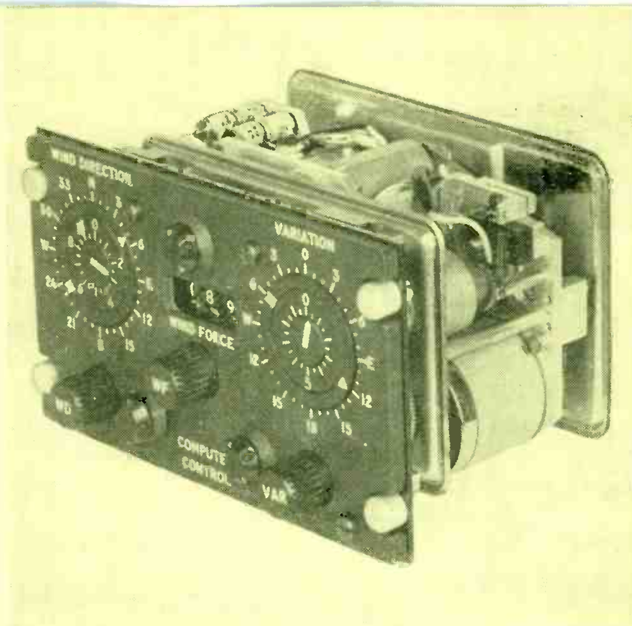


FIG. 5—Front panel of airborne navigational computer, illustrating arrangement of controls

ment installed for the whole operating space. There is some disadvantage when tubes are mounted on their side, which subjects their internal structure to abnormal static loading.

means of access

Accessibility for servicing may be achieved by mounting chassis in removable sliding drawers. This is required quite frequently in military equipment. Where drawer type construction is employed the Christmas-tree frame illustrated in Fig. 1 is used to construct the overall cabinet. Here, mild steel angle sections form the basic rectangular framework that may be strengthened by straps of channel section. Channel sections also divide the cabinet sections vertically and provide support for the drawer mechanisms. The smallest structural channel section is $3 \times 2 \times 3/16$ in. But bar channels are usually used in cabinet construction. Table I lists sizes and weight of bar channel sections.

Among the drawer mechanisms commercially available is one in which the chassis may be tilted upwards after being withdrawn from the cabinet, forming an angle of 30 degrees with the horizontal. Another type is the vertical slide in which the broad dimension of the chassis is vertical in the cabinet. Choice of whether to use a horizontal or vertical slide will depend upon the functions of the chassis themselves and upon their linear dimensions. Horizontal and vertical slides are shown in Fig. 2 and 3.

Where drawer construction is used in portable or mobile equipment precautions must be taken to prevent the chassis rattling in its drawer. The drawer can be driven onto tapered guide pins that lift it off its rollers and lock it in place. This may be done by a tie rod having a knurled knob or a cam rod with a handle. Vertical drawers or slides usually have less depth than horizontal ones. Thus there is less room for the locking mechanism and the drawers may not be secured as well.

Other means for gaining access include hinged chassis, doors and removable panels. The equipment illustrated in Fig. 4 is a radar indicator. The chassis rotates about the axis indicated; its broad side may be swung down to a 60-degree angle with the vertical.

Electronic business machines are designed with doors on the inside of which components are mounted, with servicing test points readily available. In television cameras, components and wiring are mounted on both side panels and on either side of a vertical plate midway between the sides. The side panels fold away, exposing all circuits for servicing or adjustment.

Equipment built as a single unit may be equipped either with doors or removable side and back panels. Where extremely wide equipment racks are employed care should be taken that the door is not too wide to permit opening it in confined quarters. Alternative methods include double doors latching to an upright member in the center of the cabinet's rear face, sliding doors or fold-away doors. These three latter means of gaining access may, however, become sources of vibration trouble in mobile equipment. Thus many marine transmitters still use back and side panels that are secured by captive bolts having knurled or slotted heads.

other materials

Where weight is a factor, as in airborne radio and radar equipment, cabinets may be made from aluminum or magnesium. Aluminum cabinets may be either fabricated from sheet stock and structural sections or cast. Aluminum alloys are available for either sand or permanent-mold casting. Magnesium alloy cabinets are usually cast.

Commercially pure aluminum, 2S, is quite soft and used largely for panels where strength and hardness are not prerequisite. Aluminum alloys, formed by adding small percentages of copper and other metals, provide greater strength and hardness. However, aluminum's natural resistance to corrosion is diminished by alloying. This corrosion resistance may be recovered

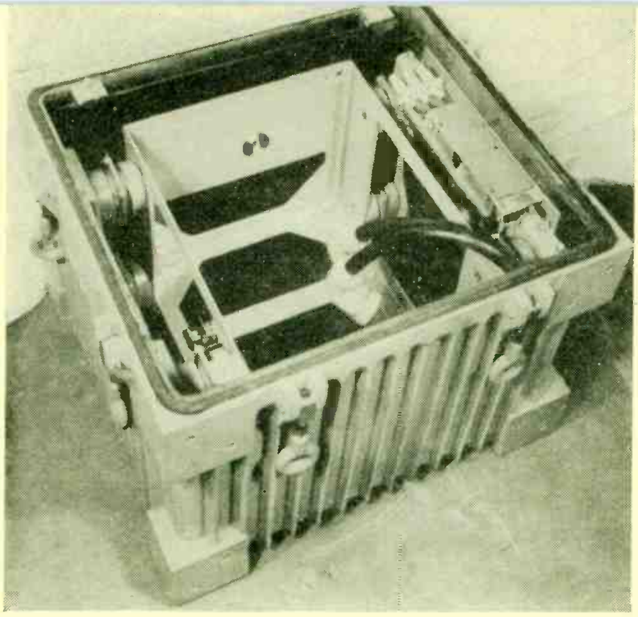


FIG. 6—Cabinet for radio transmitter designed to function underwater; gasket provides waterproof seal

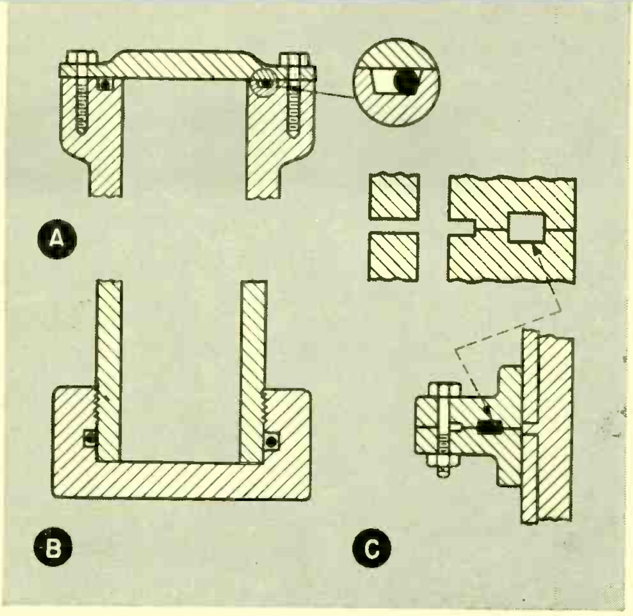
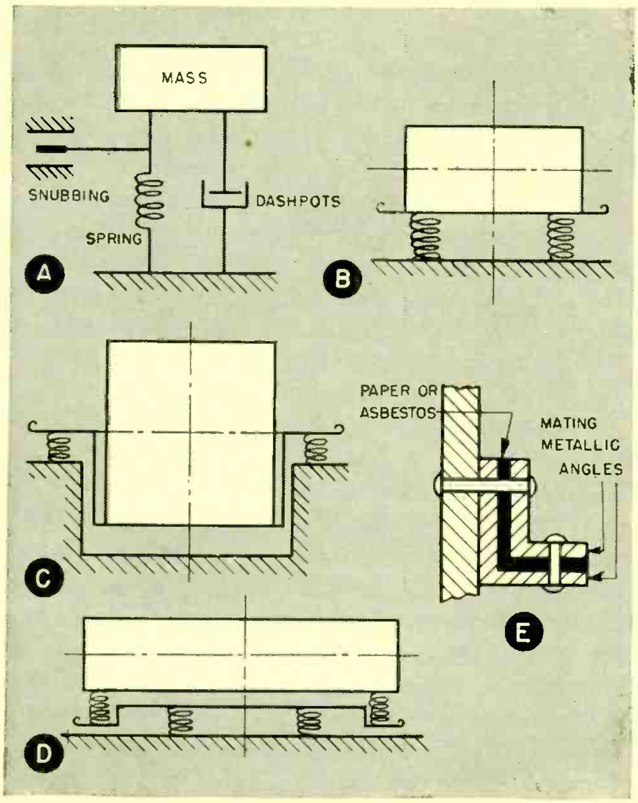


FIG. 7—Three methods utilizing O-rings to seal cabinets of waterproof or pressurized equipment



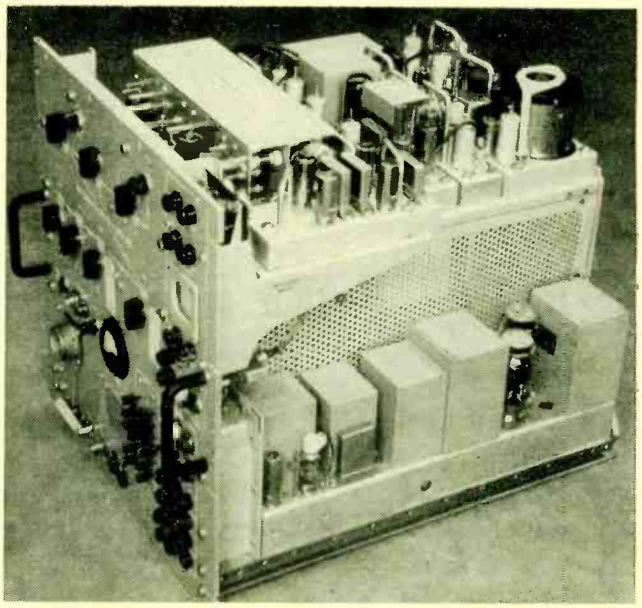


FIG. 8 (left)—Isolation; basic mechanical system of handling vibration (A), three typical methods of applying shock mounts, (B, C, D) and one form of acoustic isolation (E)

FIG. 9 (above)—Military equipment employing modern cabinet design principles. Heavy components are mounted at bottom

to some degree by rolling a coating of commercially pure aluminum onto the structural alloy when the alloy is in the ingot stage.

Structural sections are generally made from alloy 14S. Available sections include angles, unequal angles, channels and flats. Sheet aluminum is available in grades 2S, 3S, 52S, 24S and others. The characteristics of various alloys are given in Table III.

Where strength and hardness only slightly better than 2S is required, 3S may be used without additional cost. However, where strength and hardness are prime considerations 24S is often used.

Commonly used alloys for sand casting are 112, 113 and 212. For permanent-mold casting, alloys 113 and C113 are available. Where only a short production run on cast aluminum chassis is desired, sand casting may be used although for longer runs, permanent-mold casting provides increased production and better finish.

Choice of the proper alloy for casting cabinets is a critical business best done in consultation with either an aluminum supplier or staff metallurgical engineer.

appearance

The external appearance of the cabinet deserves consideration from both esthetic and functional points of view. Modern practice is to avoid sharp corners on cabinets as a safety measure. Doors should have rounded corners and be furnished with stay-open latches for

Table I—Structural Steel Forms for Cabinet Construction

Size (in.)	Weight (lbs per ft)
CHANNELS	
½ × ¼ × ⅛	0.28
1 × ½ × ⅛	0.84
2 × 1 × 3/16	2.32
ANGLES	
1 × ⅝ × ⅛	0.64
1 × ¾ × ⅛	0.70
1 × 1 × ⅛	0.80
1½ × 1½ × ⅛	1.23
1½ × 1½ × 3/16	1.80
1½ × 1½ × ¼	2.34

Table II—Weight and Thickness of Commonly Used Gages of Sheet Steel

USS Gage	Thickness (in.)	Order Limits	Weight (lbs per sq ft)	Weight (galvanized)
11	0.1196	0.1121 0.1270	5.0	5.156
12	0.1046	0.0972 0.1120	4.375	4.531
13	0.0897	0.0822 0.0971	3.75	3.906
14	0.0747	0.0710 0.0821	3.125	3.281
16	0.0598	0.0568 0.0635	2.5	2.656
18	0.0478	0.0449 0.0508	2.0	2.156
19	0.0418	0.0389 0.0448	1.75	1.906
20	0.0359	0.0344 0.0388	1.5	1.656
21	0.0329	0.0314 0.0343	1.375	1.531

the protection of maintenance personnel. Finish is often dictated by military or customer specifications but a dull crinkly finish is preferred both for appearance and to reduce operator fatigue from glare. Shatterproof and glareproof glass for windows in cabinets is often required, as is the use of clips to hold the glass in place—augmenting cement commonly applied. Designers of military equipment must be concerned about light leaks in cabinets. Military equipment must also be furnished with means of dimming panel lights. Use of transilluminated plastic lighting panels is one preferred way to illuminate dials and meters.

controls and indicators

In placing controls and indicators, it is generally desirable to group dials and meters in clusters of no more than five. The controls must be so placed that their manipulation does not interfere with reading dials and meters. The indicators must be legible, which requires that printing be done in strong contrasting colors; it should also be large and without serifs or other distracting embellishments. Counter-type indicators are sometimes preferred to pointer type indicators.

Indicators should be at eye level and controls within convenient reach of the operator. The most infrequently used controls should be placed behind the front panel or in other locations available to the technician. Controls more frequently used but not necessary used for normal operation should be located behind hinged doors to reduce operator confusion from too vast an array of controls. Factory adjustments must be clearly indicated, such as by painting, and daubed with Glyptal or a similar compound to prevent tampering. A well-designed control panel is illustrated in Fig. 5.

Cabinets for marine equipment or other gear designed to function while exposed to the elements are either drip proof, splash proof or waterproof. Drip proofing is provided by avoiding openings in the top of the cabinet, crowning the top surface for good drainage and designing louvers so that water will drain off. Splash proofing involves design of baffles to prevent water from reaching the circuits.

waterproofing

These methods stop short of actual waterproofing, which is reserved for equipment that is to function while submerged. This includes radio equipment for mounting on decks of submarines (Fig. 6), underwater television equipment etc. Waterproofing is achieved by use of gaskets and specially designed flanges as illustrated. Similar techniques are used when it is necessary to pressure seal equipment for operation at high altitudes or in explosive atmospheres. The gaskets used are often synthetic rubber O-rings. These may be backed up by leather or fiber washers where high pressure sealing is required. Sealing rings are available in special cross

Table III — Mechanical Characteristics of Aluminum Alloys

Alloy	Tensile Strength (lbs per sq in.)	Yield Strength (lbs per sq in.)	Brinell Hardness
WROUGHT ALLOYS			
2S	13,000	5,000	23
3S	16,000	6,000	28
14S	27,000	14,000	45
24S	27,000	11,000	47
A51S	48,000	43,000	100
52S	27,000	12,000	45
61S	18,000	8,000	30
75S	33,000	15,000	60
SAND-CAST ALLOYS			
112	19,000	15,000	70
113	19,000	15,000	70
195	29,000	16,000	60
212	19,000	14,000	65
PERMANENT MOLD CAST ALLOYS			
113	24,000	19,000	70
C113	25,000	24,000	80
B195	33,000	19,000	75

sections as well as the usual O shape. Three common ways of making an O-ring seal are illustrated in Fig. 7. Sealing inhibits ventilation and cooling the equipment may become a serious problem. Fins are added that increase the surface area exposed to the water, so that heat may be dissipated.

Where equipment is to be operated in an explosive atmosphere, means must be provided to eliminate sparking in the equipment and to insure that if sparking does occur resulting hot gases will be contained and not spread to the outside atmosphere.

Sparking may be reduced by using mercury switches and nonarcing relays. To contain any explosion that may occur, equipment can be housed in dome-shaped cast steel structures. These are equipped with wide flanges so that escaping hot gases will be cooled before reaching the explosive atmosphere outside.

An air purge may also be used. Here inert gas or air free of explosive gases is supplied to the equipment housing or, in some cases, to the entire equipment space under a static pressure greater than atmospheric. This technique keeps the explosive gases away from sources of flame.

As in the case of waterproof equipment, explosion proofing increases the cooling problem. Solutions include separating equipment that might spark from heat dissipating circuits and mounting the latter outside the housing, furnishing the housing with cool air under pressure, providing the housing with cooling fins and derating components to be located within the housing.

Equipment, such as missiles, which may be stored for an indefinite period but must give 100-percent performance when taken from the shelf is often hermetically sealed and filled with dry nitrogen to prevent corrosion.

mobile equipment

In a sense, all modern equipment must be transportable. Formerly, large transmitters were erected on the site but today even these units and items such as large scale computers are broken down into smaller units and shipped to point of use. In such cases, however, protection from shock and vibration while in transit is the responsibility of the packaging engineer.

Equipment designed for installation aboard ships, planes or motor vehicles must maintain its functional performance under varying conditions of shock and vibration. Such mobile equipment is subjected to both primary and secondary motions. The former are the motions of the vehicle while the latter include motions of equipment or component parts induced by the primary motion. A prime function of the cabinet designer is to eliminate secondary motion or to limit it so that fragile electronic parts will not be damaged or their life unduly shortened by fatigue.

vibration

Basically vibration is a periodic motion that occurs when an elastic system is displaced from its equilibrium position and released. When a mechanical system is excited at its natural resonant frequency, the disturbance is apparently amplified, by a means analogous to the voltage amplification across a parallel resonant circuit excited at its resonant frequency.

A piece of electronic equipment is an aggregation of simple mechanical systems. For a complex system there are a great number of natural frequencies or modes of vibration. If excitation is applied, all these modes will appear—some to a greater extent than others. If the excitation is too great the amplitudes of the various modes may be sufficient to cause failure of electronic components.

If equipment is designed so that its lowest mode of vibration occurs at a frequency higher than any anticipated forcing frequency (primary motion) no modes of vibration will be excited in the equipment. This is the principle of rugged design.

vibration isolators

When equipment must function in the presence of primary motions having such high frequencies that it

Environmental testing. Equipment at left is readied for test in Signal Corps' stratosphere chamber. Center photo shows chamber for 50-hour salt-spray test. Resistance to ice and snow is determined by testing equipment in cold room, right

is impossible to design equipment all of whose modes of vibration occur at higher frequencies, vibration isolators must be employed.

In equipment for conventional aircraft, the effects of vibration may be limited by use of soft isolators such as shock mounts.

A vibration isolation system using shock mounts is shown in Fig. 8A. It consists of resilient cushions such as steel springs, rubber mounts or mounts of composition material. Also shown is a method for snubbing or limiting the maximum excursion of the system under extreme overloads. Captive features in the mounts will prevent the unit becoming a missile should the spring or rubber be destroyed or disintegrate. Two typical systems of mounting are shown. Center-of-gravity mounting, Fig. 8C, is commonly used for military equipment. Double shock mounting, Fig. 8D, has sometimes proved ineffective.

Equipment for use in modern military aircraft must undergo vibration tests up to 500 cps or higher for pulse jets and rockets. At such high frequencies of vibration conventional isolation methods are sometimes ineffective. The problem may become an acoustical one. One method of vibration isolation, shown in Fig. 8E, involves the use of a laminated framework in which fiber or asbestos is introduced between metallic laminations to provide an acoustic block.

rugged design

In the case of shipborne equipment, Navy specifications call for vibration test in the range 5 to 23 cps at an amplitude of 0.03 in. and at a greatly reduced amplitude up to 35 cps. Resonance will be avoided in these tests only if the lowest mode of vibration is above these frequencies.

Mounting the cabinet on shock mounts may be ineffective since the resonant frequency of some shock mounts is about 30 to 35 cps and no isolation is provided below 50 cps. Rather than attenuation of vibration amplitudes, there is an amplification. One answer is to design the equipment so that all modes of vibration are above the test range. This implies that the stiffness of supporting structures such as brackets, clamps and chassis should be checked so that the natural frequency is within the correct range.

Simple mechanical systems like a transformer and its supporting bracket, or a transformer in the middle of a chassis may be checked by load deflection tests. For example, if a transformer-bracket combination should have a resonant frequency not lower than 50 cps then the static deflection of the bracket at the load should not exceed 0.004 in. This is obtained from

$$D = 10/f^2$$

where f is the natural frequency.

When assemblies become more complex, frequency response can be investigated on a vibration table. This may be done early in development. It is good practice to require components to pass a vibration test; every chassis should be subjected to similar treatment.

Such procedures will often reveal failures recognized at once as design shortcomings and at other times construction or assembly weaknesses.

Among design failures must be counted the so-called oil-canning of transformers and other solid massive components on the chassis. Motion of these components causes the broad side of the chassis to vibrate in a two-dimensional mode. The effect is similar to that produced by displacing and releasing the sides of a large rectangular oil can. It is extremely destructive of fragile electronic components.

Oil-canning can be reduced by dividing a chassis into several subchassis possibly held together by a rigid framework. Also, heavy components such as transformers and chokes should be mounted near corners to derive added support and transmit secondary vibrating motions of the part to the framework where the motions will be damped out.

The supporting framework and the various drawers or chassis assemblies make up another resonant system. For example, a drawer that contains transformers may be considered to be a solid mass compared to the framework of the supporting cabinet. The stiffness of this framework must be sufficiently high so that it does not have a low mode of vibration. Providing vibration or shock mounts for such a cabinet is sometimes ineffective since the lowest mode of vibration of the cabinet itself is below the minimum allowed. Therefore the framework of a cabinet should be sufficiently rigid to be compatible with the subassemblies which it must support. Rigid frames do not imply heavier frames but frames designed to make better use of the cross-sectional areas.

It should be noted that the amplifying effect of cabinet resonances requires that component subassemblies be tested on the vibration table at amplitudes higher than that of the cabinet as a whole.

shock resistance

Protecting electronic gear against shock is related to the modes of vibration. Shock is a transient motion with a finite time interval. If there is a proper ratio between this time interval and the period of the mode the chances are excellent that no interruption of the functional operation of the equipment will occur. It is impractical, however, to protect equipment against any and all shocks. It has been shown that shock mounts giving a natural period of 30 to 35 cps and a displacement capacity of about ½ inch provide excellent shock protection for shipborne equipment.

Some of the important steps in designing a cabinet may be summarized. Design a substantial, rigid frame compatible with the weight it must support. Put heavy components such as transformers near the base. Locate fragile components like tubes and relays in the center of the cabinet away from locations where vibration and shock disturbances are transmitted to the cabinet. Select rigid supporting brackets and tie them in properly with the frame. Make all clamping positive and avoid springs for holding parts in place.

Although such requirements may seem incompatible with weight saving, they are actually conducive to such a program. Rigidity and light weight are both associated with higher natural frequencies and any procedure that considers the dynamic response of a system will automatically result in weight saving. Selection of lighter materials is also part of the design procedure. The equipment illustrated in Fig. 9 bears out many of the foregoing suggestions.

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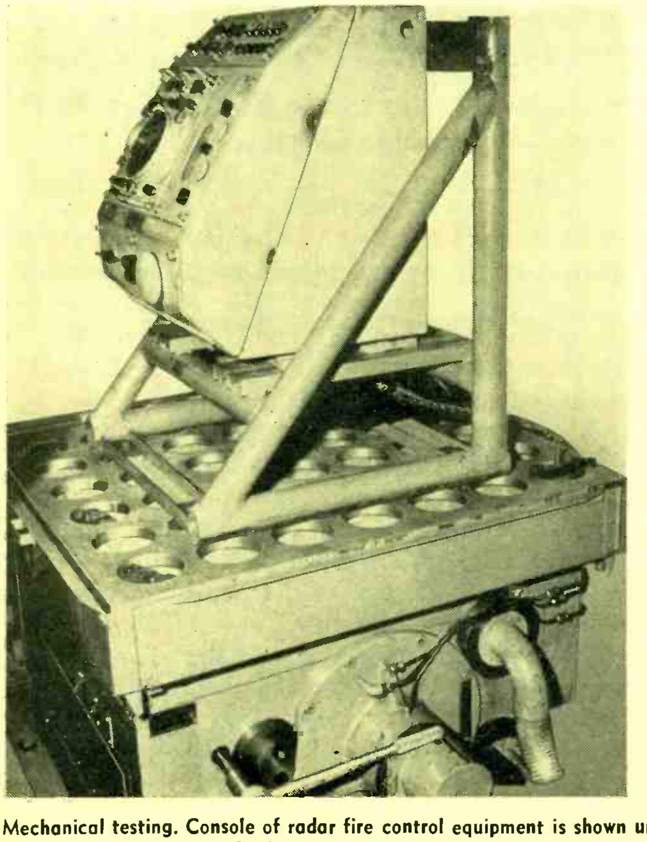

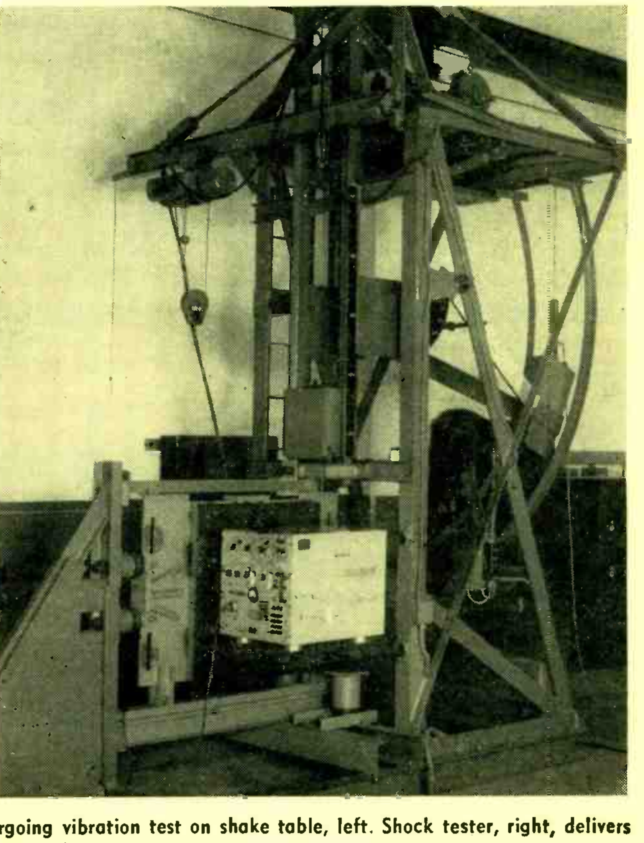

Mechanical testing. Console of radar fire control equipment is shown undergoing vibration test on shake table, left. Shock tester, right, delivers either horizontal impact shocks, by hammer, or vertical shocks by dropping test platform

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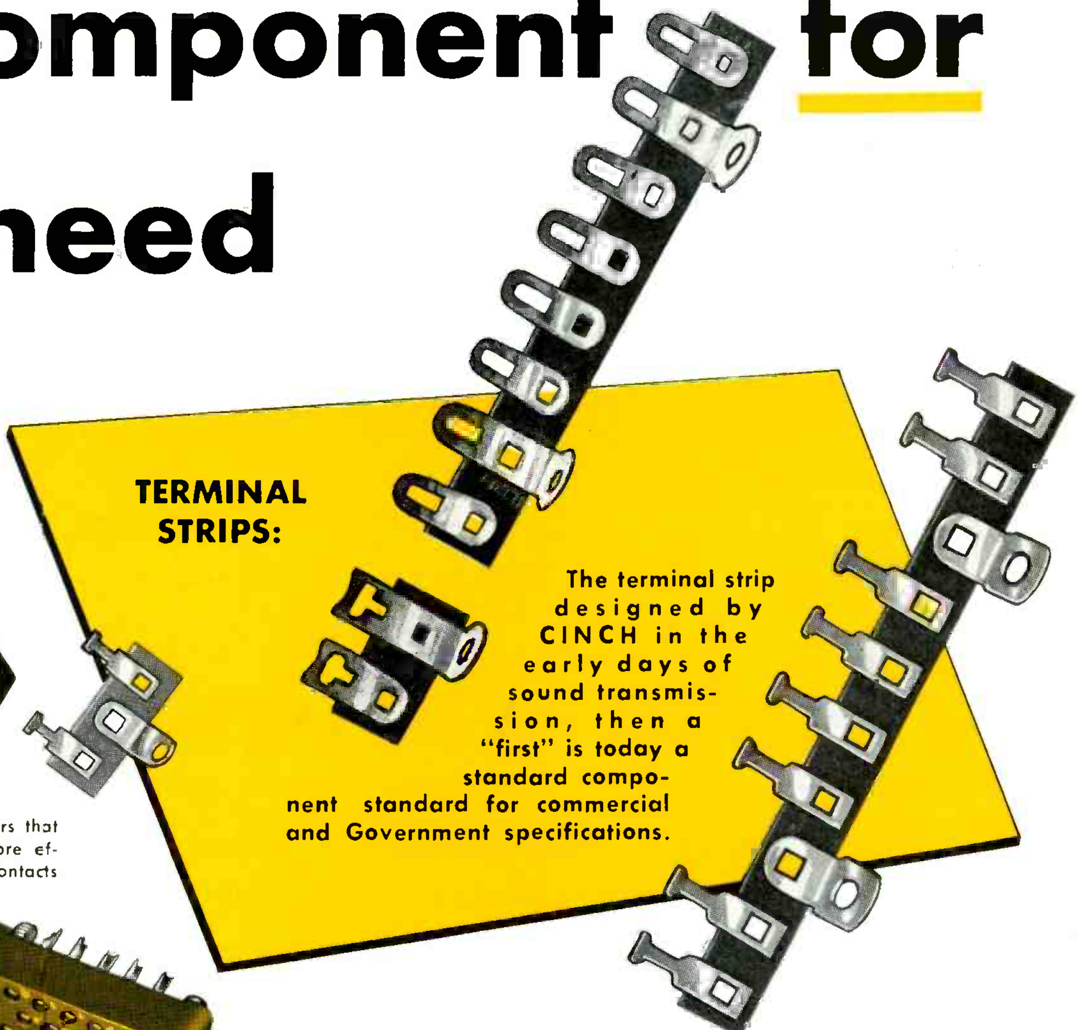

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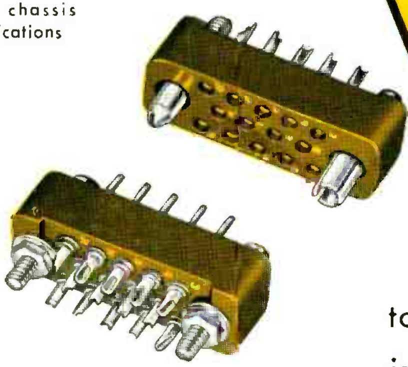

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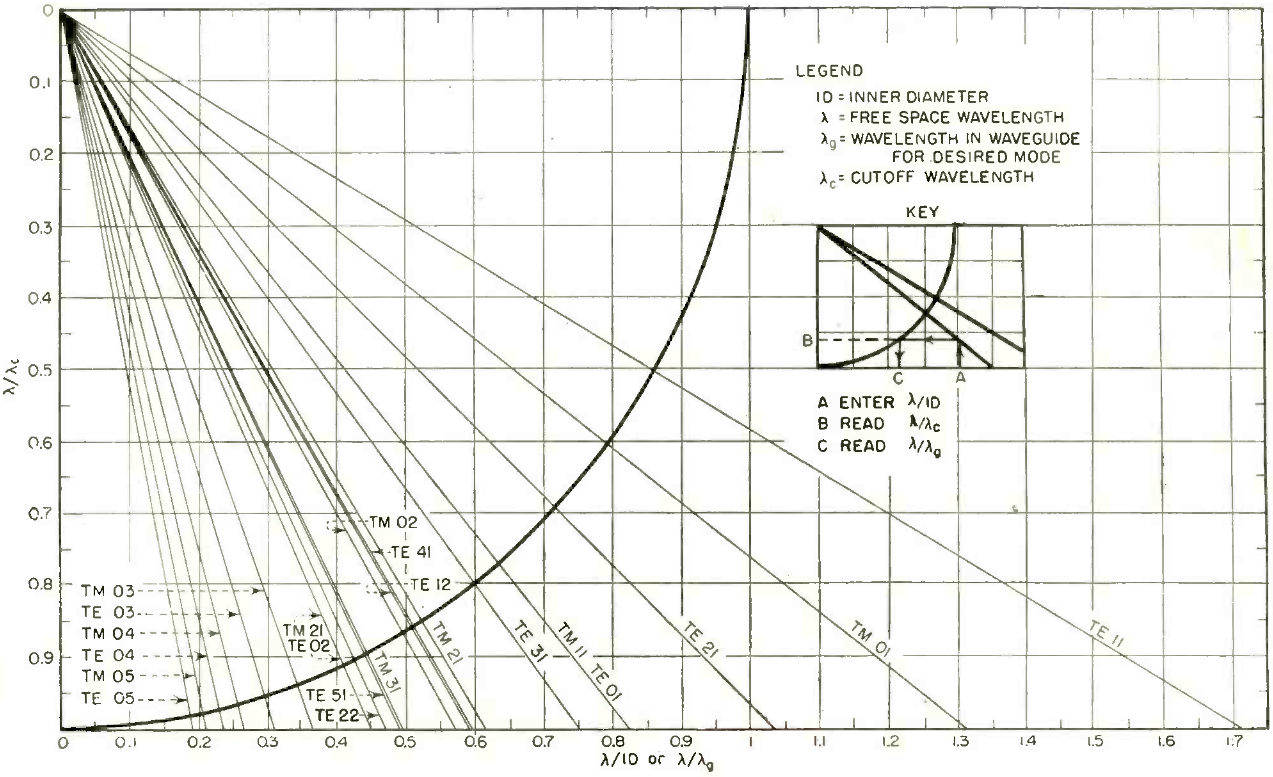

Circular Waveguide Chart

Aids in determination of guide wavelength for various modes of propagation in circular waveguide, gives cutoff wavelength for each mode and may also be used to calculate attenuation beyond cutoff for any shape guide

By A. C. HUDSON

National Research Council Radio and Electrical Engineering Division Ottawa, Canada

GIVEN a circular copper tube of inner diameter 9 centimeters, find: (a) what modes will propagate at a frequency of 3,000 mc; (b) what the cutoff wavelength is for these modes; (c) what guide wavelength is at this frequency for each mode.

A frequency of 3,000 mc corresponds to a free-space wavelength λ of 10 cm; calculate λ/ID to be 1.11 (ID is the inner diameter); find this value on the base of the chart and project it vertically. The only two diagonal straight lines that intersect this value are marked TM_{01} and TE_{11}. Thus these two modes provide the answer to (a).

Project these intersections horizontally on the chart to find that λ/λ_c is 0.85 for the TM_{01} case and 0.65 for the TE_{11} case. Dividing 10 (the free space wavelength λ) by these figures in turn will give cutoff wavelengths λ_c of 11.77 cm for the TM_{01} mode in 9-centimeter tubing and 15.39 cm for the TE_{11} mode.

Where these horizontal projections intersect the curved line, read the horizontal scale on the chart to find that λ/λ_g is 0.522 for the TM_{01} mode and 0.757 for the TE_{11} mode. Dividing 10 by these factors will indicate that λ_g is 19.15 cm for the TM_{01} mode and 13.20 cm for the TE_{11} mode.

A further use for the chart is the calculation of attenuation constant for any waveguide beyond cutoff where, as usual, copper losses are neglected. The following example will explain this method of using the chart.

Given a waveguide of any cross-section with λ_c known to be 2.5 cm, what will be the attenuation for a wave of free-space wavelength = 5.9 cm?

Calculate λ_c/λ = 0.424 and assume that the ordinate scale of the chart marked λ/λ_c reads λ_c/λ.

Find 0.424 on this scale and determine its intersection with the curved line as 0.905.

Call this value A and multiply it by $54.6/\lambda_c$, giving a value $54.6A/\lambda_c = 19.75$. This is the required attenuation in db per cm.

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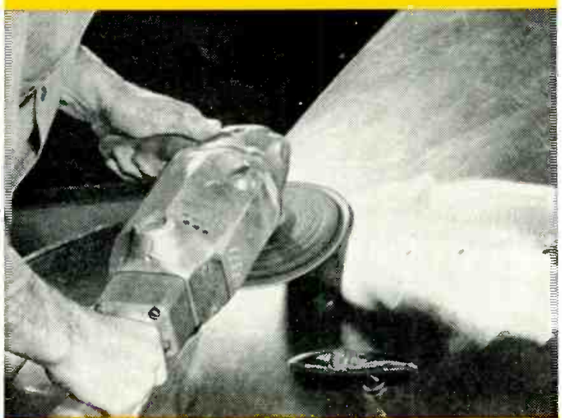

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ELECTRONS AT WORK

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS featured in this issue:

Military Carrier Telegraph Equipment

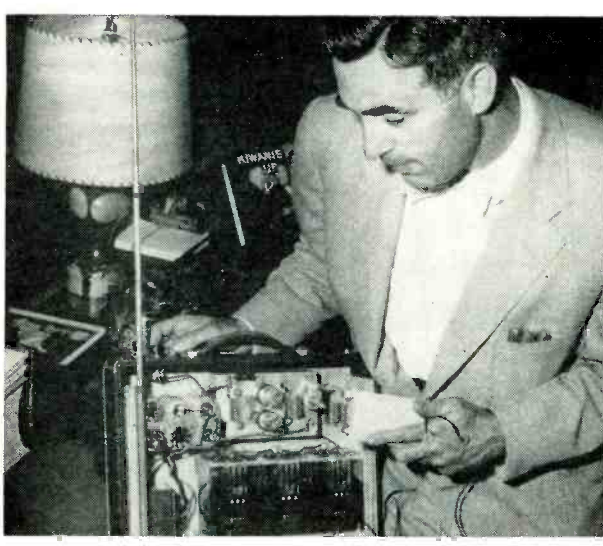
By J. EDWIN BOUGHTWOOD
and CLIFFORD H. CRAMER
Development and Research Dept.
The Western Union Telegraph Co.
New York, N. Y.

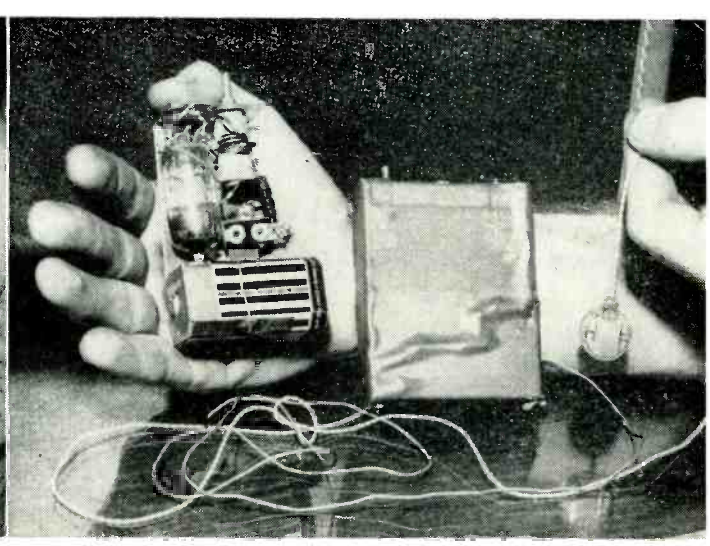
NEW CARRIER TELEGRAPH equipment specifically designed for long-distance military communications, superior in performance and adaptability to equipment currently available, will soon be produced in quantity for military radio communication networks.

Telegraph terminal AN/FGC-29 provides 16 frequency-shift carrier channels spaced 170 cycles apart from 425 to 2,975 cps, capable of teletypewriter operation at speeds up to 100 words a minute. Each carrier channel employs a dual receiver arranged for operation in conjunction with two-path diversity radio transmission, either space or frequency diversity or both. Diversity operation is commonly used on long-distance radio circuits to mitigate the effects of selective fading.

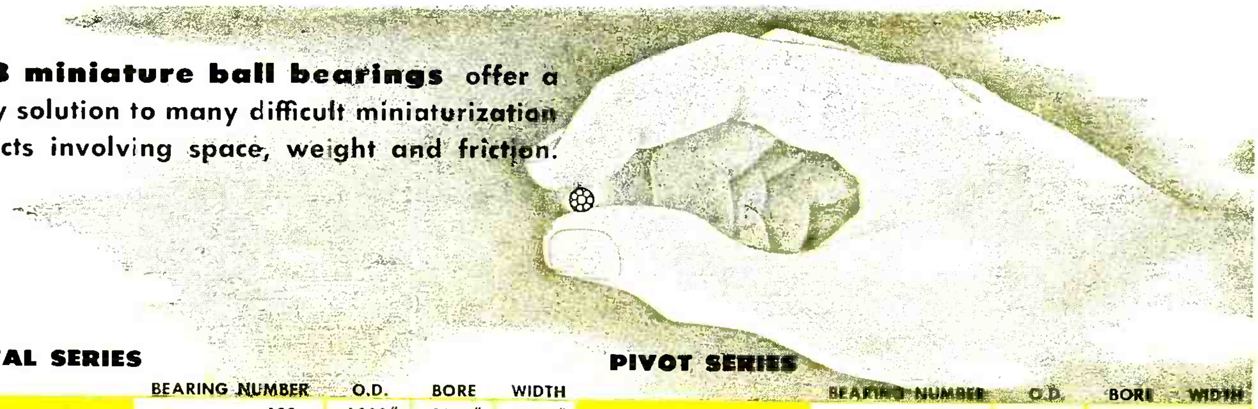
Signals incoming over the two radio paths are receivd by the dual-channel receiver of the new terminal and are then combined by a new method, called ratio squaring. Systematic time phase difference in the two paths is corrected by use of adjustable time-delay equalizers. This method of combining provides a 3-db improvement of signal to noise in addition to the normal diversity improvement factor. Under ad-

Illegal Radio Shocks Bettors





Compact radio transmitting and receiving equipment shown above was seized by New York police in a raid on country-wide gambling operation. Radio transmitter built into suitcase (left) provided an intermediate step for a tipoff system that sped racing information direct from track to vicinity of betting parlors. Official holds tiny receiver that gave coded shocks to user through dimes placed against skin. Another type of portable equipment (right) small enough to fit in the palm of the hand formed a further link in the illegal communications chain. Circuit details of such equipment are not released for publication



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RADIAL SERIES

BEARING NUMBER	O.D.	BORE	WIDTH
100	.1000"	.0250"	.0312"
2	.1250"	.0400"	.0469"
2½	.1562"	.0469"	.0625"
3	.1875"	.0550"	.0781"
▼4	.2500"	.0781"	.0938"
▼5	.3125"	.0938"	.1094"

PIVOT SERIES

BEARING NUMBER	O.D.	BORE	WIDTH
1½P	.0590"	.020"†	.0472"
3P	.1181"	.030"†	.0709"
4P	.1575"	.040"†	.0945"
▼5P	.1968"	.050"†	.1181"
▼7½P	.2953"	.075"†	.1772"
▼10P	.3937"	.100"†	.2362"

SUPER-LIGHT RADIAL SERIES

BEARING NUMBER	O.D.	BORE	WIDTH
418	.2500"	.1250"	.0938"
▼518	.3125"	.1250"	.1094"
5532	.3125"	.1562"	.1094"
5632	.3125"	.1875"	.1094"
5732	.3125"	.2188"	.1094"
614	.3750"	.2500"	.1250"

GROOVED RADIAL SERIES *(Full Race or Retainer Type)*

		O.D.	BORE	WIDTH
3G	3GC	.2188"	.0550"	.0781"
4G	4GC	.2182"	.0781"	.0938"
5G	5GC	.3438"	.0938"	.1094"
518G	518GC	.3438"	.1250"	.1094"
5532G	5532GC	.3438"	.1562"	.1094"
5632G	5632GC	.3438"	.1875"	.1094"

FLANGED RADIAL SERIES *(Full Race or Retainer Type)*

		O.D.	BORE	WIDTH
2½F	2½FC	.1562"	.0469"	.0625"
3F	3FC	.1875"	.0550"	.0781"
4F	4FC	.2500"	.0781"	.0938"
5F	5FC	.3125"	.0938"	.1094"
418F	418FC	.2500"	.1250"	.0938"
518F	518FC	.3125"	.1250"	.1094"
5532F	5532FC	.3125"	.1562"	.1094"
5632F	5632FC	.3125"	.1875"	.1094"

RADIAL RETAINER SERIES

	O.D.	BORE	WIDTH
2½C	.1562"	.0469"	.0625"
3C	.1875"	.0550"	.0781"
4C	.2500"	.0781"	.0938"
5C	.3125"	.0938"	.1094"
418C	.2500"	.1250"	.0938"
518C	.3125"	.1250"	.1094"
5532C	.3125"	.1562"	.1094"
5632C	.3125"	.1875"	.1094"

ANGULAR CONTACT SERIES

	O.D.	BORE	WIDTH
2A	.1250"	.032"†	.0469"
3A	.1875"	.048"†	.0700"
▼4A	.2500"	.063"†	.0938"
▼6A	.3750"	.094"†	.1406"
6A7B	.3750"	.125"†	.1406"

THRUST SERIES

	O.D.	BORE	WIDTH
2T	.1250"‡	.0400"§	.0625"
4T	.2500"‡	.0938"§	.0938"
5T	.3125"‡	.1250"§	.1250"
6T	.3750"‡	.1875"§	.1500"
7T	.4375"‡	.1250"§	.1875"

SPRING SEPARATOR SERIES

	O.D.	BORE	WIDTH
5S	.3125"	.0938"	.1094"
518S	.3125"	.1250"	.1094"
5532S	.3125"	.1562"	.1094"
5632S	.3125"	.1875"	.1094"

SEPARABLE MAGNETO SERIES

	O.D.	BORE	WIDTH
3M	.1875"	.0550"	.0781"
4M	.2500"	.0781"	.0938"
5M	.3125"	.0938"	.1094"
518M	.3125"	.1250"	.1094"

Prefixes indicate material: Standard is chrome bearing steel (SAE 52100): use no prefix. All bearings also available in 440 stainless, except #100 and #1½P. Use prefix "SS" in ordering stainless. ▼Indicates also available in 25 beryllium. Order with prefix "NM". Suffixes indicate type of bearing: F—flange, G—groove, M—magneto, C—retainer, S—spring separator, T—thrust, P—pivot, A—angular contact, FC—flanged with retainer, GC—grooved with retainer. Complete load ratings are given in catalog. †Shaft (S); ‡ O.D. clearance of opposite race .002"; §Bore clearance of opposite race .002".

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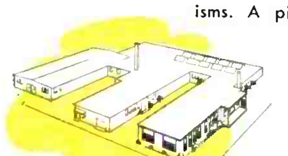

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verse fading conditions, further improvement is obtained by combining two dual channels (4 paths), reducing the number of telegraph circuits per terminal to eight.

In addition to carrier telegraph equipment the terminal includes multiplexing equipment to derive two 3-kc voice-frequency bands from each of the two 6-kc sidebands of the radio facility. These bands can be used simultaneously for telegraph, telephone or facsimile transmission. Equalizers and amplifiers are also provided to permit operation over cable pairs to remotely located radio stations.

Mechanically, terminal AN/FGC-29 is ruggedized to withstand the rigors of military transportation and service. Requirements include unusual resistance to shock and vibration, storage without damage at temperatures from minus 80 F to plus 160 F and satisfactory performance under ambient temperatures from 32 F to 122 F and relative humidities to 95 percent.

A complete terminal, shown in Fig. 1, comprises six cabinets, two (left) for transmitting equipment and four for receiving equipment, each 75 inches high, 22½ inches wide and 24 inches deep. Sending and receiving units are completely independent and need not be installed in the same location. Installation is simple, involving little more than provision of a-c power and telegraph loop circuits. Interconnections between and within cabinets are made with plug-in multiconductor cables; neither wiring lists nor soldered connections are required.

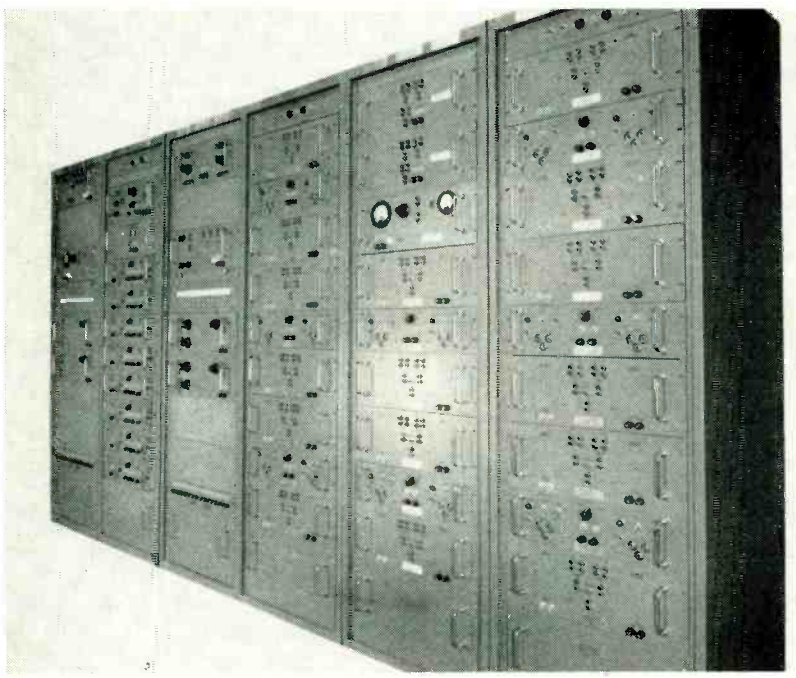


FIG. 1—Complete carrier-telegraph terminal. Two transmitting cabinets are at left. Four others are for receiving circuits

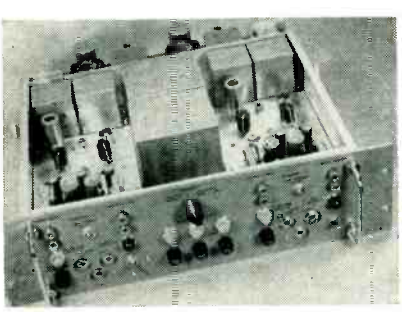


FIG. 2—Channel transmitter drawer is typical of chassis construction

Drawer-type chassis construction is used for maximum accessibility and drawers can be drawn out for maintenance work on top or bottom of the chassis without interrupting service. Drawers associated only with specific channels can be removed from the cabinets without interfering with the rest of the system. Drawers containing multiplexing equipment and equalizer-amplifier equipment are independent units complete with power supply. They can be removed from the drawer slides and installed at a remote location by front-panel mounting on any standard 19-inch relay rack. No wiring changes are required at the terminal when this is done; circuit connections are restored by use of dummy connector panels.

A channel transmitter drawer containing sending equipment for two channels and typical of chassis construction is shown in Fig. 2.

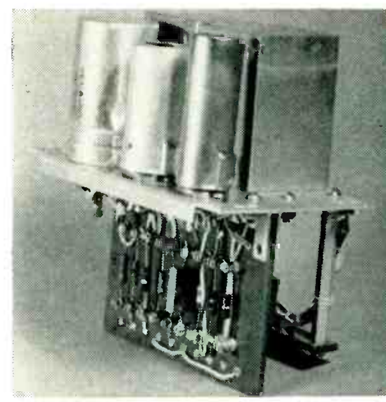


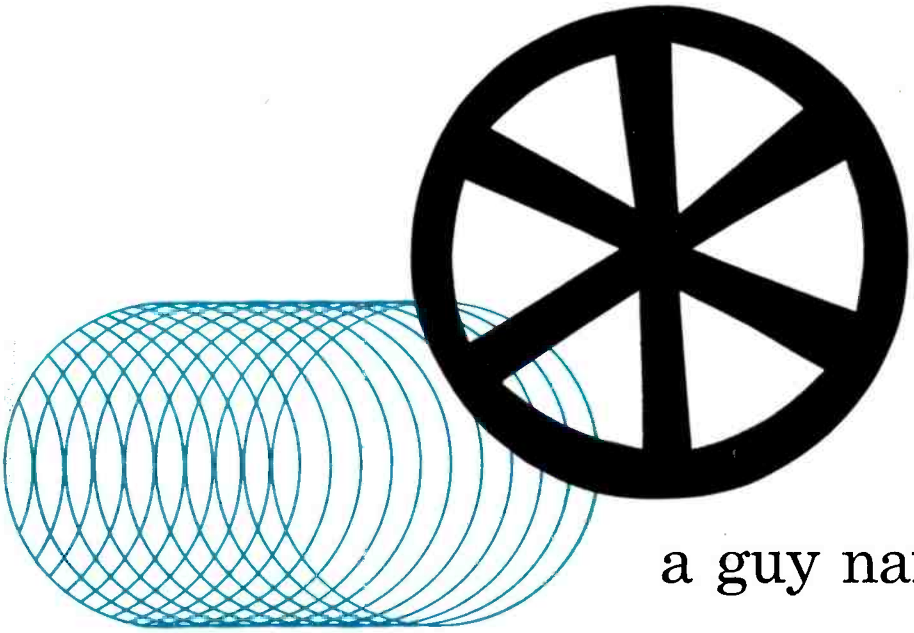
FIG. 3—Subassembly is representative of unitized construction

The drawer chassis forms a framework on which are mounted unitized subassemblies, filters and other sealed units in the center, electronic units such as amplifiers, oscillators and modulators on either side. Power supplies are in a separate compartment across the rear. A representative subassembly (Fig. 3) is a miniature amplifier used throughout the terminal for various circuit applications. Design is compacted to a degree consistent with requirements on performance, maintenance and flexibility.

The advantage of ratio-squaring combining was determined in a study of a number of methods by Crosby Laboratories, Inc., under contract with the Signal Corps.

Publications Present Problems

RECENT PUBLICATIONS issued by the U. S. Department of Commerce reveal the need for invention and development, and present information



a guy named Og

Once your name was Og. You tired of shouldering mastodon steaks...of dragging your mate by her hair. You invented the wheel.

Later, your name was Watt. Steam made your kettle-lid dance...and the Industrial Revolution was on.

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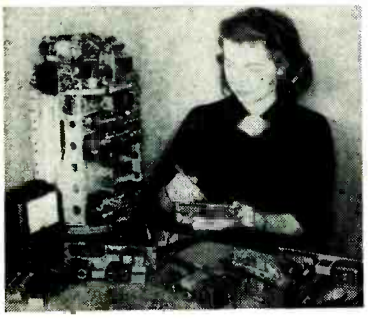
THE FRONT COVER



COLOR is used to identify plug-in chassis that form part of airborne radar navigation equipment designed by General Precision Laboratory, Inc. Features of the radar include ability to function under a wide range of environmental conditions and use of standard tubes having normal tolerances.

Because the radar unit is contained in a cylindrical housing that facilitates pressurization and cooling, these chassis are uniquely shaped. Many are identical in size and layout, although they perform different functions.

By anodizing in distinctive colors, the smaller unit assemblies can be recognized at a glance. This feature speeds maintenance and replacement by normally competent personnel. Connections are made to the units by means of the plug and jack system shown.

that may lead to solutions.

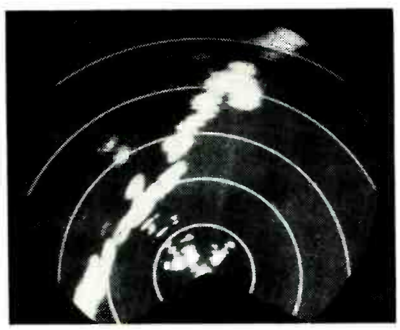
The National Inventors Council lists 70 new problems and carries over 130 in a publication entitled "Technical Problems Affecting the National Defense." Among them are such needs as a protective coating for magnesium, homing navigation system, handwheels with low thermal conductivity and new type of communication system. Copies of this publication can be obtained free from: National Inventors Council, U. S. Department of Commerce, Washington 25, D. C.

By way of partial solution to the navigational problem, a summary "Report on Electronic Systems of Air Navigation" has recently been made available. It includes the technical and economic characteristics of nondirectional beacons, standard loran, Consol, Navarho, Decca, Gee, the four-course radio range, vhf omnidirectional range (VOR) and distance measuring equipment (DME). Compiled by a panel of the Air Coordinating Committee, the 52-page report is available from U. S. Department of Commerce, Office of Technical Services, Washington 25, D. C. as publication PB 111344 at $1 a copy.

It is not unusual for an engineer to invent a circuit or device that has already been patented. Although such a situation cannot always be avoided, much time might be saved through a system of making information more easily available. The Federal Government owns many patents, 775 of which deal with instruments and date from the end of 1953. A list and brief description has been compiled in "Patent Abstracts No. 1, Instrumentation." Among the items listed are a gain-measuring device (Army) for a multiple-channel radio receiver, electrolytic resistors (Commerce Dept.) and fluorophotometer (AEC).

The 65-page listing is available at $2 from Office of Technical Services, under the publication number PB 111464.

Isoecho Spots Storm Intensities



Limited range of light intensities in cathode-ray tube screen makes storm display appear uniform throughout with ordinary circuits

Intense portions of storm where rainfall is heaviest are seen as black holes using new isoecho circuits in Bendix RDR-1 radar

Weather Radar Operates in C Band

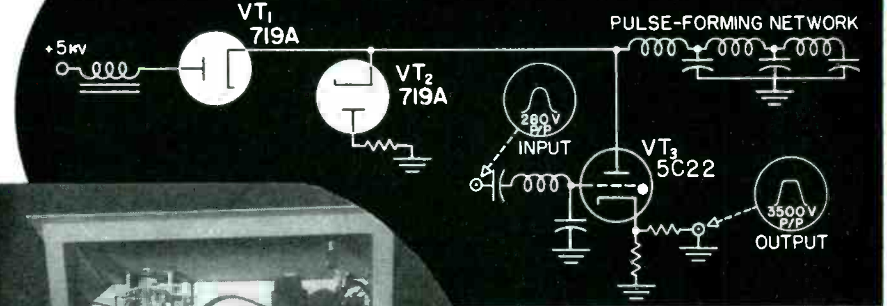
RESOLUTION of radar, which depends upon wavelength, increases directly with frequency or inversely with wavelength. Operational tests using X-band wavelengths (3 cm) show that while it gives excellent pictures of the front of storms, it is incapable of penetrating moderate to heavy rainfall. At least, it cannot give the pilot sufficient information as to what lies behind the front portion.

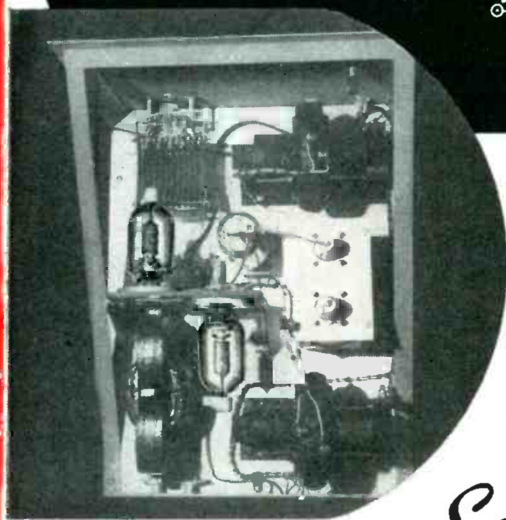
Theoretical studies indicate that for weather mapping a wavelength between 3 and 10 cm (the latter has less inherent resolution but greater penetrating power) may prove optimum.

Special equipment operating in the C band (5.5 cm) has been flown a total of 133 hours, 80 of which were in the immediate vicinity of, or through corridors of thunderstorms. From the results, it has been concluded that such equipment will permit a pilot to avoid moderate and heavier turbulence associated with thunderstorm and precipitation areas, usually by detours in the order of five miles or less from the planned flight path.

Pilots were able to penetrate visually 15 miles or more of heavy rain that was falling at a rate of not less than 60 mm an hour. There was no evidence, however, that the radar equipment was capable of identifying a tornado or tornado

MEGAWATT PULSES





and how Los Gatos 719A's shape them for Marchant

In developing a new Signal Corps thyratron-testing unit, engineers of Marchant Research, Inc. (controlled by Marchant Calculators, Inc.) needed a pulse diode combining high average and peak current capabilities with a high inverse voltage rating. Los Gatos 719A diodes were chosen to serve as both the charging diode and the clipper diode, shown in the circuit above.

Tube VT_1 charges the pulse-forming network to 10 kv with 1 megawatt of power, 270 ma average current. Tube VT_2 eliminates overshoot at the bottom of the pulse. The driver unit, as illustrated, supplies accurately controlled pulses to a hydrogen thyratron under test. Facilities are provided, in the balance of the test set, for measuring all parameters of the thyratron. The complete equipment, Mod 20MV Jr3, is part of a Signal Corps program of thyratron development for high-power hydrogen thyratron tubes.

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189 Dufferin Street, Toronto 1, Ontario, Canada

thunderstorm, although satisfactory warning was provided of hail shafts.

Isoecho contour circuitry appears essential for determining which corridors in a storm area may be flown through with safety. Isoecho circuits show which part of a storm is most turbulent (where the change from no rain to heavy rain is likely to occur in the shortest distance). The indication is a dark spot or patch within a bright display on the cathode-ray tube.

In the equipment used, transmitter frequency was 5,435 mc; peak power, 80 kw; duty cycle, 0.0008; pulse repetition frequency, 400 cycles; pulse width, 2 microseconds. The receiver had a sensitivity of 101.2 dbm; 3-db bandwidth, 0.9 mc; noise figure, 14.5 db; i-f, 60.2 mc; i-f voltage gain, 85 db and preamplifier voltage gain of 27 db.

Information on employment of this hitherto unused radar band comes from the United Air Lines, Inc. publication, "Evaluation of C Band (5.5 cm) Airborne Weather Radar" prepared by Henry T. Harrison and E. A. Post.—A. A. McK.

In-Phase Indicator

By John H. Porter
Niagara Falls, N. Y.

It is possible to determine whether two voltages are in phase or 180 degrees out of phase by the simple circuit shown in Fig. 1A. Two voltages to be examined, E_1 and E_2, are applied simultaneously to a transformer, setting up independent flux patterns in the core and inducing separate voltages in the secondary. Net voltage in the secondary is at all times the sum of the individual voltages. If the two flux patterns are out of phase and of equal strength, there will be zero flux at all times and the output voltage becomes zero. Conversely, if the flux patterns are in phase, and of equal strength, the output will be twice the individual values. Suitable transformer ratios can be found such that a neon indicator is just ignited when the voltages are in phase.

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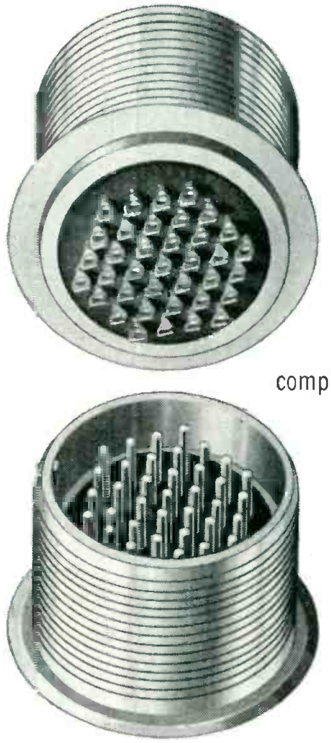

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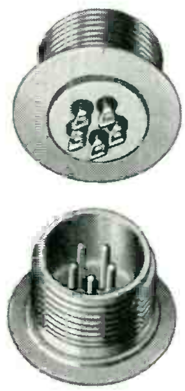

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can be accommodated by use of a double-diode limiter in the circuit

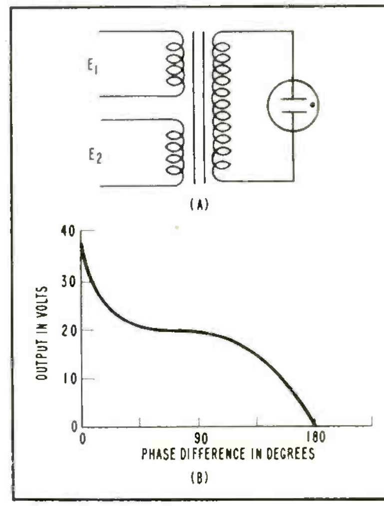


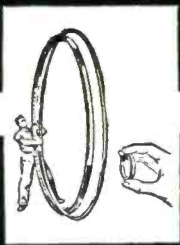
FIG. 1—Phase detector (A) uses double-winding filament transformer with neon bulb to indicate when two a-c signals are in phase. Graph (B) shows variation in output voltage with phase relationship

of greater voltage to reduce it to the level of the smaller one. It is better to provide limiters in both primaries so that both flux patterns will be of the same general shape for effective cancellation of out-of-phase signals.

In the application for which this circuit was used, a 115-volt filament transformer with two identical 6.3-volt windings was employed. A half-watt neon bulb was used to

Transistors Select Routes

Card translator unit recently installed in Richmond, Va., telephone toll center uses transistor amplifiers and electromagnetic relays to aid operator dialing of long-distance calls. The equipment automatically picks the suitable cross-country route for transcontinental calls in which the local operator dials the number of the called party in a distant city and obtains that party



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indicate phase relationship between two 5,400-cycle signals, each of 2-volt level. The device was calibrated as a phase meter using two 400-cycle signals and Fig. 1B illustrates the general shape of the results. The reference signal was 1.8 volts while the unknown varied in level and phase as a rotor revolved in a 3-phase field. The unknown signal was clipped with crystal diodes, each biased to 1.5 volts, and the indicator was a vtvm. The effect of clipping the unknown signal did not apparently upset the flux patterns as evidenced by the close similarity between Fig. 1B and the expected results of adding two sine waves of equal amplitude and varying phase.

While this device is not a precise indicator, it provides a go-no-go measure of phase relationships.

Current-Limited Variable Power Supply

By Charles R. Deming
Hughes Research and Development Laboratories
Culver City, California

To protect equipment from excessive currents in regulated high-voltage supplies, the circuit shown in Fig. 1 has been developed. Performance curves are shown in Fig. 2. Current-limiting action is obtained by using the constant-current properties of a pentode series tube, V_1, resistor R_1 and the diode in the cathode circuit of the series tube.

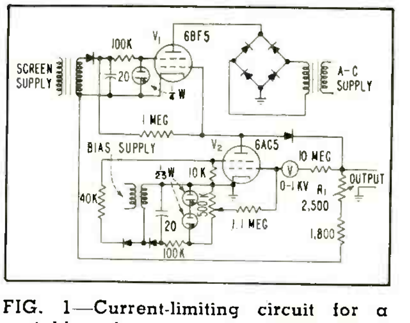

FIG. 1—Current-limiting circuit for a variable voltage power supply

The voltage regulator functions normally, as current is increased, until the voltage drop across R_1 equals the bias supplied to the series tube from amplifier, V_2. Further increase in output current will cause the additional bias de-

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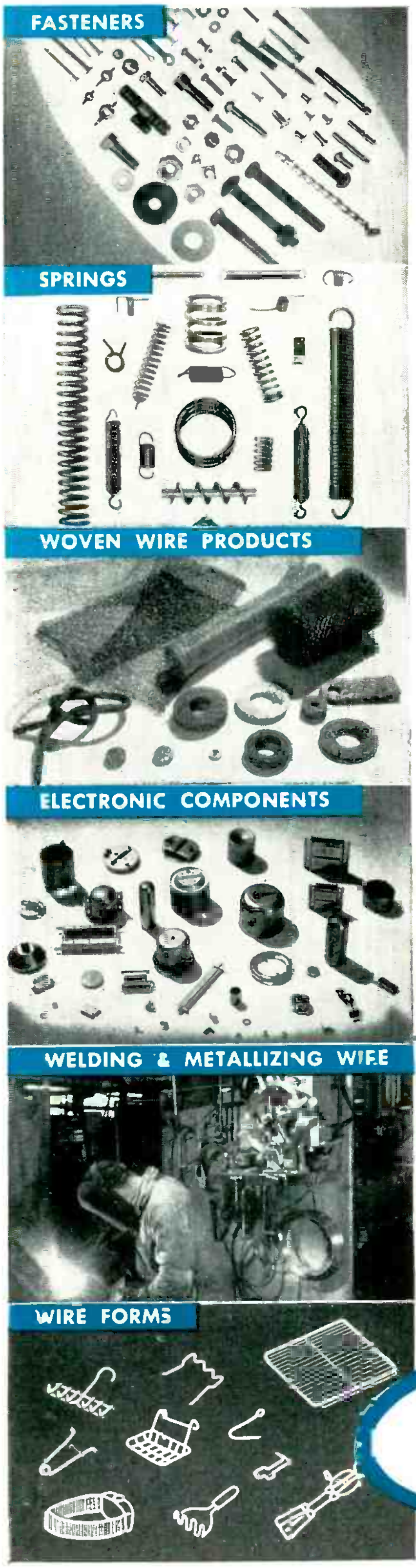

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A wide variety of Nickel alloys are also available for hundreds of electrical and mechanical applications. The excellent electrical characteristics of nickel are especially advantageous for electronic tube parts, such as grids, cathodes, support rods and pins. Monel, because of its excellent corrosion resistance and good mechanical properties, is also used for many mechanical parts, fasteners and springs.

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veloped across R_1 to be applied through the diode to the grid of the series tube. This raises the d-c resistance of the tube causing the output voltage to drop and limiting the current. With different values of R_1, this limiting action will begin at different currents, so that a potentiometer at R_1 will give a convenient adjustment. The positive side of the amplifier plate resistor is connected to the series-tube screen supply, giving a convenient bootstrapping action. Several types of receiving tubes (6AG5, 6BF5, 6S4) have been operated in this type of power supply with good results.

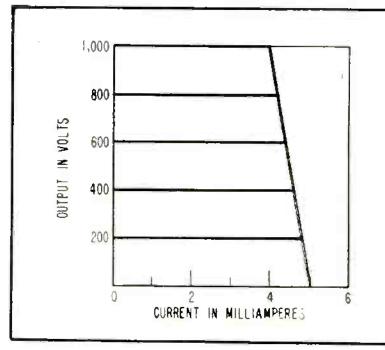

FIG. 2—Curve shows limiting action for various output voltage levels

Thyratons Protect Unloaded Amplifier

By Robert W. Woods
Biophysicist
College of Medical Evangelists
Los Angeles, Calif.

AUTOMATIC PROTECTION for the output transformer of a 250-watt oscillator-amplifier, used as a variable frequency power source, has been designed for no-load conditions.

The circuit shown consists of two 5557 type thyratrons connected across the 500-ohm output coil in parallel, but in reverse polarity. The 5557 is rated at 0.5 amp and two of them will handle the 0.7 amp flowing in the 500-ohm circuit at 250-watts output.

Since 250 watts across a 500-ohm line should give a 500-volt peak, the circuit was designed so that the tubes would not fire with less than 600 volts. The characteristic firing curve for the 5557 indicates that this should occur when $E_g = -9$ volts. A fixed bias of -9 volts is satisfactory. However, to make the

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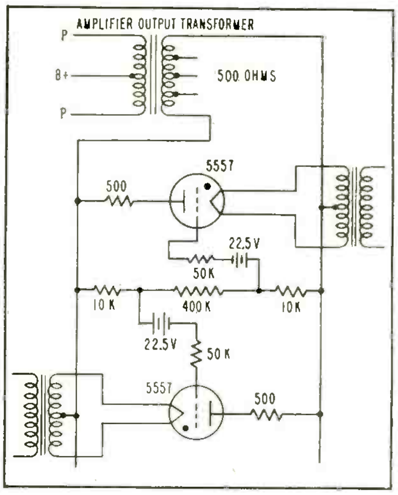
point of firing more definite grid voltage has been made dependent on the signal, so that $E_g = -22.5 + KEp$.

At the firing point $E_g = -9$, $E_p = 600$ volts and consequently $K = 0.0225$. This voltage KE_p was obtained by tapping a voltage divider across the line. A series resistor limits grid current and series plate resistors provide load limitation.



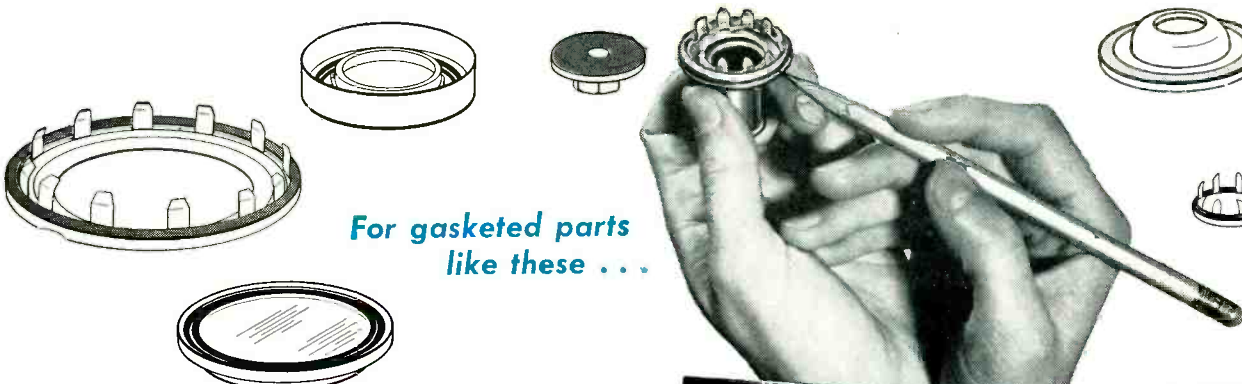
Thyratron circuit across 500-ohm tap of amplifier output transformer affords protection under no-load conditions

There is a differential frequency response that causes one tube to fire first at low frequencies and the other to fire first at high frequencies. This variation in behavior is not significant in the application for which the circuit was designed. For low-power amplifiers, other tubes are available. For example, at 10 watts the type 2050 should be satisfactory.

Stabilizing Circuit for X-Ray Gages

By George M. Ettinger
London, England

Resolution obtainable in x-ray thickness gages[1,2,3] is limited by signal-to-noise ratio. In the photoelectronic gage[4] the signal, representing variations of sample thickness from a mean value, is obtained as a voltage varying about a mean level. This level is the amplified photomultiplier current for a particular output from the x-ray generator and for a particular thickness of



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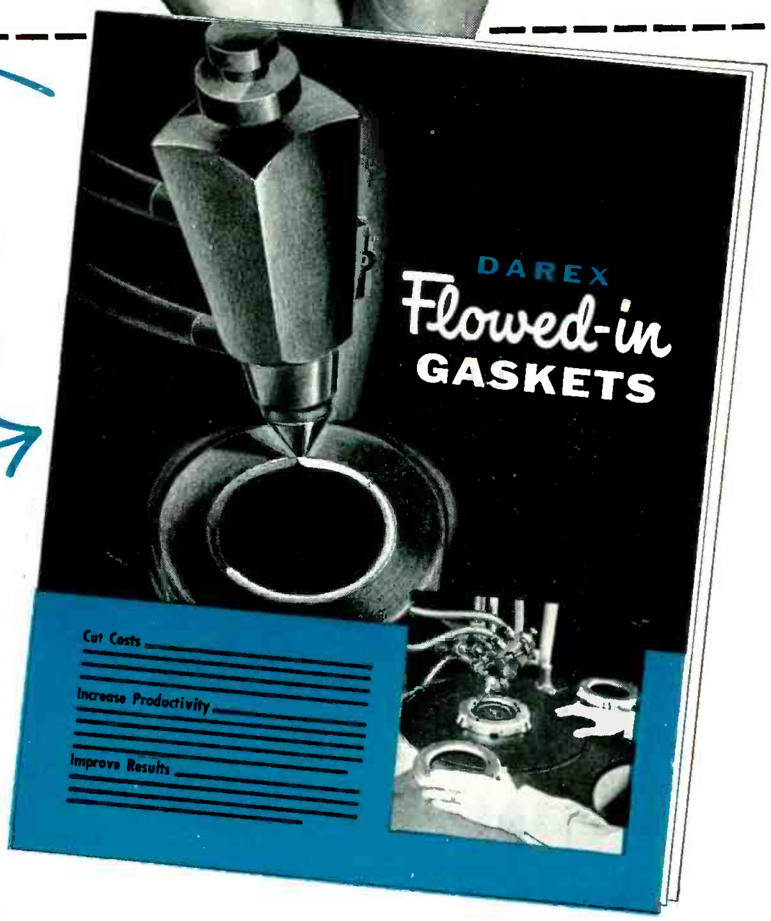

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the absorber.

Noise, in this type of system, has two causes. These are the random nature of the secondary-emission processes in the photomultiplier, and fluctuations of x-ray intensity. Photomultiplier noise may be reduced by special circuit arrangements[4,5] or by decrease of bandwidth.

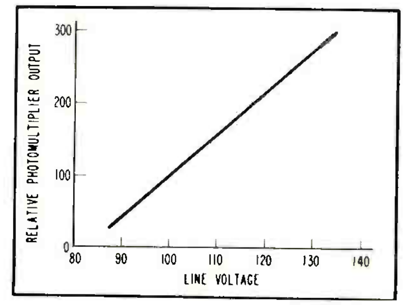


FIG. 1—Variation of phototube output with line voltage

The effect of x-ray intensity fluctuations, however, cannot be easily eliminated. Voltage regulators are sometimes employed but where motor-driven, these are slow and where electronic, considerable circuit complications are encountered.

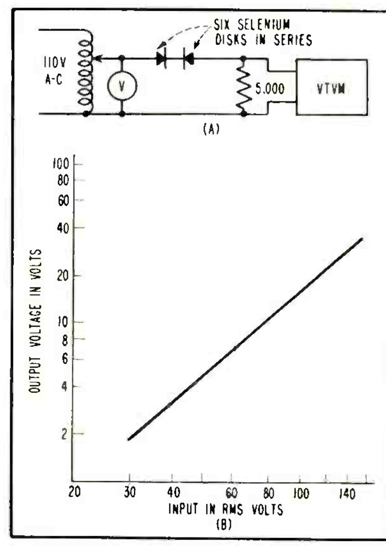
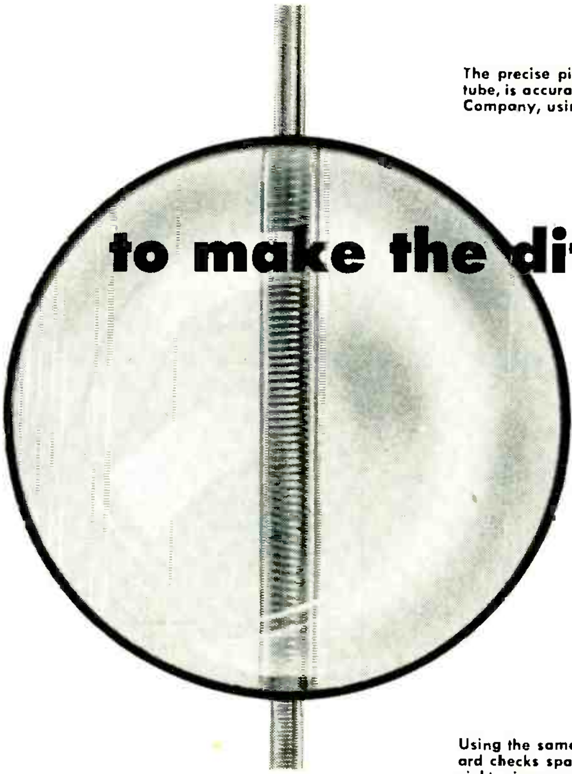


FIG. 2—Test circuit for single-stage nonlinear impedance (A). Curve (B) shows impedance variation with change of line voltage

This is particularly so in the case of self-rectifying x-ray tube circuits, where the x-ray tube is fed with raw alternating current. In these cases, x-ray output depends on the waveform as well as on the amplitude of the anode voltages.

In the system described here, no effort is made to keep the voltages on the x-ray tube constant. Instead,



The precise pitch of this wire helix, in its glass tube, is accurately measured by Hewlett-Packard Company, using a Kodak Contour Projector.

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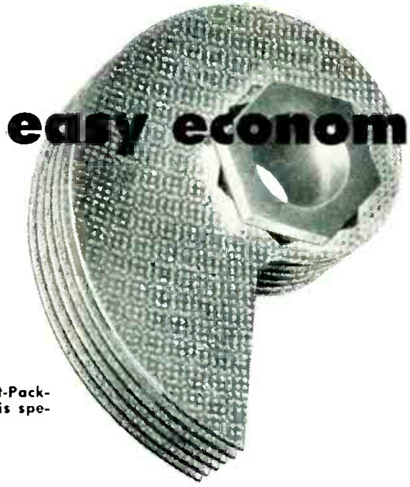

Using the same contour projector, Hewlett-Packard checks spacing and parallelism of this special tuning condenser.

Hewlett-Packard relies on the Kodak Contour Projector

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Using a Kodak Contour Projector, Hewlett-Packard Company measures the pitch of a precision wire helix for a unique electronic tube. Surface and shadow illumination provide a 20× enlarged image of the minute and delicate part. "Without the Kodak Contour Projector," say Hewlett-Packard officials, "it would not be practical to make the measurements necessary to get a satisfactory instrument."

Using the same contour projector, Hewlett-Packard also checks spacing and parallelism of a special tuning condenser for electronic test equipment. Conventional shadow projection provides a 10× enlarged image of the leaves. "Use of the projector," the company reports, "permits economical measurements of parallelism to an accuracy impossible to obtain by other methods."

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a signal depending on line voltage is applied to a nonlinear circuit whose output is subtracted from the output of the x-ray absorption gage. When sensitivity and time constant of the nonlinear circuit, designed to have an approximately fifth-power output-input relation, are properly adjusted the output of the compensated x-ray gage remains substantially unchanged as x-ray voltage is reduced from 200 kilovolts peak to zero.

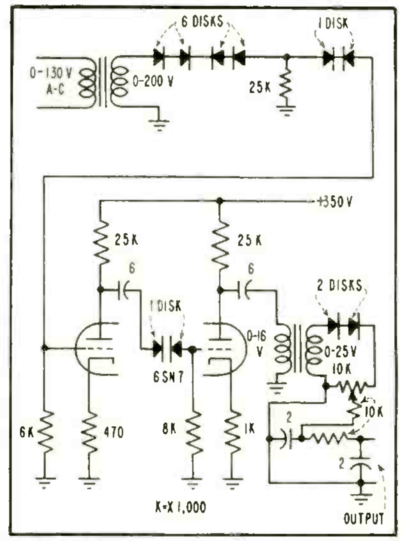

FIG. 3—Circuit of three-stage nonlinear compensation circuit

In a single-channel x-ray absorption gage a variation of 3 volts in 110 is sufficient to give the same change of output as a change of 0.005 inch of sample thickness. Variation of gage output is plotted against relative line voltage in Fig. 1.

Output is not proportional to line voltage. The variation may be expressed by as $v_{OUT} = a\ (v_{LINE})^n$ where $5 < n < 6$. A characteristic of this nature must, therefore, be produced in the compensating circuits.

A square-law input-output voltage variation may be obtained from a potential-divider network of which one element is a metal rectifier. To maintain symmetrical characteristics, it is desirable to use two rectifiers back-to-back. The simple circut of Fig. 2A gives the results plotted in Fig. 2B.

Several nonlinear stages of this kind may be connected in cascade to give characteristics that are the product (subject to a constant multiplying factor) of the indi-

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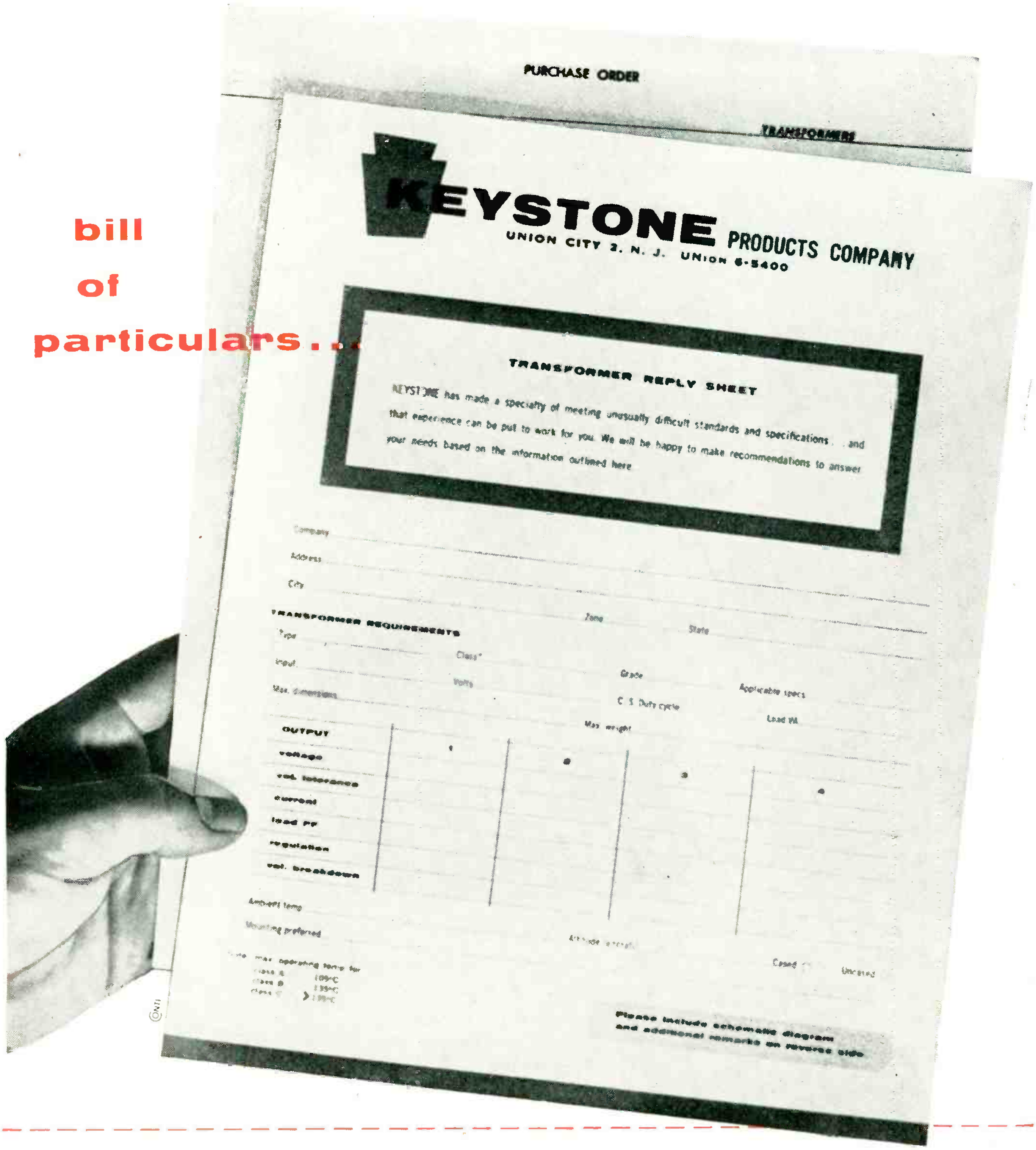

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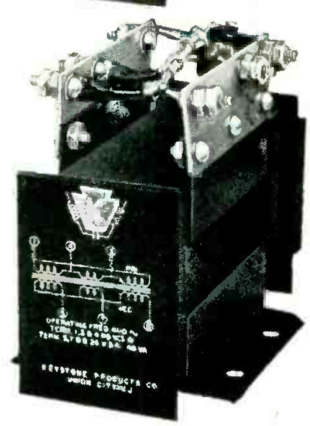

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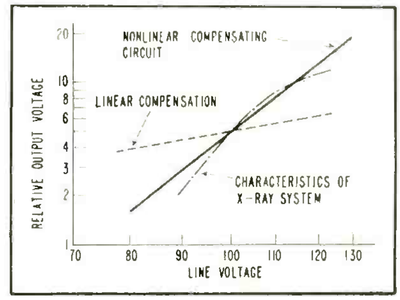

FIG. 4—Characteristic of three-stage compensator plotted against x-ray characteristic curve and curve of single-stage compensator

vidual characteristics. Figure 3 shows how the three-stage nonlinear impedance is constructed. The second and third stages are isolated by a 6SN7. The output of the last nonlinear stage is amplified in the second half of the 6SN7, passed through on a step-up transformer and rectified. The characteristics of the 3-stage nonlinear impedance are plotted in Fig. 4. This agrees fairly closely with the x-ray characteristic curve. For comparison, a linear impedance characteristic is also drawn.

X-ray gage output with line-voltage variations is substantially unchanged as line voltage is reduced from 110 volts rms to 80 volts rms.

Time constant of the compensator must be considered. In order to improve photomultiplier signal-to-noise ratio, the x-ray absorption gage used in these tests had a bandwidth of 5 cps. The compensator circuit however, had a faster response. Therefore, transient overcompensation was obtained. This was overcome by connecting sufficiently large time constants in the output of the compensator.

Thanks are due to Frederic Fua for helpful advice and criticism.

REFERENCES

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(2) J. E. Jacobs, ELECTRONICS, 24, p 125, Aug. 1951.
(3) G. M. Ettinger, ELECTRONICS, 26, p 142, April 1953.
(4) G. M. Ettinger, *Proc NEC*, 8, p 113, 1952.
(5) H. H. Greenblatt, W. W. Green, P. W. Davison and G. A. Morton, Two New Photomultipliers for Scintillation Counting, *Nucleonics*, 10, Aug. 1952.

Color Filter for Monochrome Broadcasts

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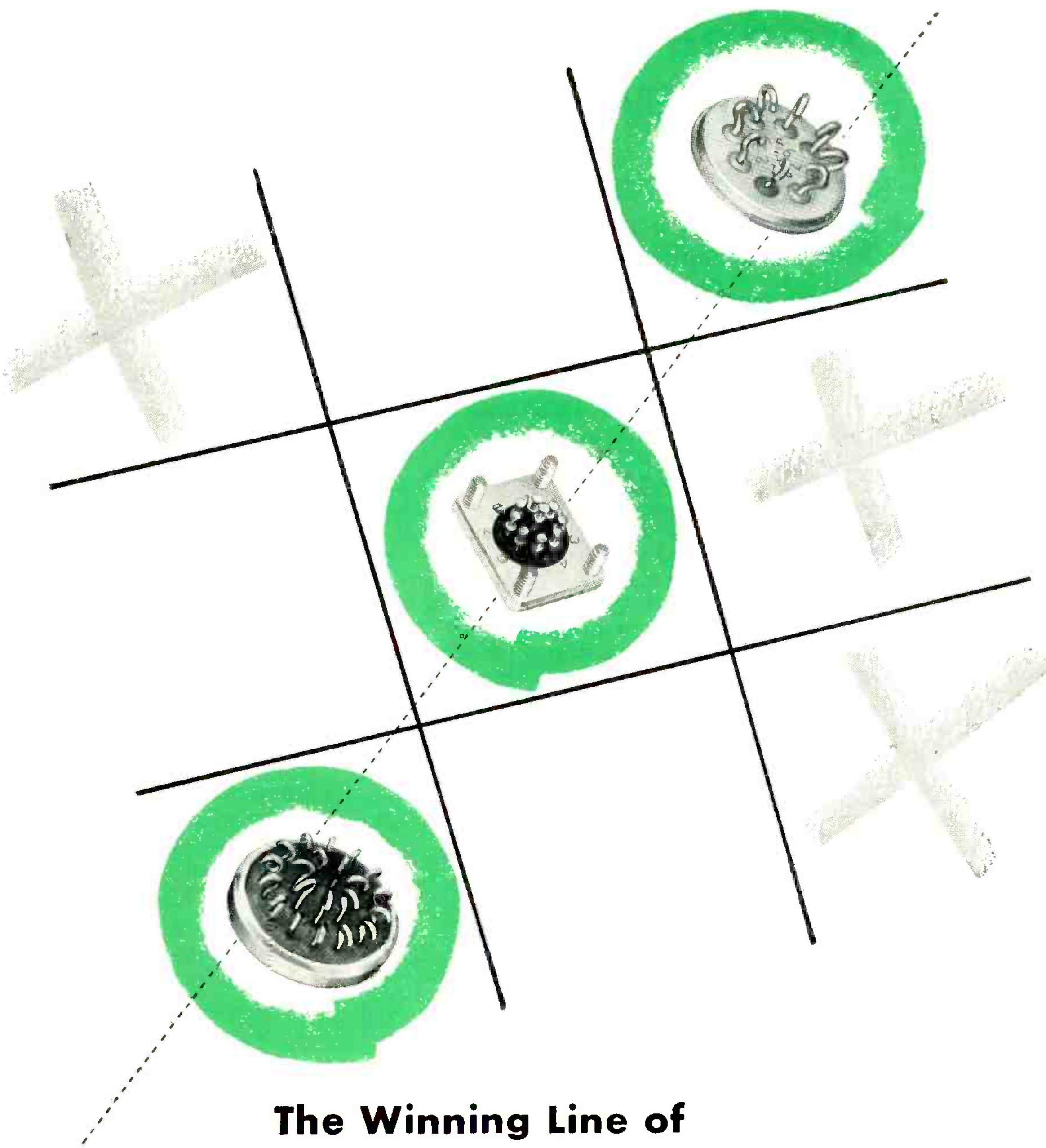

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Silicon Diodes Replace Klystron in CW Radar

by HAROLD B. GOLDBERG

Engineer, Laboratory for Electronics, Inc.
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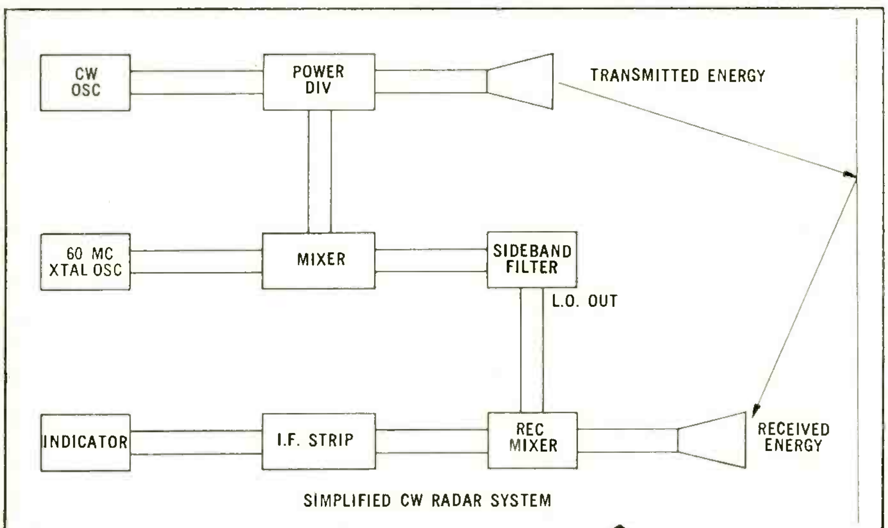
The klystron local oscillator and AFC system in a 9000 mc CW radar are eliminated by the use of a quartz crystal controlled 60 mc source modulating a small portion of the transmitter power by means of two silicon diodes in a magic-Tee. Side bands of 9060 and 8940 are generated and the desired band is selected by a filter cavity. If the transmitted frequency changes from 9000 mc to 9001, the selected side band changes by the same amount, thus achieving AFC. The use of one reversed polarity diode paired with one regular polarity diode allows the carrier and IF signals to be supplied in the same relative phase generating side bands in phase opposition which add in arm 4 of the mixer.

Thirteen milliwatts of "local oscillator" signal can be generated by feeding 150 milliwatts of carrier power into arm 3 of the Tee dividing equally between the MICROWAVE ASSOCIATES 1N23C and 1N23CR silicon diodes on arms 1 and 2. Four volts of 60 mc is impressed across the two diodes in parallel. Each side band issuing from arm 4 contains 13 milliwatts of energy indicating a conversion efficiency of 10.5 db with respect to the input carrier. Carrier leakage is down 10 db from the selected side band level. Noise is comparable to klystron oscillators. This system has operated for 250 hours with no decrease in side band output power.



Showing klystron local oscillator and conventional AFC system replaced by silicon diode side-band generator.

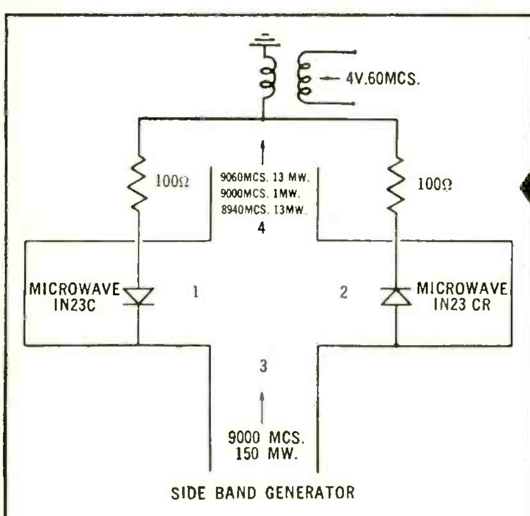


Diagram shows method of mixing 60 mcs. and 9000 mcs. carriers to produce desired side-bands.

missions are prohibited from broadcasting network color programs. If the characteristic 3.58-mc color subcarrier is removed from network color programs, the color-killer circuits of receivers will interpret television signals as being black-and-white. The simple filter to be described permits use of all incoming programs, either color or monochrome, in full compliance with FCC rules.

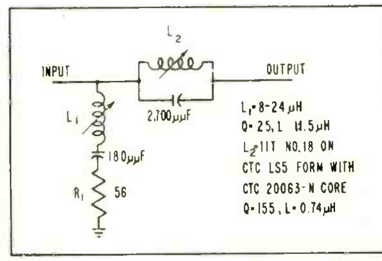


FIG. 1—Color remover filter for transmitter input

For stations desiring to remove the color subcarrier the filter shown in Fig. 1, inserted in the line to the transmitter, will attenuate the fundamental of the 3.58-mc subcarrier approximately 23 db. Absence of this signal allows the color receiving set to operate as a black-and-white device. Sidebands are attenuated as little as possible in order to prevent removal of high-frequency luminance information.

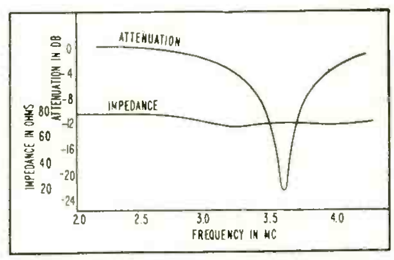


FIG. 2—Characteristics of the input filter

Insertion of such a filter in a line carrying an RETMA test-pattern signal cuts the vertical wedge from about 300 lines to 250 lines. It also adds one or two rings after all sharp transitions. Complete elimination of ringing would require many additional filter sections that would complicate adjustment.

The filter is adjusted using a video sweep generator at the input and a detector probe at the output. Inductors L_1 and L_2 are set for maximum attenuation at the subcarrier frequency. With at least 100 ohms in series between sweep generator output and filter input, L_1 is then adjusted for constant in-

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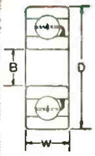
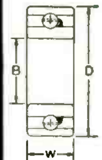


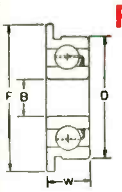
Retainer

Brg. No.	B	D	W
R0	3/64 (.0469)	5/32 (.1562)	1/16 (.0625)
R1	(.0550)	3/16 (.1875)	5/64 (.0781)
R1-4	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
R1-5	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
R2-5	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
R2	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)



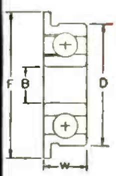
Retainer Extra Light

R133	3/32 (.0937)	3/16 (.1875)	1/16 (.0625)
R144	1/8 (.1250)	1/4 (.2500)	3/32 (.0937)
R155	5/32 (.1562)	5/16 (.3125)	7/64 (.1094)
R156	3/16 (.1875)	5/16 (.3125)	7/64 (.1094)
R166	3/16 (.1875)	3/8 (.3750)	1/8 (.1250)
R168	1/4 (.2500)	3/8 (.3750)	1/8 (.1250)
R188	1/4 (.2500)	1/2 (.5000)	1/8 (.1250)
R613M	6mm.	13mm.	3.5mm.



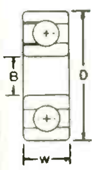
Flanged Retainer

FR1	(.0550)	3/16 (.1875)	5/64 (.0781)
FR1-4	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
FR1-5	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
FR2-5	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
FR144	1/8 (.1250)	1/4 (.2500)	3/32 (.0937)
FR155	5/32 (.1562)	5/16 (.3125)	7/64 (.1094)
FR156	3/16 (.1875)	5/16 (.3125)	7/64 (.1094)
FR166	3/16 (.1875)	3/8 (.3750)	1/8 (.1250)
FR188	1/4 (.2500)	1/2 (.5000)	1/8 (.1250)



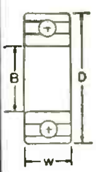
Flanged Full

F13	(.0550)	3/16 (.1875)	5/64 (.0781)
F14	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
F15	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
F154	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
F155	5/32 (.1562)	5/16 (.3125)	7/64 (.1094)
F156	3/16 (.1875)	5/16 (.3125)	7/64 (.1094)



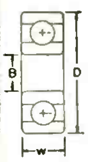
Full

10	(.0250)	(.1000)	1/32 (.0312)
12	(.0400)	1/8 (.1250)	3/64 (.0469)
12½	3/64 (.0469)	5/32 (.1562)	1/16 (.0625)
13	(.0550)	3/16 (.1875)	5/64 (.0781)
14	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
15	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
16	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)



Full Extra Light

144	1/8 (.1250)	1/4 (.2500)	3/32 (.0937)
154	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
155	5/32 (.1562)	5/16 (.3125)	7/64 (.1094)
156	3/16 (.1875)	5/16 (.3125)	7/64 (.1094)
157	7/32 (.2187)	5/16 (.3125)	7/64 (.1094)
168	1/4 (.2500)	3/8 (.3750)	1/8 (.1250)
1810	5/16 (.3125)	1/2 (.5000)	5/32 (.1563)



Spring Separator

R1-4Z	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
R1-5Z	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
R2-5Z	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
R2Z	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)
R168Z	1/4 (.2500)	3/8 (.3750)	1/8 (.1250)

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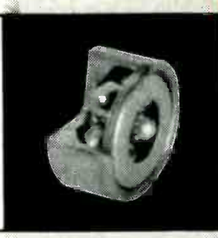
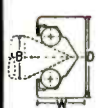
Brg. No.	B	D	W
FR1-P,PP	(.0550)	3/16 (.1875)	(.1094)
FR1-4P,PP	5/64 (.0781)	1/4 (.2500)	(.1406)
FR1-5P,PP	3/32 (.0937)	5/16 (.3125)	(.1406)
FR2-5P,PP	1/8 (.1250)	5/16 (.3125)	(.1406)
FR2-P,PP	1/8 (.1250)	3/8 (.3750)	(.1562)
FR144P,PP	1/8 (.1250)	1/4 (.2500)	(.1094)
FR155P,PP	5/32 (.1562)	5/16 (.3125)	(.1250)
FR156P,PP	3/16 (.1875)	5/16 (.3125)	(.1250)
FR166P,PP	3/16 (.1875)	3/8 (.3750)	(.1562)
FR168P,PP	1/4 (.2500)	3/8 (.3750)	(.1250)
FR188P,PP	1/4 (.2500)	1/2 (.5000)	(.1875)

Shielded Radial

R0P,PP	3/64 (.0469)	5/32 (.1562)	(.0937)
R1P,PP	(.0550)	3/16 (.1875)	(.1094)
R1-4P,PP	5/64 (.0781)	1/4 (.2500)	(.1406)
R1-5P,PP	3/32 (.0937)	5/16 (.3125)	(.1406)
R2-5P,PP	1/8 (.1250)	5/16 (.3125)	(.1406)
R2P,PP	1/8 (.1250)	3/8 (.3750)	(.1562)
R144P,PP	1/8 (.1250)	1/4 (.2500)	(.1094)
R155P,PP	5/32 (.1562)	5/16 (.3125)	(.1250)
R156P,PP	3/16 (.1875)	5/16 (.3125)	(.1250)
R166P,PP	3/16 (.1875)	3/8 (.3750)	(.1562)
R168P,PP	1/4 (.2500)	3/8 (.3750)	(.1250)
R188P,PP	1/4 (.2500)	1/2 (.5000)	(.1875)

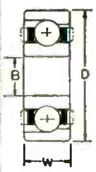
OTHER TYPES





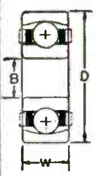
Pivot

Brg. No.	B	D	W
22½M	(.040)	4mm.	2.4mm.
23M	(.050)	5mm.	3.2mm.
24	(.085)	1/4 (.2500)	1/8 (.1250)
24H	(.085)	1/4 (.2500)	1/8 (.1250)
26	(.165)	3/8 (.3750)	3/16 (.1875)
26H	(.165)	3/8 (.3750)	3/16 (.1875)



Angular Contact

113	(.0550)	3/16 (.1875)	5/64 (.0781)
114	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
115	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
1154	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
116	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)



Self Aligning

214	5/64 (.0781)	1/4 (.2500)	3/32 (.0937)
215	3/32 (.0937)	5/16 (.3125)	7/64 (.1094)
2154	1/8 (.1250)	5/16 (.3125)	7/64 (.1094)
216	1/8 (.1250)	3/8 (.3750)	5/32 (.1562)

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RO CIRCLE • PETERBOROUGH, N. H. • TELEPHONE 424 put impedance as judged from constant input voltage when the detector probe is connected to the filter input.

If about 6 db more attenuation at considerably greater sacrifice in impedance characteristic is desired, resistor R_1 can be shorted out.

Performance of the filter is shown in Fig. 2. This material is abstracted from a field bulletin of Allen B. DuMont Laboratories, Inc.

Low-Distortion Electronic Attenuators

By WILLIAM H. SWAIN
Pleasantville, N. Y.

ELECTRONIC ATTENUATORS are commonly used as part of studio-type amplifiers, computing apparatus and various ranging and navigational devices. The variable gain element is usually a tube and is required to operate in the audio and ultrasonic range. These automatic gain-control circuits generally provide for changing the operating bias of a multigrid tube, thus introducing a moderate amount of distortion at some point in the control range.

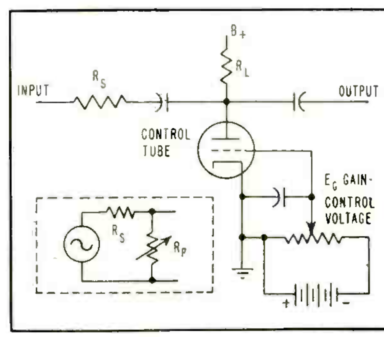

FIG. 1—Control tube in electronic attenuator acts as variable shunt to ground

A usable control is obtained in this manner, especially if the control range is not great and a moderate distortion level can be tolerated. The electronic attenuators discussed here are designed particularly for applications where minimum distortion and wide control range are desired. Some types of military apparatus require that audio signals be attenuated automatically and rapidly, with distortion not in excess of about 2 percent.

The solution has been to design

LABORATORY DELAY LINE STANDARDS

The Millen delay line kit effectively provides a means for the development and design engineer to check the affect of various delays in their actual developmental setups without the time loss and expense of producing separate lines for each trial. Increased requirement for time delay circuits in radar, color television and other modern electronic applications has presented a problem to the design and development engineer as it has been both time consuming and expensive to obtain delay lines for developmental work as each line was necessarily cut to the estimated delay and any change in requirements necessitated the fabrication of a new delay line. The Millen delay line kit is designed to provide a ready means of obtaining various delays from .10 microseconds through 2 microseconds in increments of .05 microseconds except at the extreme ends of this range. The lines may be used repeatedly without deterioration as they are hermetically sealed, the smaller lines in glass tubes, the 1 microsecond line in a metal container.

Each set consists of:

NOMINAL DELAY	TOL.	CALIBRATION TOLERANCE
2—0.10 μs.	± 0.01 μs.	± 0.002 μs.
2—0.25 μs.	± 0.025 μs.	± 0.002 μs.
1—0.30 μs.	± 0.03 μs.	± 0.002 μs.
1—1.00 μs.	± 0.05 μs.	± 0.01 μs.

Actual delay as measured by phase shift method are marked on each delay line. The laboratory calibration of each delay line is accurate to ± 0.002 microseconds on all of the .10 microsecond, .25 microsecond and .03 microsecond lines and ± 0.01 microsecond on the 1 microsecond line. Combination of delay lines supplied makes possible the following delays:

0.10 μs.	0.55 μs.	1.10 μs.	1.55 μs.
0.20	0.60	1.20	1.60
0.25	0.65	1.25	1.65
0.30	0.70	1.30	1.70
0.35	0.75	1.35	1.75
0.40	0.80	1.40	1.80
0.45	0.90	1.45	1.90
0.50	1.00	1.50	2.00

Characteristic impedance — 1350 ohms ± 20%.

PHYSICAL DIMENSIONS:

0.1 μs.—15/32" dia. x 4⅛" long
0.25 μs.—15/32" dia. x 7⅝" long
0.30 μs.—15/32" dia. x 7⅝" long
1.00 μs.—4¾" x 4¾" x 1"

All seven lines are mounted in a metal case 9½" x 5" x 1¾" for convenience in storing and safety in handling.

JAMES MILLEN MFG. CO., INC.
MAIN OFFICE AND FACTORY
MALDEN, MASSACHUSETTS, U.S.A.

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good amplifier stages and operate them at all times with constant bias and gain. They are followed by gain controls that introduce a minimum of distortion. However, the device should not include a servodriven potentiometer for rapid ($\frac{1}{10}$ sec or less) response must be possible.

The first solution investigated is shown in Fig. 1. It comprises a fixed resistor, R_s, in series with the signal source and a variable shunt to ground provided by the dynamic plate resistance R_p of the control tube. Maximum transmission is obtained when the control tube is cut off. As the control voltage E_g decreases the dynamic plate resistance of the control tube becomes less and the tube acts as a greater conductance shunt to ground. This results not in a true potentiometer, but in an attenuator with a fixed series arm and a variable shunt arm.

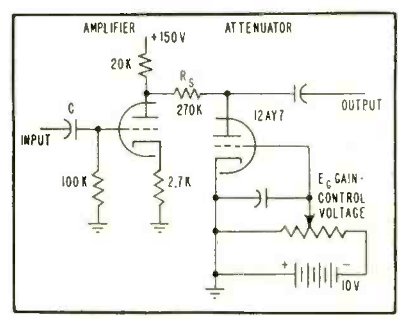
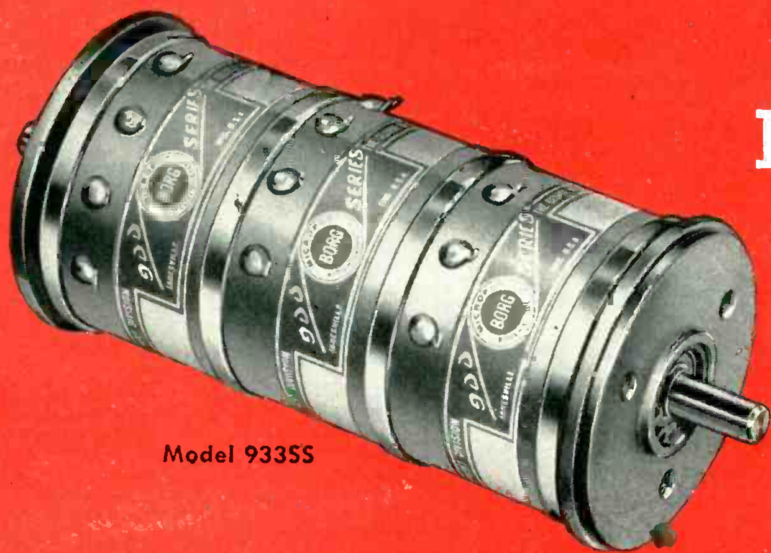


FIG. 2—Attenuator circuit for low-level signals

Operating limits are usually established by the maximum resistance that can be tolerated for the series resistor R_s owing to stray capacitance and the shunting effect of R_L in parallel with the output load impedance. Of course, the minimum resistance of the control tube determines the maximum attenuation and the tube should be selected with this in mind. Tube types 12AY7, 12AT7 and 2C51 were found to combine good control range with relatively low distortion.

The circuit shown in Fig. 2 is a basic form of the electronic attenuator and may be used at low levels. The first section of the tube is a voltage amplifier operating at constant bias level and gain. The second section is the attenuator and derives its d-c plate voltage from the first section through the series

BORG MICROPOTS



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931S 932BB 933SK 935SS 901SK 902B 903BK 903S

Standard models of Borg 900 Series Micropots offer such flexibility that they meet special design needs. Borg has created a new standard for high-precision, multi-turn potentiometers.

Advantages of the Borg 900 Series include greater accuracy, finer resolution, lower torque, longer life, better performance under severe and excessive vibration, greater adaptability and versatility of application.

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- ☐ Precision Multi-Turn Potentiometers, 900 Series
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attenuator resistor R_s.

Values in the order of 270,000 ohms may be used with the 12AY7 resulting in a control range in the order of 17 db (+13 to −4 db net gain). With an applied signal of 0.3 volt rms at the input, the maximum observed distortion was 0.4 percent over the total control range.

A version of the circuit shown in Fig. 3 has been used in military equipment to provide a 40-db attenuation range with about 3 percent maximum distortion at 0.2 volt rms output. The value of R_s shown is rather high, but a resistance in the order of 47K can also be used. Control tube V_1 produces a variable shunt impedance to ground. In this case, however, the grid is coupled directly to the output and this results in voltage negative feedback having an effective gain a, which is the gain of V_1 at any particular operating bias.

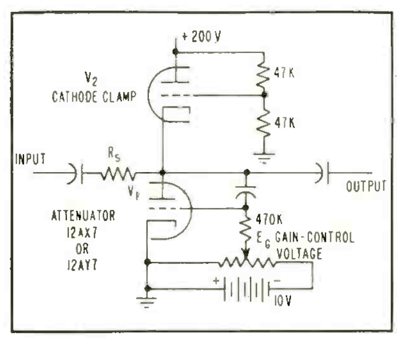

FIG. 3—Circuit providing 40 db attenuation with about 3 percent distortion

The value β is unity and this results in a reduction of the dynamic plate resistance by the gain factor of V_1. Tube V_2 acts as a cathode clamp, establishing a well-regulated plate potential for V_1. In addition, when V_1 is drawing a large current, V_2 acts as an added shunt conductance to ground. The net impedance presented by the two tubes to ground is

$$Z_s = 1/2\,G_m$$

where Z_s is the minimum impedance shunting the signal to ground, and G_m is the manufacturer's rating for the tube under normal operation. Values of Z_s in the order of 500 ohms are readily obtained.

The writer expresses appreciation to A. O. Dority, John Barney, Robert Crane and to General Pre-

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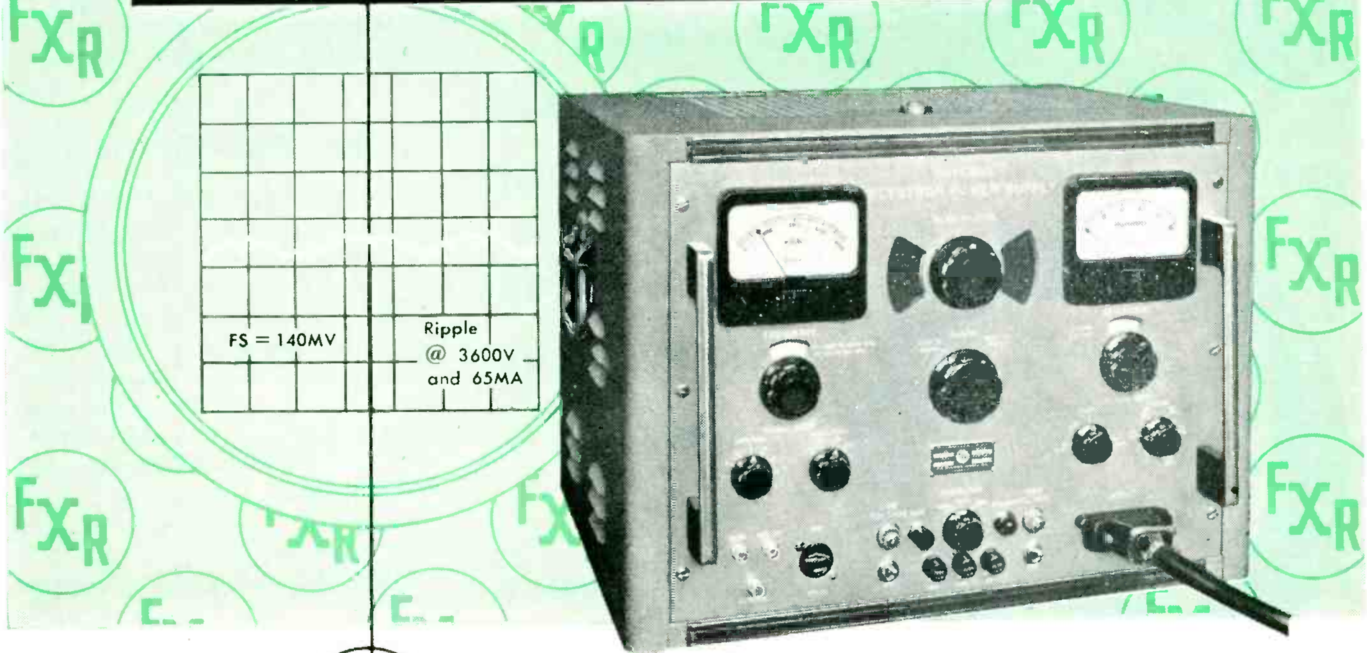

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CONTROL GRID:
Positive; 0 to 150 volts @ 0 to 5 Ma
Negative; 0 to 300 volts
MODULATOR:
Squarewave; 250 to 2500 CPS @ 0 to 200 volts
Sawtooth; 40 to 120 CPS @ 0 to 200 volts

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3 MV RMS maximum from any point to ground

GREATER STABILITY
The stability is insured by the use of the 5651 as a reference tube

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All DC voltages regulated to 0.03% for input variation from 105 to 125 volts

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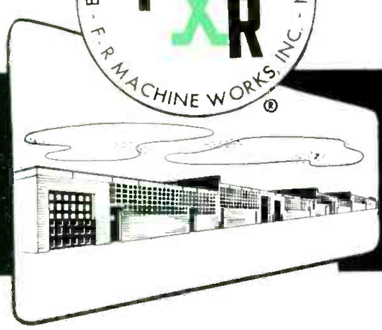

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cision Laboratories Inc. who furnished assistance and facilities to develop this attenuator concept into part of a practical device.

Adding UHF-TV Coverage

TECHNIQUES PROPOSED for filling in shadowed areas in uhf-tv coverage include picking up the signal close to the area of shadow using a highly directive receiving antenna and rebroadcasting the signal. The method requires a high-gain, directive antenna, carefully placed in relation to the area to be given better service. Such an antenna is energized from a very low power transmitter that is inexpensive to run and maintain.

Recently, the Federal Communications Commission approved the use of low-power satellite tv broadcast transmitters that operate on a different ultrahigh frequency from that assigned to the main station. Since the booster-type station operates on the same frequency as the parent station it requires a more exacting performance. Where experimental boosters have operated successfully, satellites might be expected to work as well with less difficulty.

Field tests conducted by RCA in the Vicksburg, Miss. area have been successful in bringing television programs broadcast from station WJTV on channel 25 to the area about 37 miles from the main transmitter.

According to a report filed with FCC, the station received an effective increase in power by 200 times in the shadowed area since the

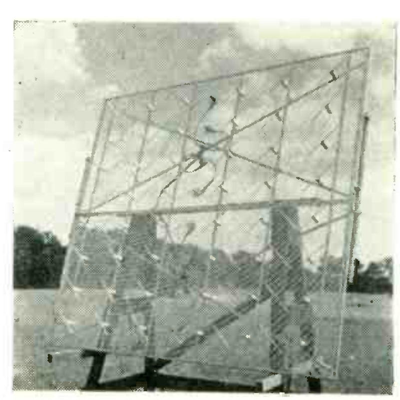
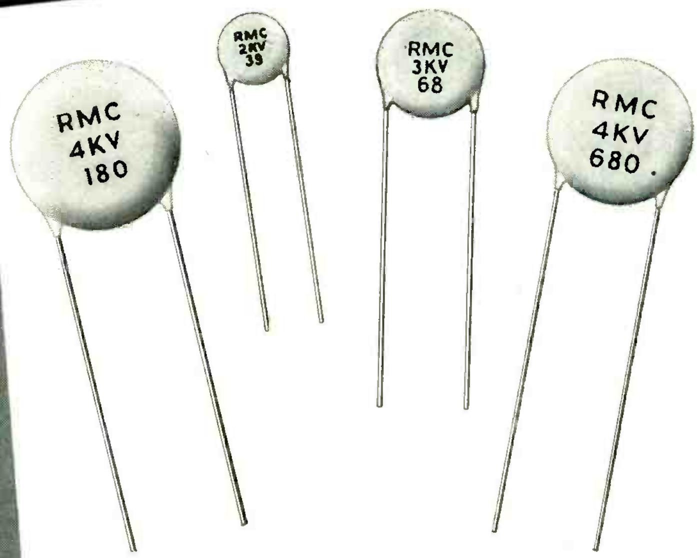


FIG. 1—High-gain receiving antenna picks up main-station signal for rebroadcast by booster on same frequency



CAPACITY	DIELECTRIC	SIZE	AVAILABLE CAPACITY TOLERANCES
	2-KV		
5-47	N-750	5/16"	5-10-20% GMV
48-68	N-750	1/2"	5-10-20% GMV
69-82	N-750	5/8"	5-10-20% GMV
83-130	N-750	5/8"	5-10-20% GMV
131-200	N-1500	5/8"	5-10-20% GMV
201-250	N-1500	3/4"	5-10-20% GMV
251-330	N-1500	7/8"	5-10-20% GMV
	3-KV		
5-15	N-750	5/16"	5-10-20% GMV
16-20	N-750	1/2"	5-10-20% GMV
21-56	N-1500	5/8"	5-10-20% GMV
57-180	N-1500	5/8"	5-10-20% GMV
181-240	N-1500	3/4"	5-10-20% GMV
241-330	N-1500	7/8"	5-10-20% GMV
	4-KV		
5-68	N-1500	7/8"	5-10-20% GMV
69-180	N-1500	7/8"	5-10-20% GMV
	5-KV		
5-30	N-1500	5/8"	5-10-20% GMV
31-60	N-1500	3/4"	5-10-20% GMV
61-130	N-1500	7/8"	5-10-20% GMV
	6-KV		
5-20	N-1500	3/4"	-10-20% GMV
21-100	N-1500	7/8"	-10-20% GMV

POWER FACTOR: .1% Max. @ 1 MC (initial)
INSULATION: Durez phenolic—vacuum waxed

CAPACITY	DIELECTRIC	SIZE	AVAILABLE CAPACITY TOLERANCES
	2-KV		
331-470	1200-K	9/16"	±20% GMV
471-1000	1200-K	5/8"	±20% GMV
1001-2700	HI K	9/16"	GMV
2701-5000	HI K	3/4"	GMV
5001-10000	HI K	3/4"	GMV
	3-KV		
220-500	1200-K	5/8"	±20% GMV
501-1000	1200-K	5/8"	±20% GMV
1001-5000	HI K	3/4"	GMV
	4-KV		
181-680	1200-K	3/4"	±20% GMV
681-1000	HI K	5/8"	GMV
	5-KV		
131-330	1200-K	7/8"	±20% GMV
331-1000	HI K	7/8"	GMV
	6-KV		
101-220	1200-K	3/4"	±20% GMV
221-470	1200-K	7/8"	±20% GMV
221-1000	HI K	7/8"	GMV
471-1000	HI K	7/8"	GMV

POWER FACTOR: 1.5% Max. @ 1 KC (initial)
INSULATION: Durez phenolic—vacuum waxed

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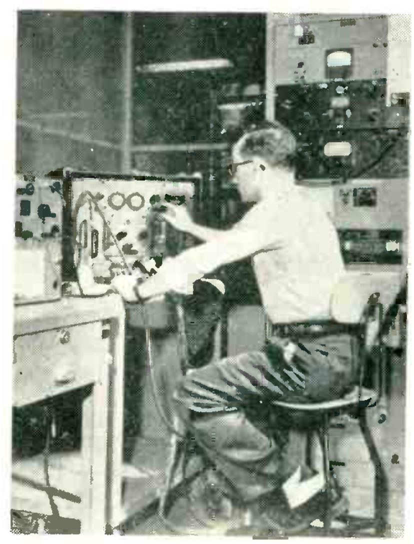
FIG. 2—Experimental transmitting antenna undergoing tests found later use in uhf booster installation for channel 25

booster system employed produced a 23-db improvement in field intensity in at least 50 percent of the total receiving areas.

The booster transmitter, with a power of about 10 watts provided acceptable service in an area partially shadowed by intervening terrain.

In the test area, it was determined that an effective radiated power of 1,000 watts was needed for adequate coverage. This power was obtained from the 10-watt transmitter by using a special transmitting antenna with a gain of 100.

Testing Signal Equipment



New Signal Corps radio transmitter AN/TRC-24 undergoes Western Electric tests in shielded room. Equipment, to which engineer is making adjustments (right hand on knob) is part of multichannel communication relay system that links points up to 30 miles apart by radio

(Continued on page 230)

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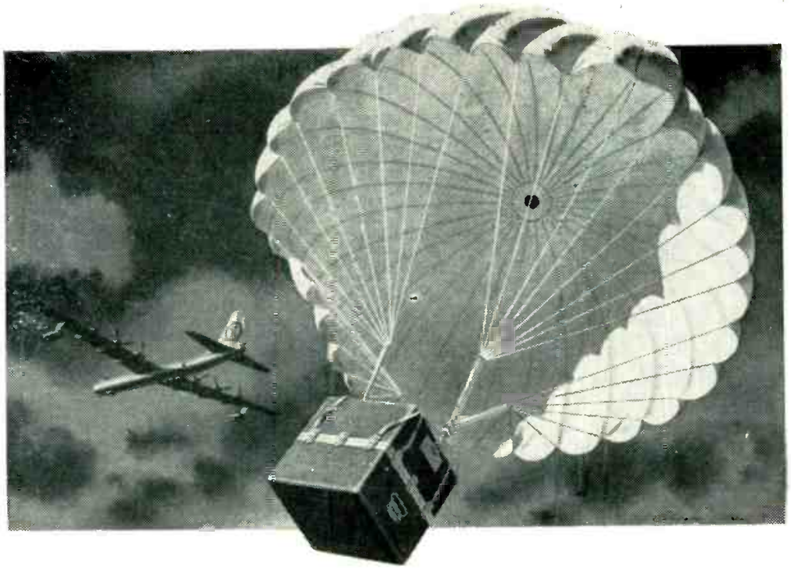

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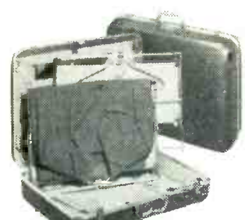

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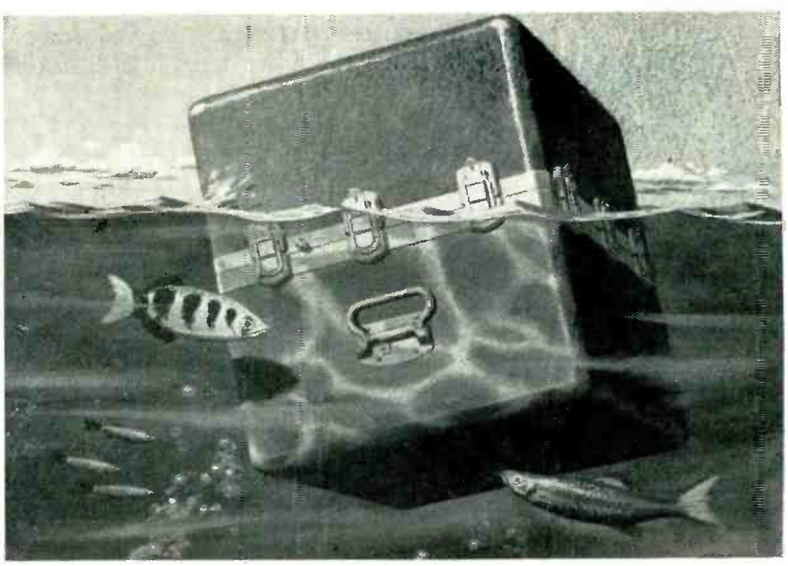

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PERTINENT PATENTS

By NORMAN L. CHALFIN
Hughes Aircraft Co.
Culver City, Calif.

WHILE COMMUNICATIONS and industrial applications of electronics vie with each other among patents granted, the majority reported in this month's collection shows the broadening importance of the noncommunications phase.

Counting Tube

Patent 2,638,541 has ben granted to John T. Wallmark of Bromma, Sweden for an Impulse Counting Tube. The patent is assigned to the Radio Corporation of America.

Figure 1 shows the internal structure of the tube. There is a plurality of dually stable discharge devices in the envelope of the tube. Where ten such devices are included in the tube it becomes a decade impulse counter.

Each dual-stable device comprises a secondary emitter or dynode and a collector element, but there is a common squirrel-cage control grid and cathode-emitter for all ten secondary emitter-collector pairs.

Each of the collectors is positioned to be within the shadow of the grid wires. The secondary emitter of each pair is between the shadows of adjacent grids in the path of rectilinear electron flow from the cathode emitter. This structure results in a beam of electrons from cathode to secondary emitter between two collectors. Thus there are ten radial electron

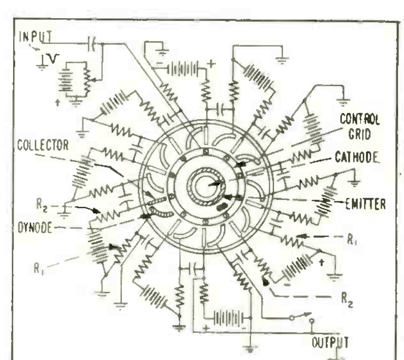

FIG. 1—Internal structure of the impulse counter tube

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beams directed at ten secondary emitters. The grids shield the collectors from primary electrons.

Operation of the decade impulse counter may be followed from Fig. 2. This is a plot of the conditions of a single pair of the elements connected with one of the dynodes. Resistor R_1 is a dynode load. Component R_2 is the collector load resistor. When the pushbutton switch in the output circuit is closed the resistors to the source are connected together at their cold ends. They form a voltage divider placing the collector and dynode to which they are joined at a common potential at the divider voltage point. This potential should be higher than V_b.

The values of resistance are so chosen. As a result of the positive potential on the dynode now energized, a beam of electrons will flow towards it from the cathode between the two adjacent grid wires. This results in secondary electron emission, which will return to the emitter as long as the switch is closed. As soon as the switch is opened, the collector electrode potential will rise and that of the secondary emitter will drop to V_b. Electron current will now flow from the emitter to collector because of the potential difference and the polarity of that difference between them. The electron space discharge resulting will now provide the low-impedance path from secondary emitter to collector in place of the switch contacts.

While the secondary emitter will draw primary current it will release a greater secondary electron current. The total current will therefore be negative. The drop across resistor R_1 as a result is of the proper polarity to maintain the secondary emitter sufficiently positive to continue drawing current and remain stable in this condition. The voltage versus total electron current for the dynode is shown in Fig. 2.

As in all secondary emitters there exist two stable operating points, 0 and V_b. The stable-current condition may be cut off by the application of a pulse to the input that is impressed on the grid. Cutoff of the electron beam results in a return

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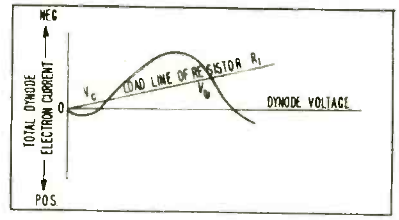


FIG. 2—Stable operating point V_b and 0 of secondary emitter

of this pair of elements to its first passive condition. The collector electrode potential during this transition rises sharply and the rise is coupled by the capacitor to the next clockwise secondary emitter to initiate another conductive stable state. Such condition, described for a dynode collector pair, is maintained until the next negative pulse is applied to the grid. This cycle repeats to the subsequent pairs as each pulse is applied.

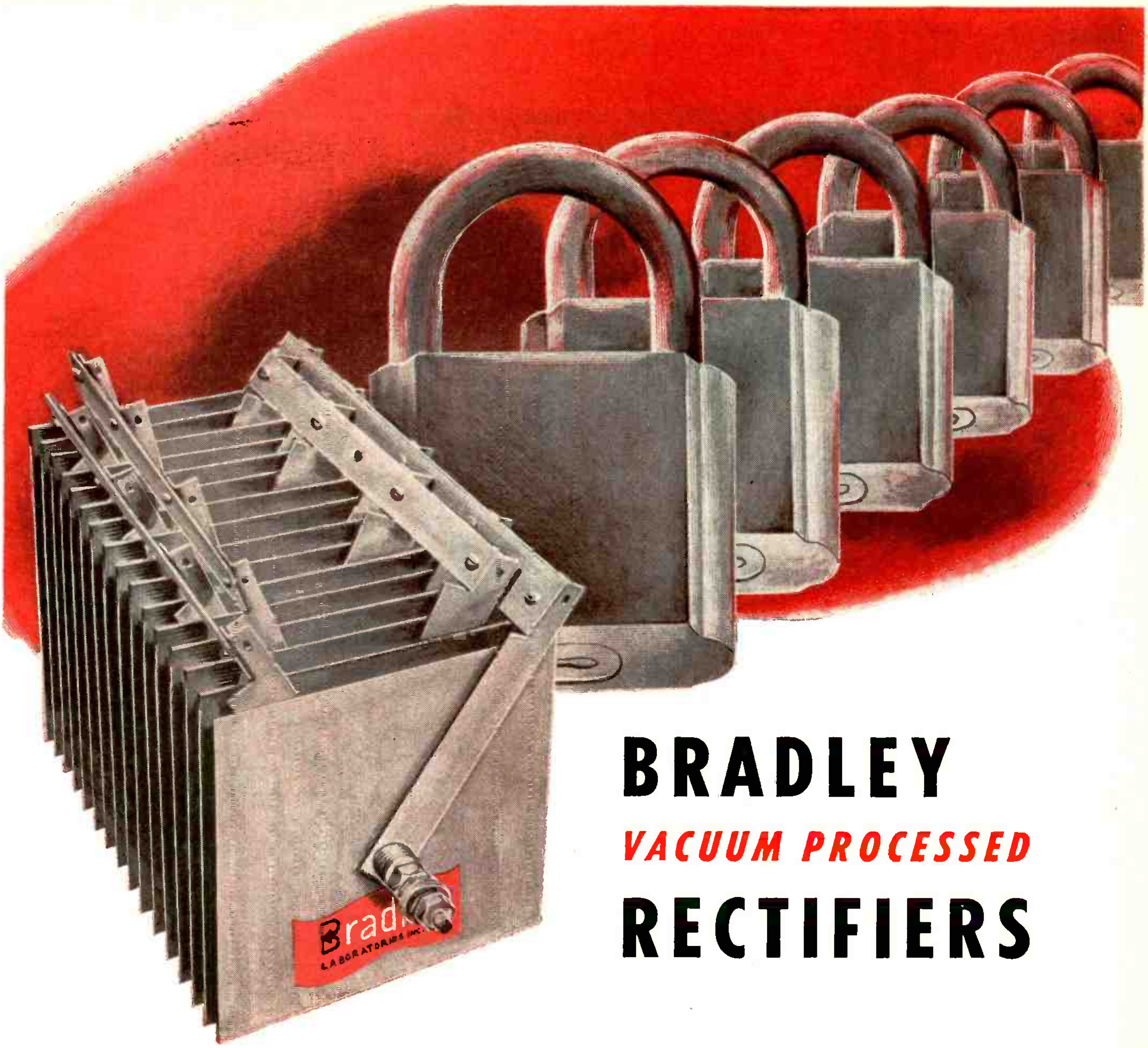
If at the output circuit there is connected the grid of another of these decade impulse counters, a digital decade impulse counter may be set up with as many digits as there are tubes. Indicating devices such as glow discharge tubes may be connected for displaying the position of the conducting dynode-collector pair then in operation.

Some of the operating circuit data are included in the patent specification as to pulse shaping and the time constants of the R and C combinations. They should be substantially shorter than n times the period between the highest frequency pulses to be counted. The inventor claims that very weak pulse amplitudes can control the counting system of this tube.

Radio Viewer

Recently awarded to H. A. Iams of Princeton, N. J., patent 2,668,-869 describes a Radio Viewing System. The patent is assigned to the Radio Corporation of America.

Figure 3 shows the basic idea. Radio waves are received as reflected from a source illuminated by some radio frequency in the range of 1-cm wavelength. The receiving antenna is a spherical mirror that collects the reflected waves onto a plane mirror. This, in turn, reflects the waves into an opening in the



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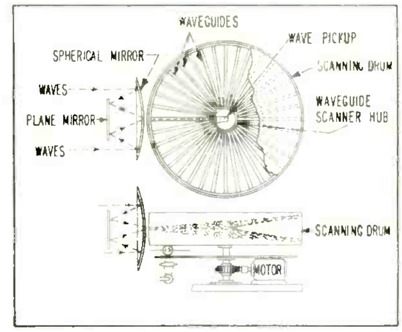

FIG. 3—Basis of microwave scanning system

spherical mirror.

A waveguide scanning drum is passed over the opening in the spherical mirror to receive the waves and carry them to a waveguide pickup at the center of the drum. The positions of the radially arranged waveguides of the drum are such as to produce a scanning action over the opening. This portion of the system is reminiscent of the Baird mirror-drum tv pickup and reproducer.

The drum and scanning are synchronized with a sweep circuit and the signals received at the waveguide pickup are detected and converted to light intensity signals on a cathode-ray tube to reproduce the image picked up by the spherical mirror. Figure 4 illustrates the system for reproducing the radiowave image.

Textile Recorder

An Indicating and Recording Device for Yarn Diameters was granted patent 2,641,960. The inventor, Fred P. Strother, of old Grenwich, Conn., has assigned the patent to Deering-Milliken Research Trust, of New York.

The circuit of the system is shown in Fig. 5. A pair of phototubes is employed with the anode of one connected to the cathode of the other. This connection is in the grid circuit of one half a d-c push-pull amplifier. Two batteries of equal potential are connected in series. An unbalance current resistor R is connected between the phototube junction with one grid and the junction of the two batteries with the second grid.

A common light source feeds the two phototubes. One tube receives a constant light through a

and furthermore . . .

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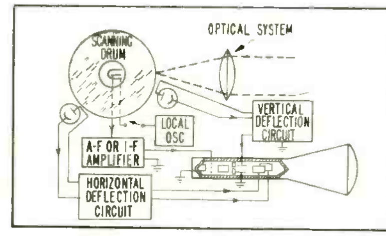


FIG. 4—Method of reproducing radiowave images

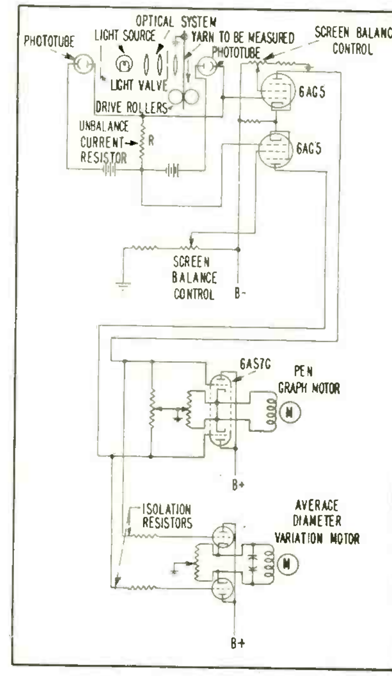
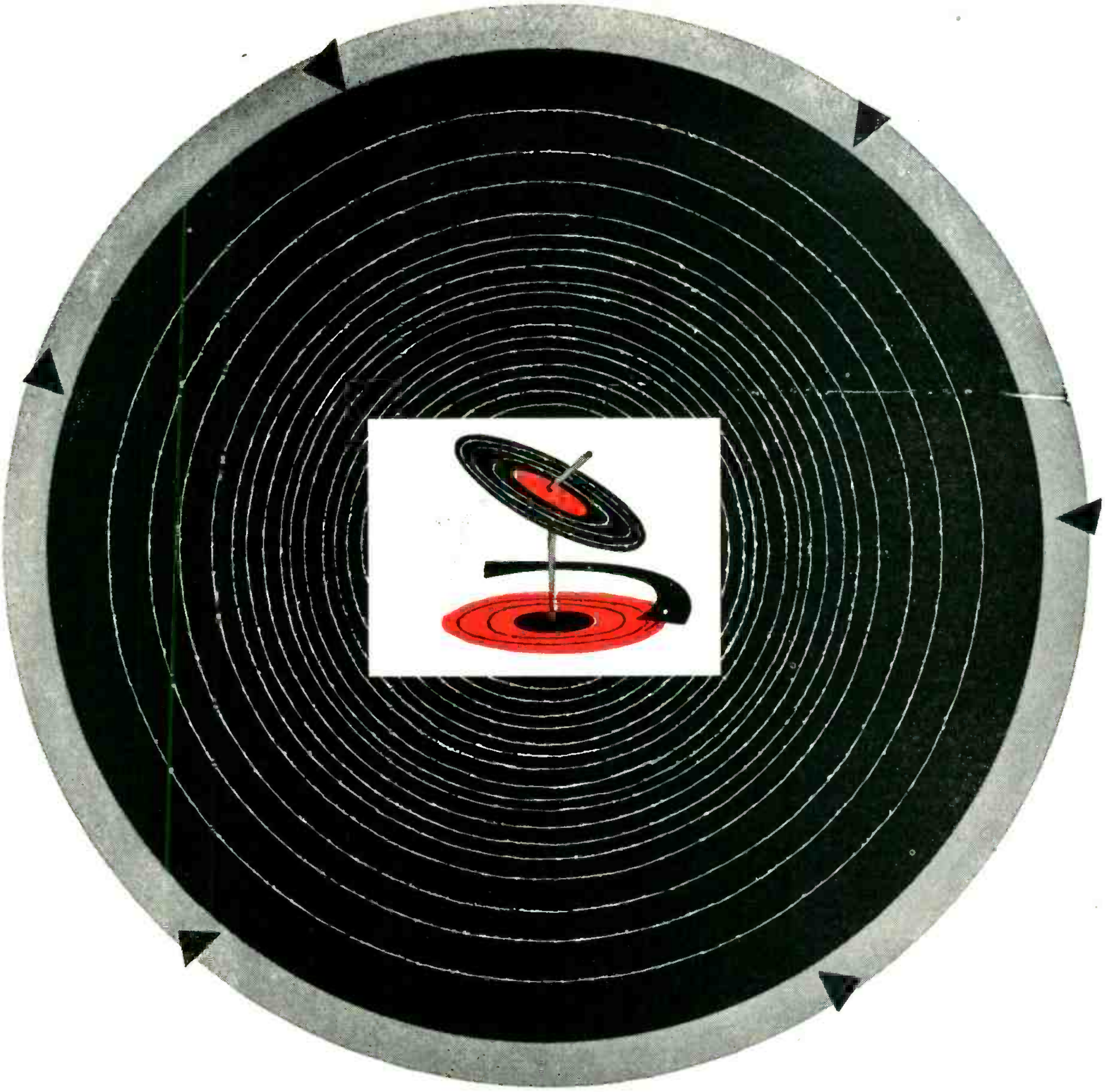


FIG. 5—Circuit of the photometric yarn measuring device

fixed slit. The other receives the light through a slit before which the yarn is pulled at a constant speed by drive rollers. The light valve before the first of the phototubes is the fixed slit and may be set for any predetermined diameter. When the light on the two tubes is equal there will be no unbalance current in *R*. Any deviation of the yarn from the preset diameter results in unbalance current in *R*.

The resulting potential difference is amplified by the pair of 6AG5 tubes and power amplifier 6AS7G. A motor is driven by the cathodes of the 6AS7G. The motor operates only when the yarn deviates from the desired diameter to give a pen record of the deviation. An additional push-pull d-c amplifier with its grids in parallel with the 6AS7G pen-graph motor-drive amplifier is provided to record only



average variation. This second amplifier has isolating grid resistors and the output circuit is damped with capacitors. The capacitors integrate the variations and drive the second pen motor to produce an average diameter record.

Frequency Discriminator

In a patent awarded Leo Staschover, 2,667,576 for a Frequency Discriminator Circuit a novel arrangement is disclosed. The patent is assigned to International Standard Electric Company of New York.

The discriminator circuit is shown in Fig. 6. Its particular novelty resides in the network inserted between the source of f-m waves and the detector. The network may be a T or pi conformation; the T type is shown. Another feature is the use of a unity-coupled transformer in which the primary and secondary are interwound on a common form.

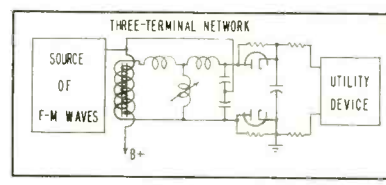


FIG. 6—Frequency discriminator uses network and unity coupling

The advantages claimed are that a wide band of frequencies may be covered in the tuning range of the discriminator, while at a particular frequency setting there is a narrow band of operation. A further advantage claimed is ease of tuning. The inventor claims the improved result to be obtained by impedance rather than magnetic coupling as in conventional discriminators.

Microwave AFC

Patent 2,667,636 was issued to O. H. Winn of the General Electric Co. for Automatic Frequency Control Circuits for Superheterodyne Microwave Receivers.

Microwave receivers generally employ a local oscillator of the velocity-modulated type such as a reflex klystron. These tubes may be adjusted in frequency by changing the potential on the repeller. This has been accomplished in the past

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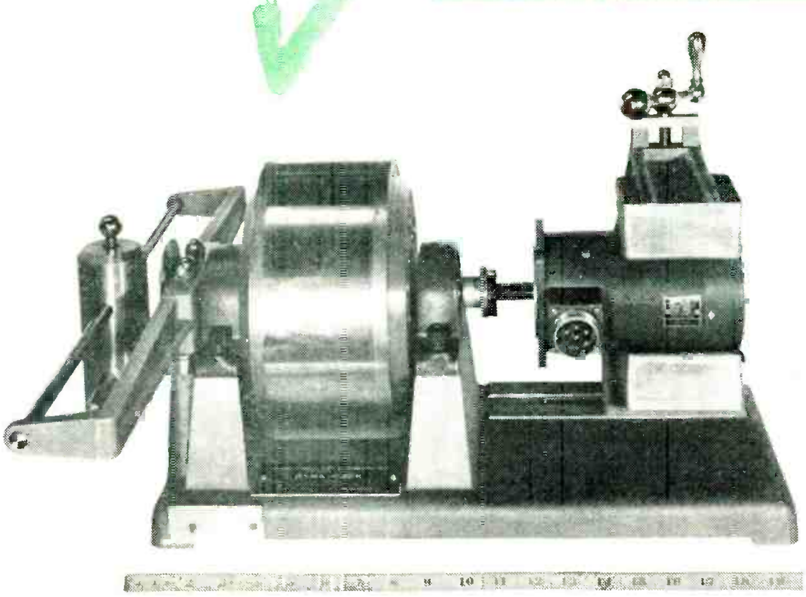

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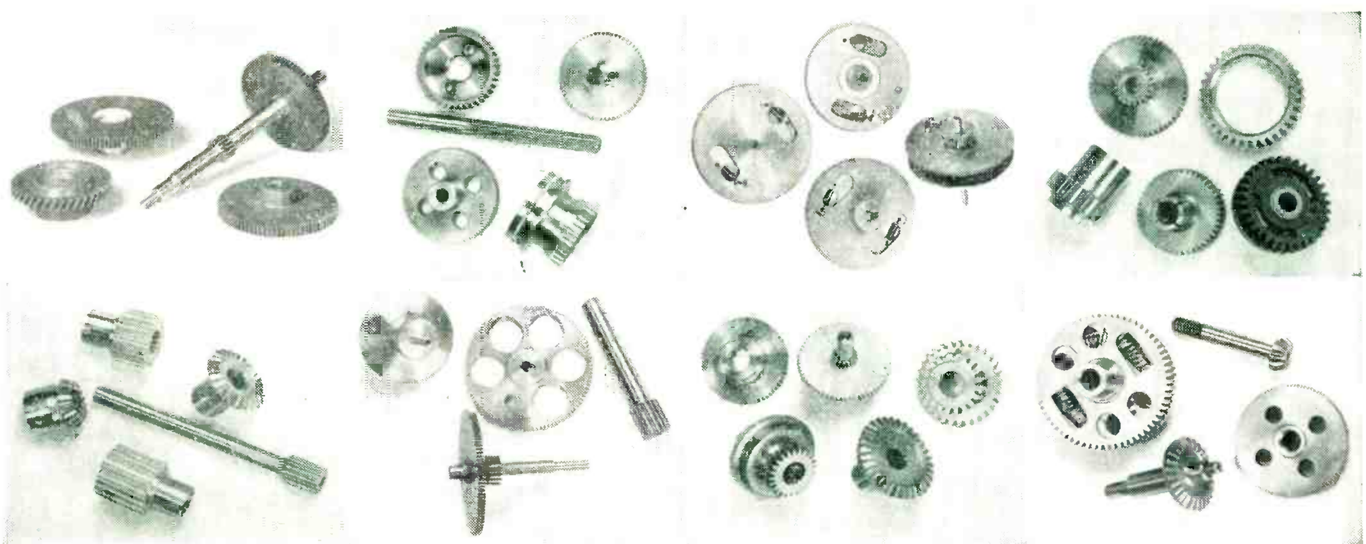

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PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE, HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES by a separate afc crystal detector for use in a system mixing local-oscillator and transmitter frequencies to develop the appropriate afc voltage that in turn is applied to the repeller. Crystal detectors, because of their nonlinear characteristics, produce harmonics that interfere with proper operation of afc circuits.

This inventor has found that by eliminating the separate afc crystal detector and mixing within the reflex klystron oscillator's resonant cavity, he has been able to accomplish an improved afc action. The output of the klystron has a circuit tuned to the i-f resulting from the mixing of a portion of the transmitter-oscillator frequency in the klystron cavity with the local-oscillator frequency. The resultant difference frequency appears in the beam current of the oscillator. The resonant circuit in the local oscillator output is tuned to the difference frequency and the voltage applied to the afc voltage generating circuits. The resultant afc voltage is applied to the local-oscillator klystron repeller.

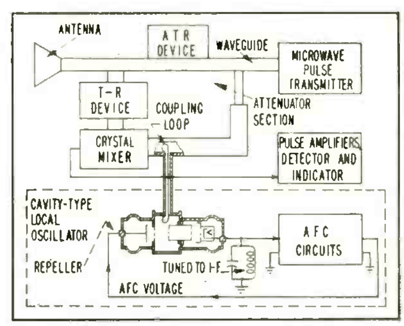

FIG. 7—Microwave superheterodyne eliminates separate afc crystal

Figure 7 is a simplified diagram of the inventor's circuit.

Color TV Tube

E. O. Lawrence has been awarded patent 2,669,675 for a Display Surface for Color Television Tubes. The patent is assigned to Chromatic Television Laboratories, Inc. of San Francisco, California.

Dr. Lawrence's color-tube inventions have been writen up in many publications since their initial public demonstrations. This new development provides a somewhat different approach to the solution

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of the problem presented by the perforated screen type of color picture tube.

In the present invention, Lawrence applies the principles of his earlier tubes in both the horizontal and vertical planes for more accurate control of the position at which the cathode-ray beam impinges upon the proper color area of the screen in synchronism with the transmitted color-image signal.

Figure 8 shows the structure of a lens grid screen employed in this invention to direct the beam to the

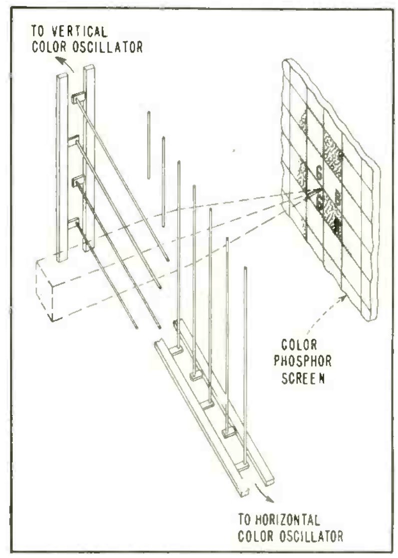


FIG. 8—Lens-grid screen for color tubes directs beam to desired area

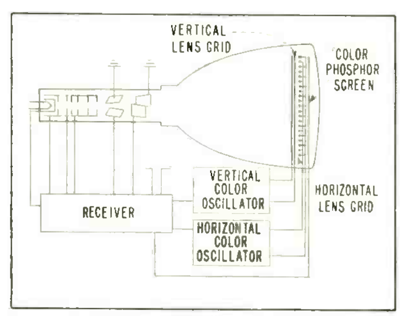


FIG. 9—Method of energizing color-tube grid with vertical and horizontal oscillators controlled by receiver

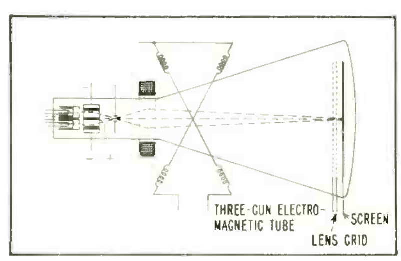
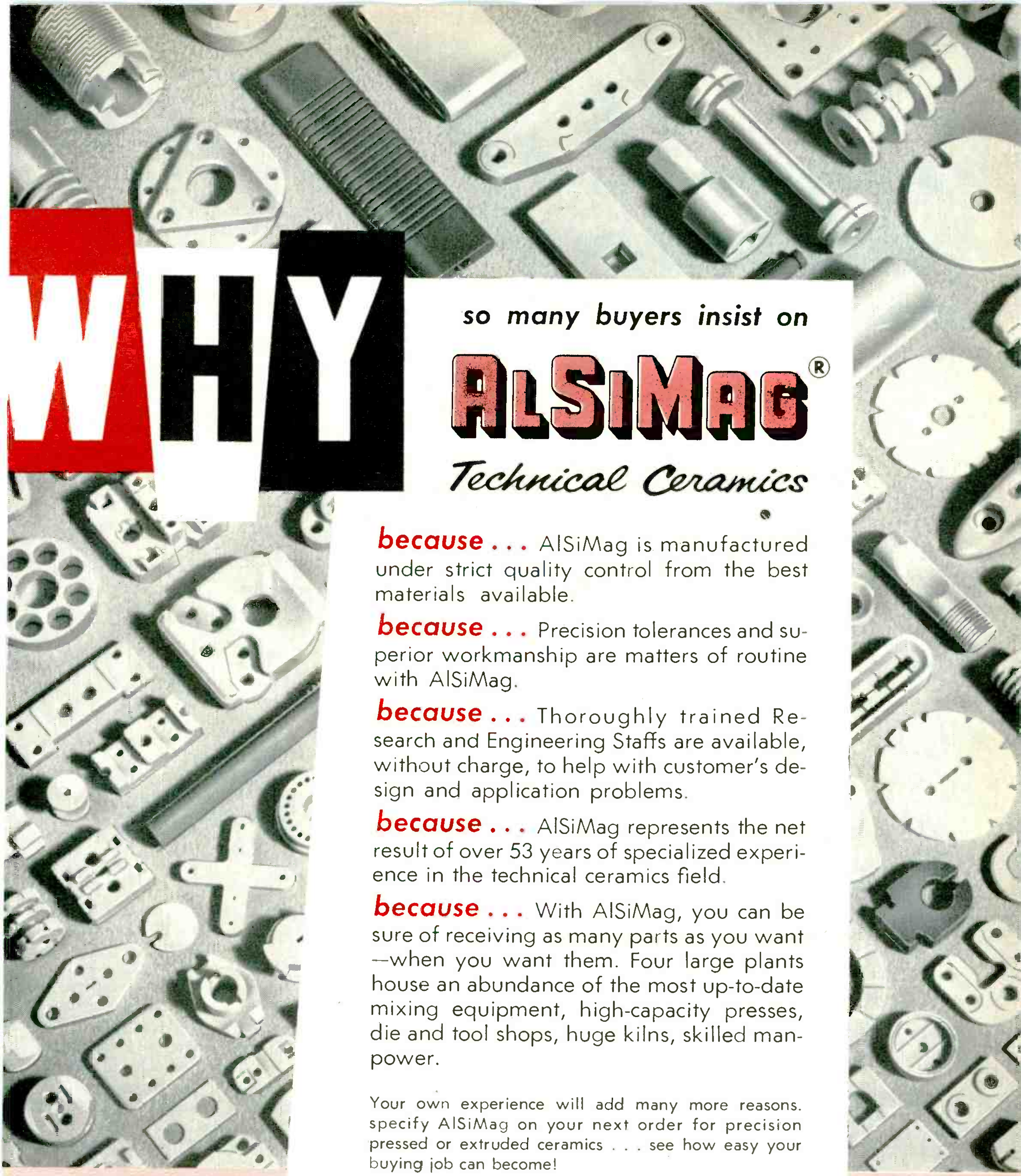


FIG. 10—Three-gun tube used to demonstrate how beam can be directed to a common point on screen area



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desired color area of the picture surface, as the beam is swept by the deflection circuits.

The block diagram of Fig. 9 shows the circuits by which the lens-grid structure is excited by a vertical and a horizontal oscillator. While the arrangement essentially describes a field-sequential application of the system to an electrostatic deflection tube, there is a likelihood that the vertical and horizontal color oscillators can be so phased as to provide operation in the manner of the dynamic convergence coil of the electromagnetic systems now in use in the present NTSC system.

An arrangement of the principle of this invention applied to a three-gun electromagnetic cathode-ray tube structure is shown in Fig. 10. Here all three guns are tied together to direct the beam to a common point on the lens grid screen area.

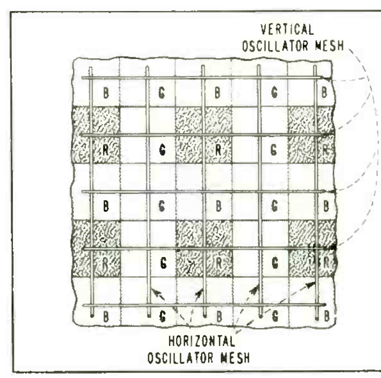
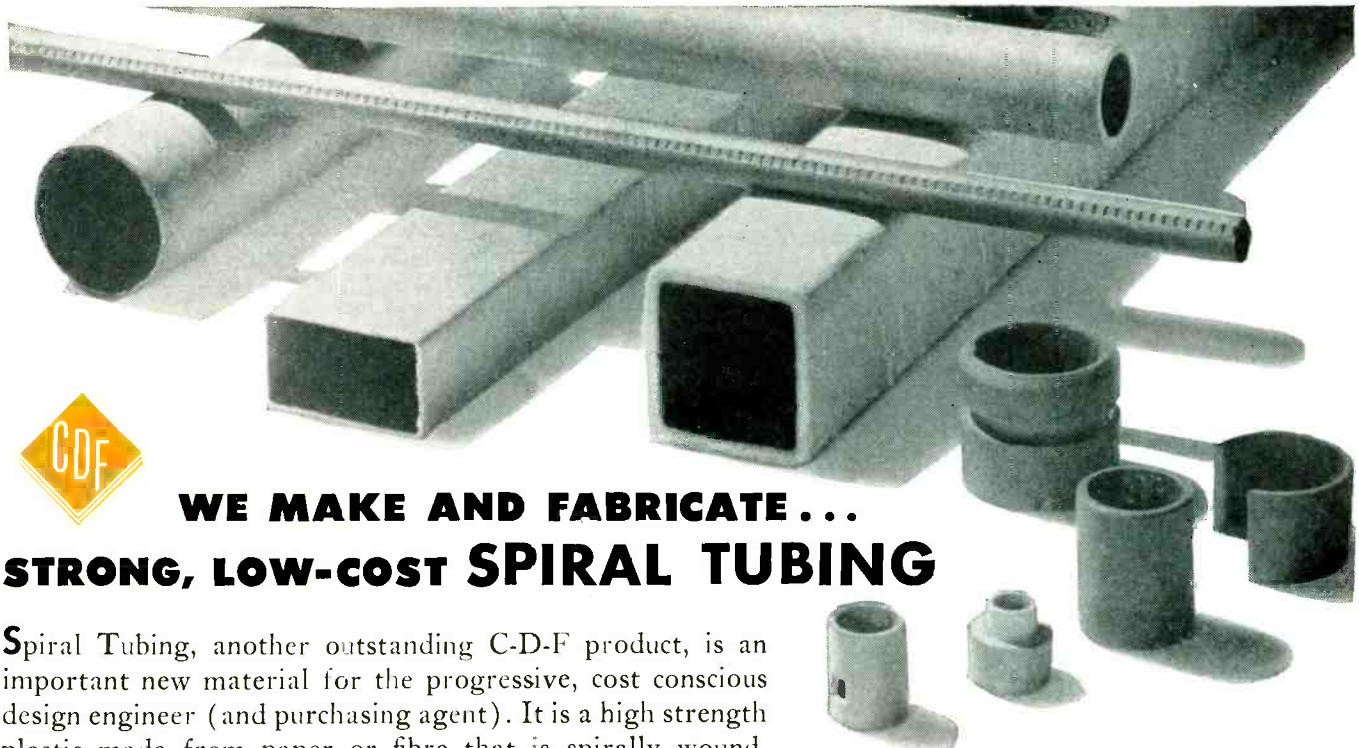


FIG. 11—Position of the color areas that are activated by the beam

Figure 11 shows the positions of the color areas with respect to the vertically and horizontally controlling deflection meshes of the lens grid. By appropriate polarities of voltages applied to the meshes the beam may be positioned to impinge on a greater or lesser proportion of the areas of each color section within the grid square to provide the appropriate color in the combination, or the beam can be spun inside the mesh with brightness changes effected by control-grid excitation of the beam.

Piezo Voltmeter

In patent 2,667,104 issued to W. E. Buck and assigned to the



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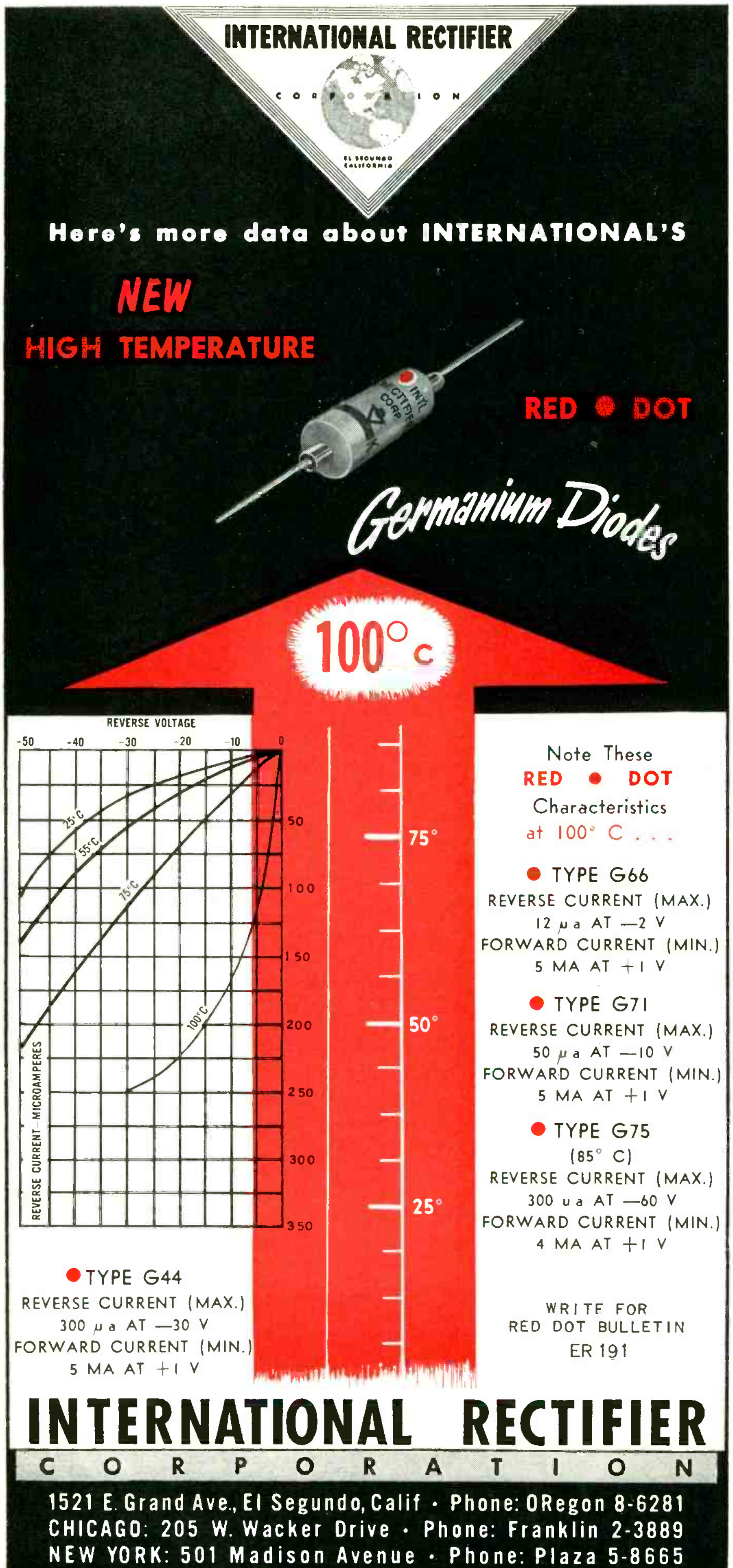

U. S. Atomic Energy Commission, there is described a piezoelectric voltmeter, although the title of the invention is Light Valve.

Figure 12 is an end-view illustration of the piezoelectric voltmeter arranged with an optical film recorder. The top view of the piezoelectric structure is shown in Fig. 13.

The piezoelectric crystal shown has a chamfered edge that is coated to form a partially reflective surface. The surface of the plate glass nearest the crystal is partially coated also. Since the crystal and

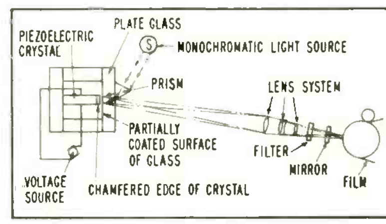

FIG. 12—End view of piezoelectric voltmeter

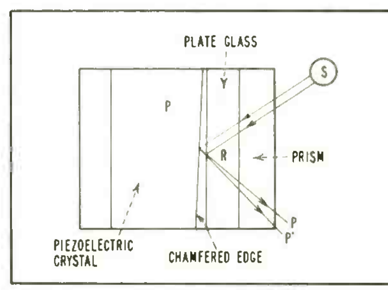

FIG. 13—Top view of piezoelectric structure

glass surfaces are not in parallel planes, these surfaces define a wedge-shaped film. When a monochromatic light source is directed at an angle on the interference fringe created by these surfaces interfering rays appear to diverge from the reflecting surface at points P and P' respectively.

Light from the monochromatic source when passing through the coated surface of the glass is reflected by the chamfered edge of the crystal to the film recorder. As the crystal is deformed by the voltages applied to it the thickness of the pattern formed is a measure of the voltage applied to the crystal. The response of the system is best from 1,000 to 50,000 cycles.

Piezoelectric crystal voltmeters are the only types useful for measurement of high voltages at high frequency without load upon the

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Mass Separator

Another recently awarded patent assigned to the U. S. Atomic Energy Commission is for a Mass Separator. J. G. Backus is the inventor. Patent is No. 2,667,-582.

Mass separators resolve beams of ions into separate distinguishable groups of like mass-to-charge ratios and provide visual indications of the ratios and abundance of ions in each group.

The present invention is a velocity-focused mass separator. Figure 14 illustrates the electronic system of this invention as utilized

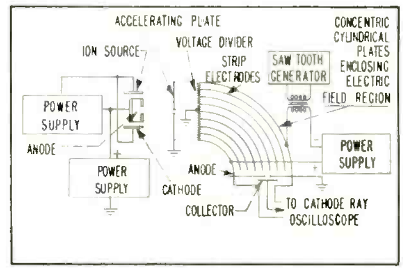

FIG. 14—Electronic portion of focused mass spectrometer

in a chamber into which is inserted a material to be studied.

An ion source bombarding an accelerating plate sends a beam of ions down a crescent-shaped enclosed electric field area towards an anode and ion collector.

The crescent-shaped area has strip electrodes arranged concentrically within the area. There is an equal number on each side of the beam area with respect to center. That is, there is an equal number in each of the positive and negative areas as the area is swept by a saw-tooth voltage; the ion beam is swept to focus ions of like mass-to-charge ratios in succession. The saw-tooth voltage is also connected to the horizontal plates of an oscilloscope and the output of the mass separator to the vertical plates of the oscilloscope. A trace is thereby provided of the magnitude versus mass-to-charge ratio on the oscilloscope screen.

The calibrations of the screen with respect to the saw-tooth voltage make possible the identification of elements and their isotopes present in the source material and the comparison of relative abundance.

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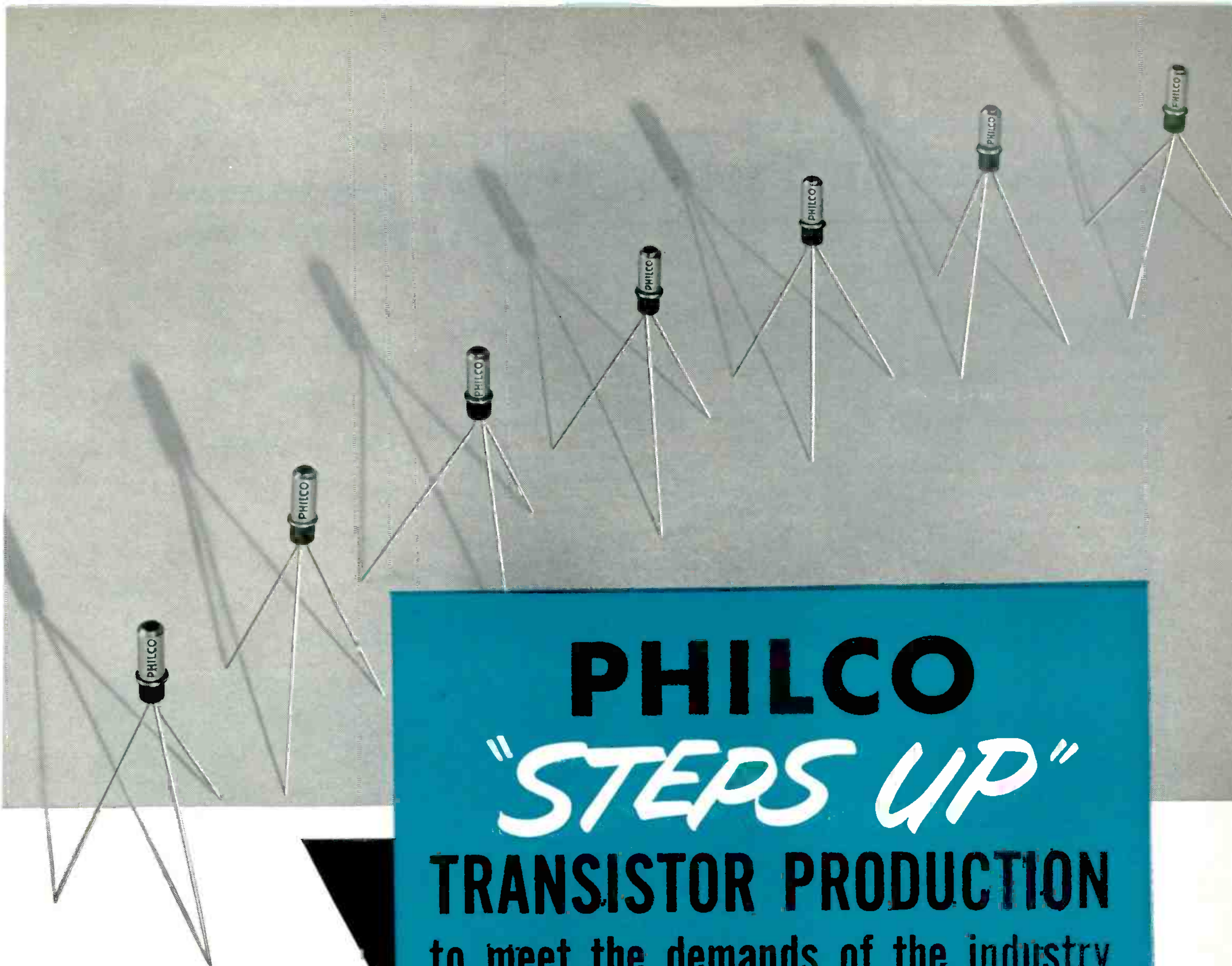

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Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS
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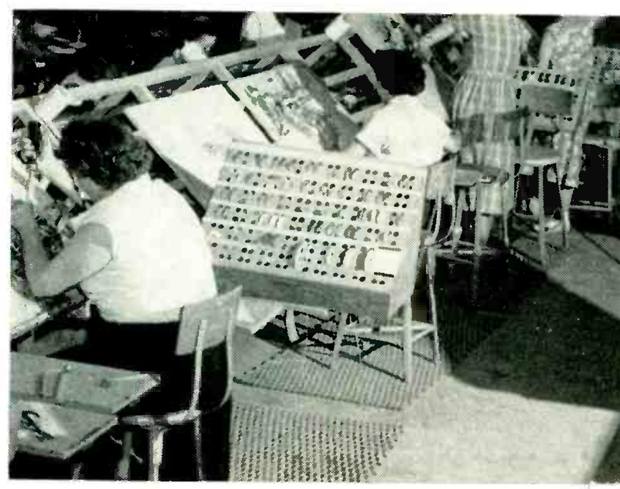
Frames for Cable-Lacing Boards Cut Production Costs

Storage rack for different lengths and colors of stripped wires used on lacing board. As many parts as possible are wired directly into the harness



Bench setup in lacing board department, showing frames for supporting boards on bench and method of using pull-out breadboards to support tools and wire rack

DIVIDING wire harness boards into labeled rectangular coordinates much as for maps permits specifying individual wires by means of an origin coordinate square and a destination coordinate square. This simplifies placement of wiring and improves accuracy in the North Hollywood, Calif. plant of Pacific Bendix Division.

Wood frames for supporting harness boards are constructed in sections that sit on top of benches and can easily be removed or shifted as the work load varies. Each standard eight-foot-long workbench is equipped with sliding breadboards at each end and in the middle on both side of the bench. These boards, made from five-ply plywood, can be pulled out as required to support cut wire racks and tools at the most convenient locations for the operator regardless of lacing board size.

The racks for cut wires are made by drilling holes in a sheet of tempered pressed wood and mounting this sheet at an angle on a wood frame. Wires are inserted in pairs of holes. The operator grasps a wire at its center and pulls it out; this eliminates the annoyance of pricking fingers on sharp ends of stripped wire. Strips of masking tape are run across the board and holes are identified by lettering on the strips. Lettering can thus be changed easily by putting on new strips.

Chassis components are wired into the harness wherever possible, to avoid more difficult wiring later in the chassis. Even tube sockets and resistor subassembly panels are wired into the harness and later riveted or bolted to the chassis.

Scribing Dial Windows

THE PROBLEM of inscribing lines evenly in transparent plastic dial windows for electronic apparatus when the plastic varies in thickness is a tricky one. The line must be evenly cut, because illumination of the dial when the apparatus is in use shows up any irregularities.

Hewlett-Packard in Palo Alto,

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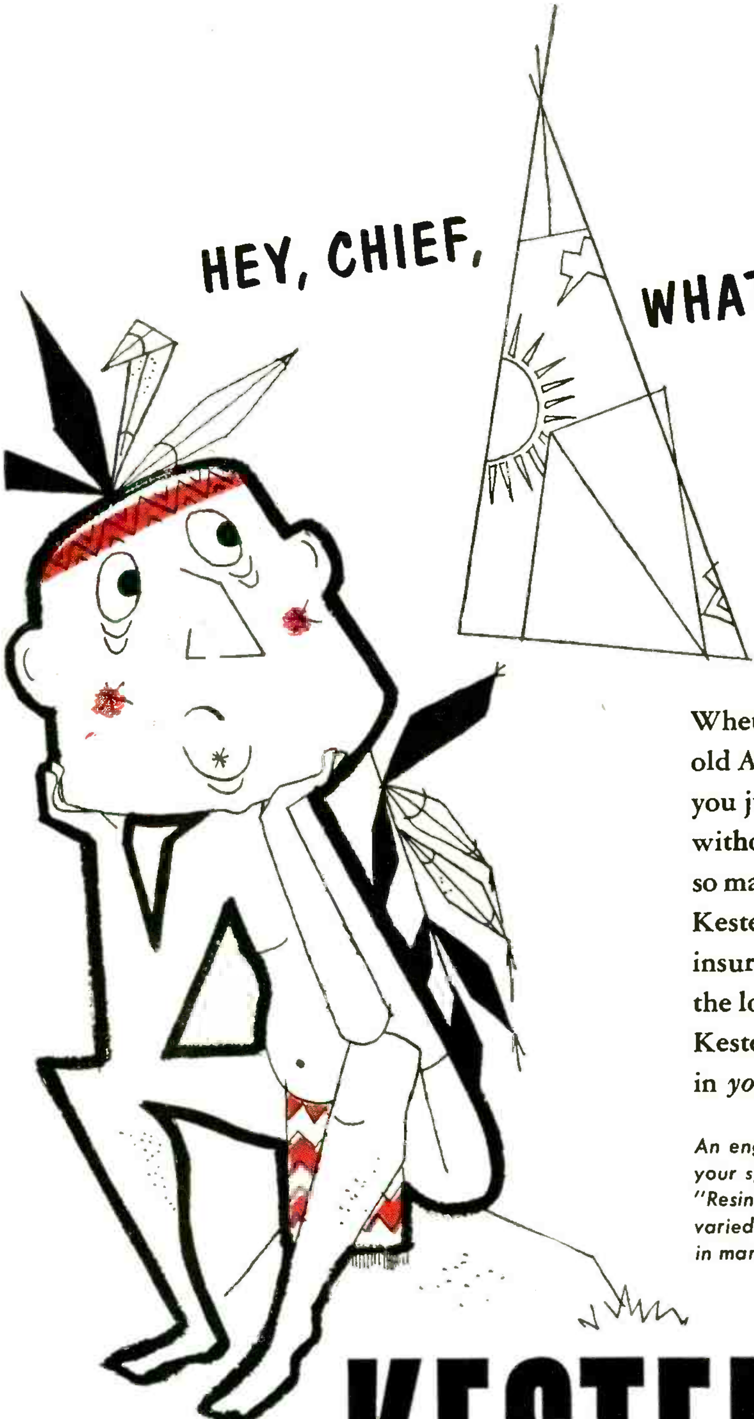

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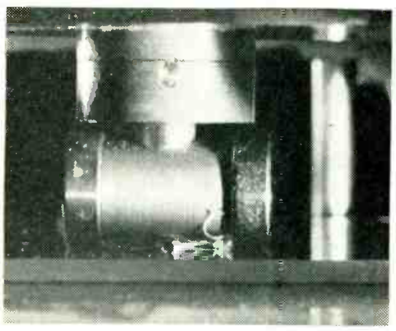
Lucite dial window panels are positioned in the tool by studs that mate with panel holes. Windows of five different shapes and thicknesses are accommodated by moving the studs to different positions in the tool



Operator drops needle on Lucite and moves needle-supporting slide the length of the panel to cut line. Needle here projects downward from center of spool-shaped holder. Ends or flanges of holder roll freely on plastic

Calif., found that a hand scriber used against a straight edge was unsatisfactory, producing uneven work. An engraving machine didn't work either; the line was cut with reference to the engraving table instead of the sometimes irregular plastic surface.

The solution worked out uses a recording needle mounted in a spring-loaded cutting head which rolls along the surface of the plastic to obtain a depth of slot constant to 0.001 in. The needle is self-adjusting to 0.040 in. and can be adjusted by a setscrew for various thicknesses of plastic sheet. A micrometer can be added for exact adjustment.

For some applications, the engraved lines are filled with black ink or colored pigments to improve visibility. For other uses, the lines are unfilled and the panel is edge-lighted.

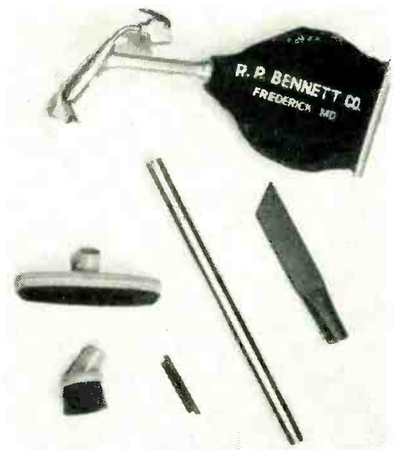
Vacuum Cleaner Cleans Drill Press

A CLEANING tool operating from a compressed-air supply and using the principle of the Venturi tube contributes to good housekeeping in metal-working departments of electronic plants. When permanently mounted on a drill press, the unit picks up chips as fast as they appear and shoots them through a rubber hose into a waste barrel.

With a bag attached in place alongside of a rubber hose, the unit can be used as a hand vacuum cleaner for lifting lathe cuttings out of a lathe and for cleaning other machines employed in the production of electronic components. Absence of moving parts in the cleaner minimizes clogging, and absence of electrical contacts permits use in locations having fire hazards.

The new cleaner can be attached to grinding wheels, belt sanders and other machines that produce lint, grit or filings during operation. By placing appropriate sizes of screens on the nozzle, it can be used to separate particles of different sizes or to clean stock bins without picking up parts.

Another shop use is picking up liquids. The cleaner will empty a 50-gallon drum of water in 60 seconds and transfer the liquid through a rubber hose to any other container. Since the aluminum housing of the cleaner is essentially acid-proof, electroplating tanks can be emptied with it.



New model of industrial cleaner which operates from air line and takes all standard vacuum cleaner attachments

Exclusive of air hose, the unit weighs less than 2½ pounds, permitting easy cleaning of overhead areas without operator fatigue. When operated from a compressed-air line at approximately 90 pounds pressure, the vacuum produced at the nozzle is about twice that of the largest domestic tank cleaners. The unit is distributed by Merchandising and Manufacturing Associates, Inc., Lancaster, Pa. and is available in several models to meet a variety of industrial cleaning problems. Recent redesign to take standard

Cleaner mounted on drill press for transferring chips to waste barrel as fast as they are produced, while drilling instrument panel

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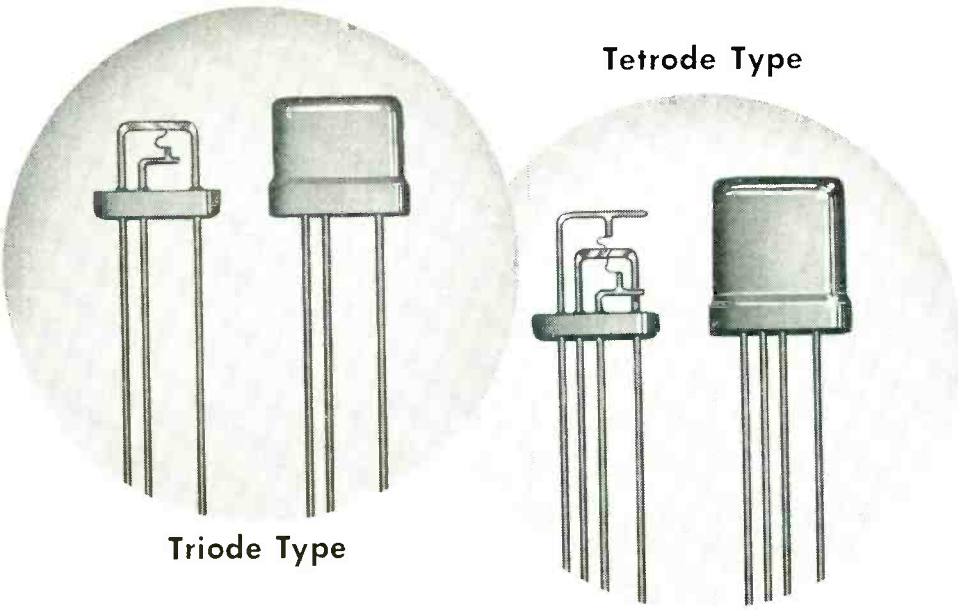

Tetrode Type

Triode Type

1. No change with age
2. Greater power gains
3. Hermetically sealed
4. No temperature hysteresis
5. I_{co} lowest available
6. Better frequency response

REPRESENTATIVE APPLICATIONS

D.C. amplifiers, multivibrators and high speed switches, pulse amplifiers, radar timers, computors, radio receivers, transmitters, etc.

Available from local distributor stocks:

NPN GROWN JUNCTION RADIO FREQUENCY TRANSISTORS

NPN GROWN JUNCTION TRIODES (Typical Characteristics)

Type No.	(A1) Power Gain at 455 kcs (db)	(A2) Power Gain 1000 cps (db)	Collector Capacity ($\mu\mu f$)	Alpha Cutoff Frequency (mcs)	Collector Resistance (megohms)	Base Resistance (ohms)	Alpha	Rise Time (us)	Noise Figure	(B) Ico Collector Current Cutoff (uamp)	List Price
RD-2525A	23	47	14	5.0	5.0	400	.993	<0.20	20	2	17.85
RD-2521A	22	47	14	2.5	5.0	150	.975	<0.20	20	2	7.85
RD-2517A	20	38	19	1.0	3	100	.93	0.20	20	2	5.00
NPN-3	15	35			2	100	.80			5	3.00

(A) At V_c = 5 v, I_e = −1 ma. (1) Grounded emitter, conjugate matched. (2) Grounded emitter, matched maximum loads.
(B) V_c = 5 volts, I_e = 0.

NPN GROWN JUNCTION TETRODES (Typical Characteristics)

Type No.	(C3) Power Gain at 5 mcs (db)	(C4) Collector Capacity ($\mu\mu f$)	(C3, 4) Input Impedance (ohms)	(C3, 4) Output Impedance (ohms)	(D) Oscillator Frequency (mcs)	List Price
RDX-300-A	17	3	25	9000	60	40.00
RDX-300	15	5	25	9000	45	25.00
RDX-301	14	7	25	9000	30	15.00
RDX-302	12	10	25	9000	15	10.00

(C) At V_c = 22.5 v, I_e = 1.3 ma. (3) Grounded base, matched loads. (4) Varies with tetrode bias.
(D) In a Colpitts type circuit.

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Subsidiary of Radio Development & Research Corporation

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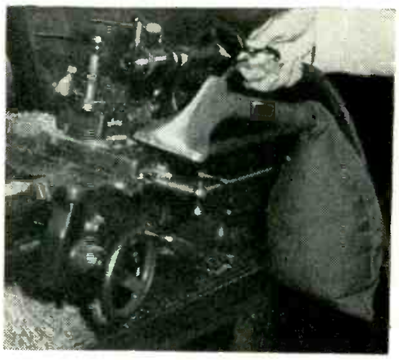


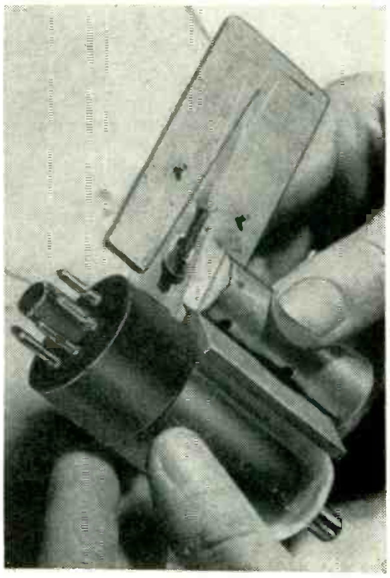
Using cleaner with bag for picking chips out of lathe recesses

vacuum cleaner accessories greatly reduces cost by eliminating the need for special cleaning brushes and tools for various production-lines locations.

Base Alignment Gage Checks Octal Tubes

WHEN the V-block of a Tung-Sol gage is cradled against the cylindrical glass envelope of an octal tube, a pointer indicates the exact angle by which the base deviates from alignment with the envelope. Good alignment is desired both for appearance and for utilitarian reasons.

Since the tube base and the glass bulb can vary considerably in diameter, a special gage design was required to make the angular indica-



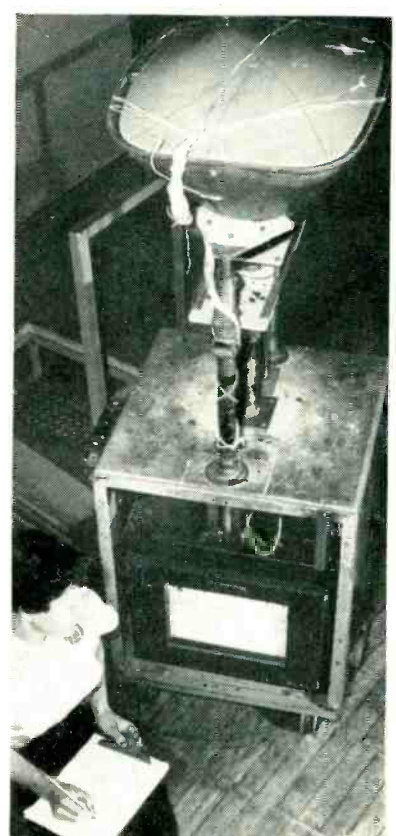
Method of using gage

tion independent of these diameters. The problem was solved by using a hand-held V-block for the glass portion of the tube. An extension of the V-block holds a small pointer and scale calibrated in degrees.

The pointer has a small slot at its pivot point instead of a hole. The pointer can thus slide up and down and thereby adjust itself to any diameter variations. The indicated degrees will still be correct because it is the angle of the indicator in relation to the face of the V-block that is the correct reference point. Longer scale lines on the gage indicate permissible 3-percent tolerance limits that are observed for most tubes.

Oven Heat Recorder for Picture Tubes

A DUMMY PICTURE-TUBE pumping cart, equipped with a temperature recorder in place of the vacuum pump, is used to monitor temperatures in straight-line exhaust ovens at RCA's Lancaster, Pa. picture-tube plant. The high temperatures



Recorder cart with picture tube is taken out of production line after trip through oven, for analysis of recorded data

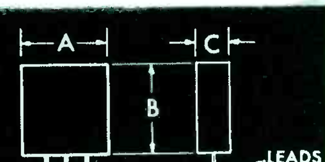
For Hermetic Sealing

E-I MINIATURE TRANSISTOR COMPONENTS*

ALL COMPONENTS ARE SHOWN ACTUAL SIZE — ALL OUTSIDE LEADS APPROX. 1¼"

These precision made components for transistors and other assemblies requiring hermetic sealing are available in three electrode, two electrode and single wire types. Where other than the standard types illustrated are required, E-I can custom design, and economically produce, special types in square, round or rectangular shapes. For complete information, call or write E-I — there is no obligation.

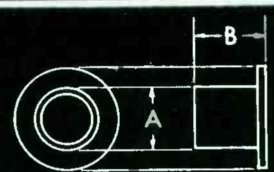
*PATENT PENDING



THREE ELECTRODE TYPE — Supplied complete with case. Suitable for transistor and other assemblies.

TYPE	A	B	C
TB-1	.335	.300	.183
TB-3	.217*	.300	—
TB-5	.132*	.325	—
TB-6	.398	.300	.191

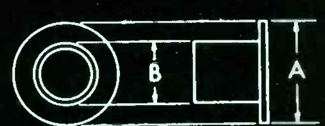
*Diameter



TWO ELECTRODE TYPE—Miniature headers for diode assemblies and similar applications.

TYPE	A	B
DB-1	.215	.170
DB-2	.217	.197
DC-5	.375	.275*

*With .050" O.D. and Projection for Resistance Welding.



SINGLE WIRE TYPE — Standard subminiature components available in compression and Kovar types.

TYPE	A	B
5AS	.125	.104
6A	.110	.088

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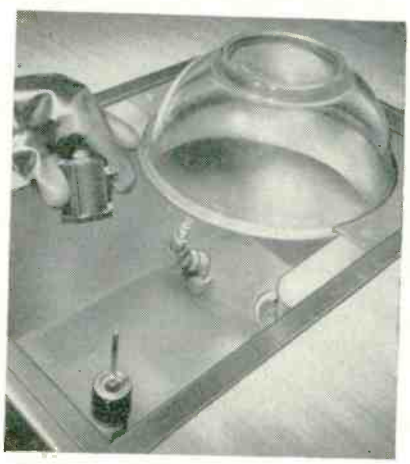
must be rigidly controlled for each type of picture tube to avoid strains in the glass, particularly at the faceplate and wall of the tube.

A sample tube on the cart has five thermocouples attached externally and connected to a Honeywell electronic recorder. At intervals during the day the guinea-pig cart travels through the exhaust ovens, emerging with a charted temperature picture for the particular tube in production. Temperature deviations are quickly spotted and necessary adjustments made immediately.

Corrections can be made quickly because the recorder indicates the exact location in the oven of such temperature deviations. Exhaust schedules for new tube types can be readily established and evaluated by running a new tube through on the recorder cart.

Cleaning and Oiling Completed Components



Washing tank for potentiometers

ALL MULTITURN precision potentiometers are processed in a specially designed washing device at Helipot Corp., South Pasadena, California, as part of the regular manufacturing procedure, after the resistance coil has been assembled into the case. A special cleaning solution is run into the tank, deep enough to cover the brush. The operator places the potentiometer over the shaft and moves it up and down against the brush. Then the potentiometer is held over the jet through which the same cleaning solution is sprayed under pressure. The inverted glass bowl prevents

each of these HOLTZER-CABOT motors solved a special problem!

Holtzer-Cabot specializes in motor and generator design, and is tooled to produce both AC and DC motors and generators, in a wide range of frames, with unlimited varieties of mechanical and electrical features.

Quality motors correctly designed result in lowest ultimate cost.

Bring your small-motor application problem to Holtzer-Cabot. Our experience in developing custom-built motors assures you of a prompt and expert solution.

N.B. — The different mechanical designs shown were selected from one day's quantity production.

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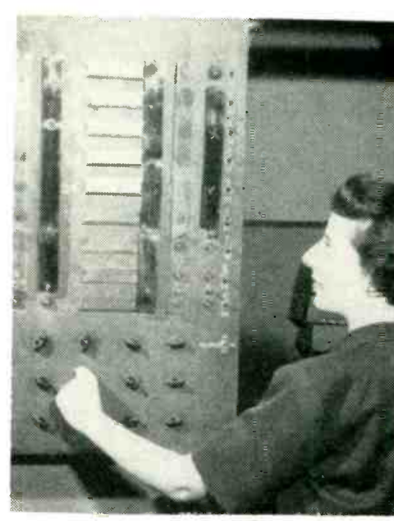
Oil-spraying setup

splattering of the cleaning solution.

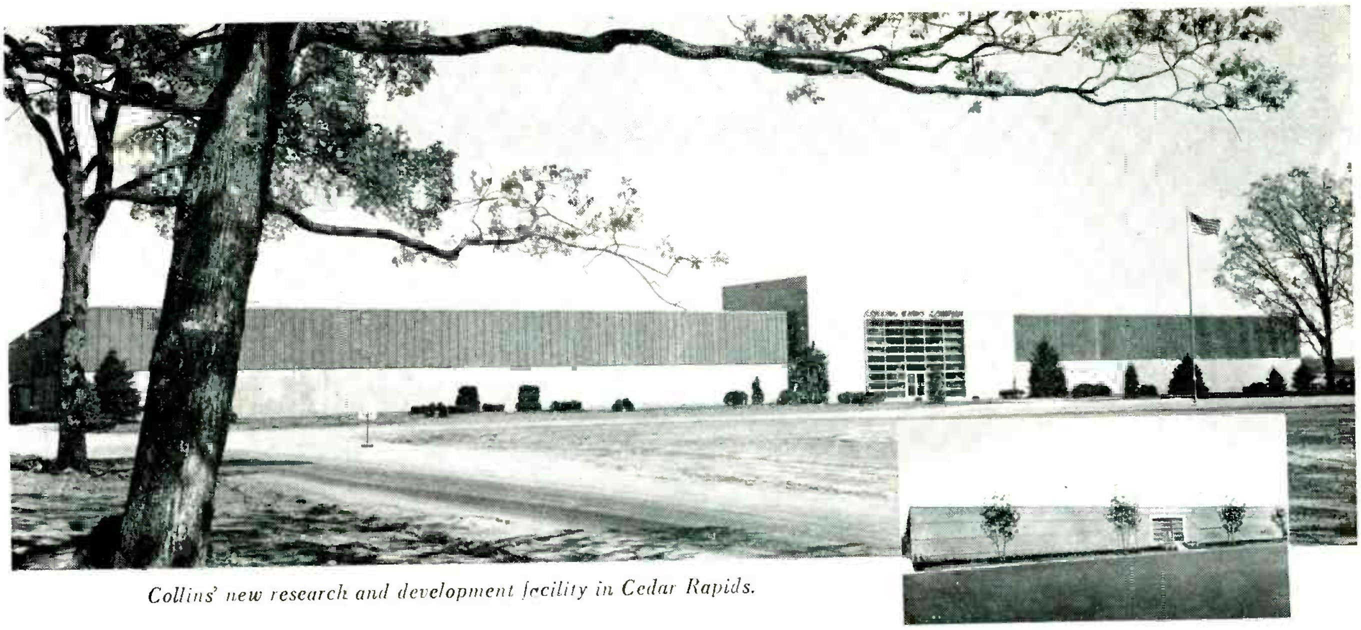
To complete the cleaning process, the potentiometer is then placed on a fixture in the middle of an adjacent tank, and a foot-pedal-controlled air jet dries the pot completely. Finally, the pot is held in front of an atomizer and a light mist of lubricating oil, also controlled by a foot pedal, is sprayed into the pot.

Quality Control Sets Factory Traffic Lights

IN FRONT of each tube production unit in the Bloomfield, N. J. plant of Tung-Sol Electric Inc. are red, yellow and green traffic lights. These are turned on and off by the quality control department to tell production how it's doing. The green light means OK—go ahead; the yellow means caution; the red light means stop the machine. No more tubes may be shipped to the



Switchboard for quality lights



Collins' new research and development facility in Cedar Rapids.

Dallas, Texas, facilities.

Burbank facilities.

From COLLINS

outstanding research and development facilities

come these contributions to industry

Collins' new research and development facility in Cedar Rapids (pictured top above) houses 12 ultra modern laboratories, with especially designed equipment required by Collins in its diversified development program. It brings together, under one roof, highly trained engineering teams and the most advanced electronic research tools. This new Collins facility in Cedar Rapids is supplemented by Dallas and Burbank laboratories for the development of specialized electronic components for industry.

In addition to the finest facilities, Collins places even greater importance on engineering personnel. Some of the best engineering talent in the nation is at work on Collins' development projects. So today, with greatly expanded research and development laboratories, Collins is better equipped than ever to assist the Electronic Industry. Technical literature is now available on the Collins components shown, and your inquiry is invited.

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Oscillators

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quality control department by a red-lighted unit until the trouble has been corrected.

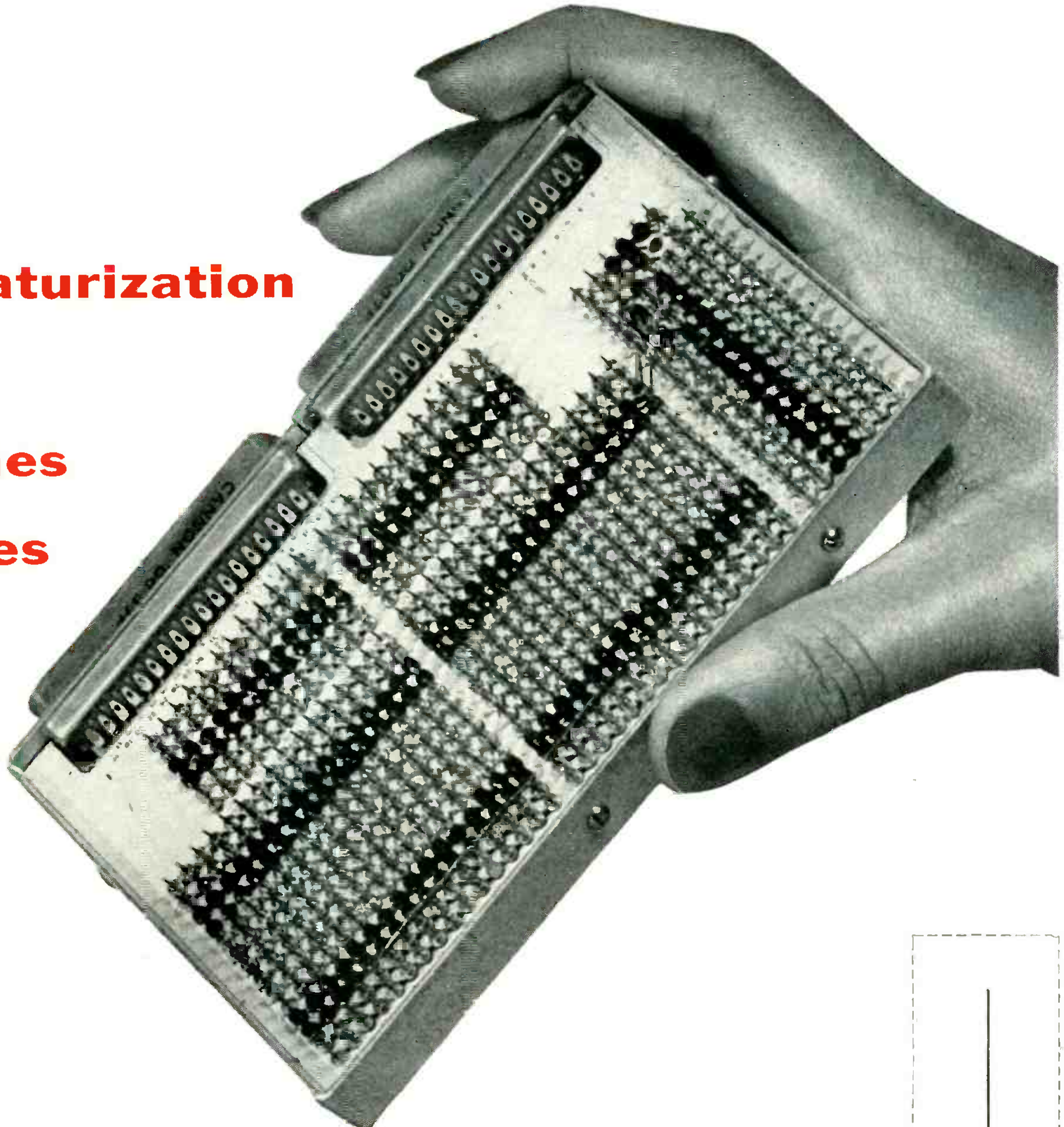
To determine how lights should be set, quality control continuously inspects the output of the fifteen or more units in operation, each producing a different type of tube. These tubes are 100-percent tested for noise defects, electrical defects and mechanical defects. The number of defects in each category for each batch of 100 tubes is entered on a continuous strip chart for that type.

Strip charts used for recording numbers of rejects in each batch of 100 tubes of a given type. Noise, electrical and mechanical defects are listed separately in a vertical row of three boxes

The strip charts are arranged in groups on a holder in such a way that a strip can be advanced by pulling the end with the left hand. Labels or crayon markings on transparent plastic guides identify the tube represented by each strip chart. These markings are easily changed when a different tube type is placed into production.

The cumulative averages for the last 1,000 tubes produced are transferred regularly from the strip charts to a bulletin board type of chart, the composite results of which determine the settings of the traffic lights. This chart is four-sided and is mounted on a vertical pipe for easy rotation, much in the manner of postcard display racks in stores. Small horizontal strips of wood divide each side of the rack into 16 areas in which the

Miniaturization with Hughes Diodes

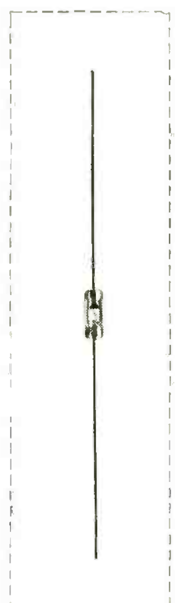


New computer matrix has high component density

This experimental reading gate matrix for airborne computers effectively *utilizes the subminiature size of Hughes Point-Contact Germanium Diodes*. Developed by the Miniaturization Group of Hughes Research and Development Laboratories, the unit measures 5¼ by 3⅛ by ½ inches (excluding plugs and frame). It contains 504 diodes, 209 resistors.* Average component density: *94.5 per cubic inch!*

Frequently, space requirements of conventional wiring techniques will not permit electronic equipment to be miniaturized to the same extent as the components. However, spot-welded connections can effectively reduce wiring space . . . and it is easy to spot-weld the dumet leads of Hughes diodes. There is no adverse effect on diode characteristics, even when the connections are welded close to the diode body. With Hughes diodes, designers can take full advantage of advanced packaging and wiring techniques.

Hughes diodes are easy to mount in conventional assemblies or in subminiature equipment. In service, these diodes have earned a reputation for reliable performance and stability under severe operating conditions. Make your selection from the many standard and special types available — all listed and described in our new Bulletin, SP-2A.



*Actual size, diode body: 0.265 by 0.130 inches, maximum.

Reprints of a paper describing the packaging techniques of the subminiature matrix are available, too. Your copy will be sent promptly on request.

Hughes

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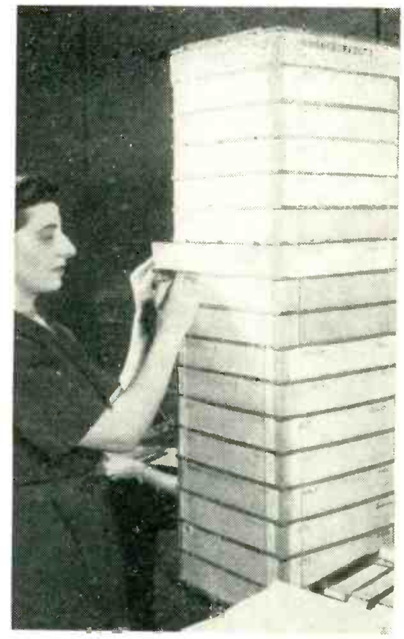


Master lamp-controlling chart on which are drawn the master curves for last 1,000 tubes produced. Each tube type has three cards in a horizontal row, for separate entry of noise, electrical and mechanical defects

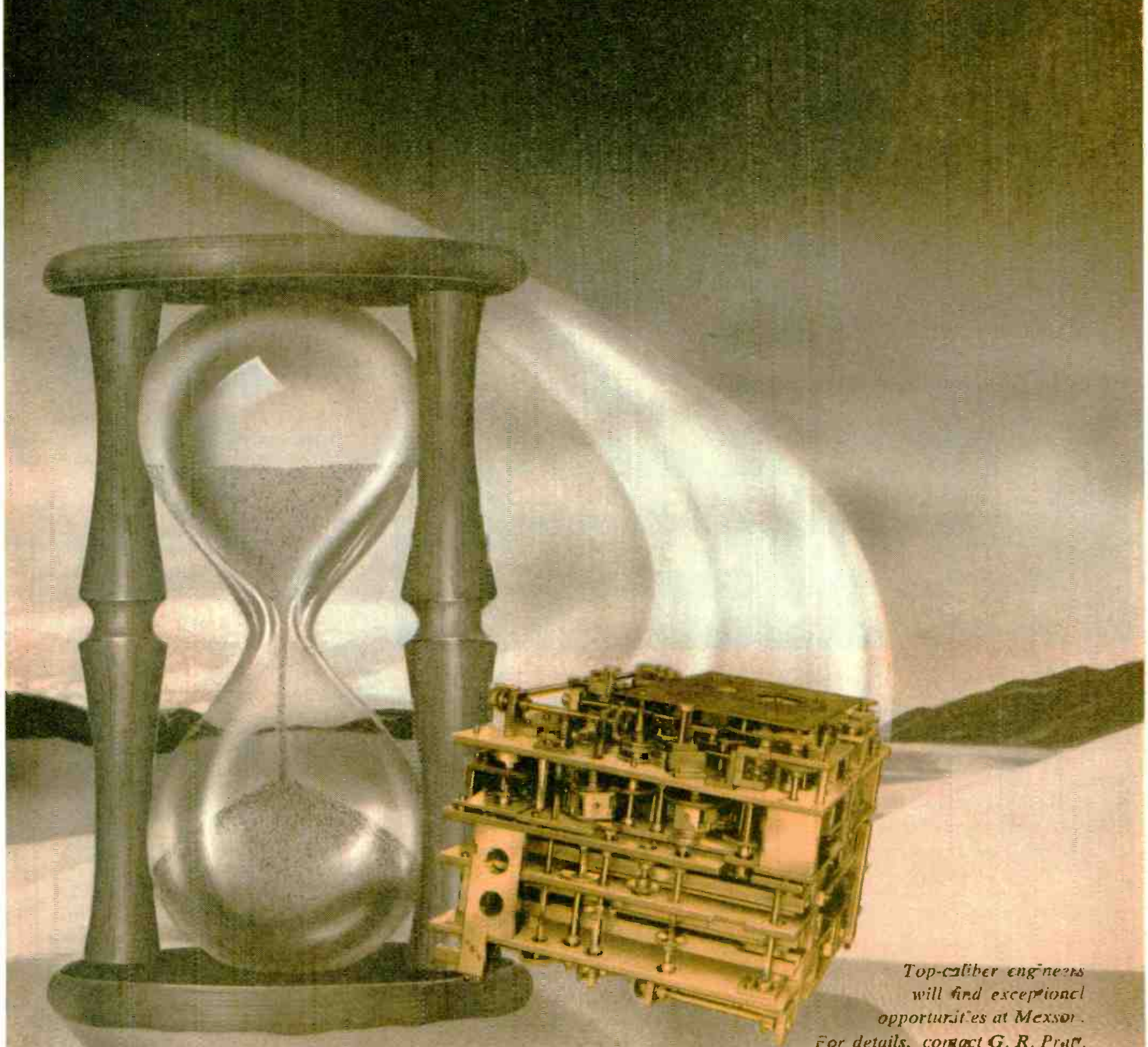
data cards are placed. Transparent plastic sheets hold the cards in position. To record a value, the operator pulls out a card just far enough to give room for marking the point and extending the curve, then slides the card back in. Each point on this curve represents the quality of the last 1,000 tubes produced.

If the curve on a particular card is 0.2 percent or better, the green light for that particular tube type is turned on by means of a three-position selector switch on the control panel in the quality control department. If defects run over 1 percent, the red light is turned on. In-between values get the orange caution light. Two-position toggle switches on the sides of the master control panel actuate other signal lamps that tell the factory whether the rejects are electrical or mechanical in nature.

Turret Socket Fixture

WIRING of turret sockets is expedited in the plant of The Edo Corp., College Point, N. Y. through use of a fixture that supports the turret while permitting rotation. An empty turret is plugged into a standard seven-pin socket that is bolted to the rotatable head. The

CONQUERING the Time Barrier



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Method of using fixture for supporting turret socket during assembly. Finished chassis is shown in nest on other part of fixture

other end of the turret is supported by a hinged arm which is under spring tension. This arm is easily bent back out of the way for insertion or removal of a turret.

On the same wood base is an additional fixture that serves as a nest for supporting the subassembly chassis on which the turret is later mounted. The chassis is used in the Fishscope transmitter designed for use on commercial fishing boats to locate schools of fish deep under water.

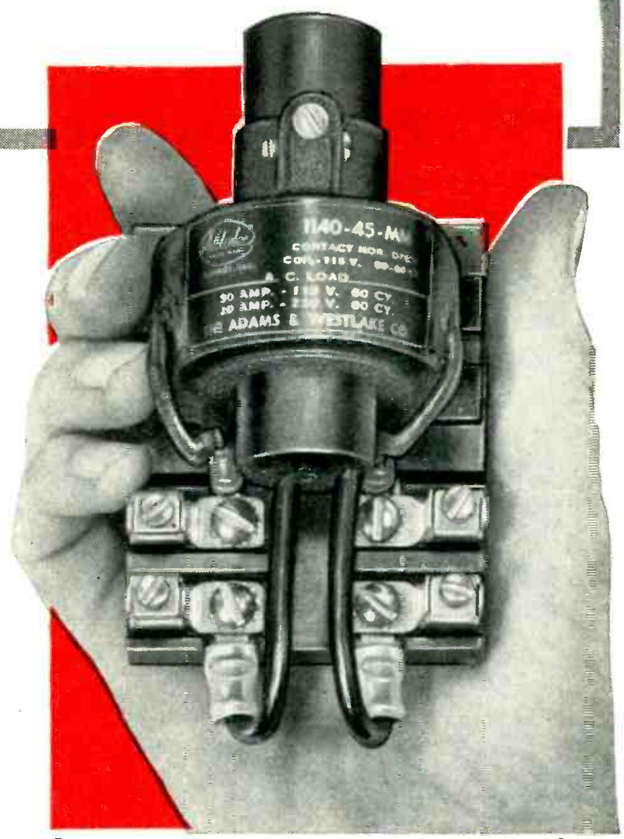
Pneumatic Lift Serves as Assembly Worktable

By Bert Goldrath
San Mateo, Calif.

Wiring and assembly of electronic instrument panels is simplified at the Lenkurt Electric Co. plant in San Carlos, Calif. by use of a pneumatic lift which holds work at different heights for maximum convenience during progressive stages of the operation. The work platform can be rotated through 90 degrees for maximum accessibility. Two quick-acting clamps (manufactured by the Desta Co.) on each upright member of the jig hold the unit in place against positioning pins. Two more quick-acting clamps hold the platform which,

Look

at the extra features that assure dependability in ADLAKE Mercury Relays!



● **Dependability** is the sum of many things . . . and ADLAKE's dependability is built on engineering skill, exhaustive testing, and quality construction features like these:

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

Arc-resisting ceramics—ceramics with great temperature-resistance are used to reduce any destructive effect caused by the arc.

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

And, of course, ADLAKE Mercury Relays are hermetically sealed, require absolutely no maintenance, and are silent and chatterless. Write for your free copy of the ADLAKE Relay catalog today . . . The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana. In Canada, address Powerlite Devices, Ltd., Toronto.

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Contact normally open or closed.

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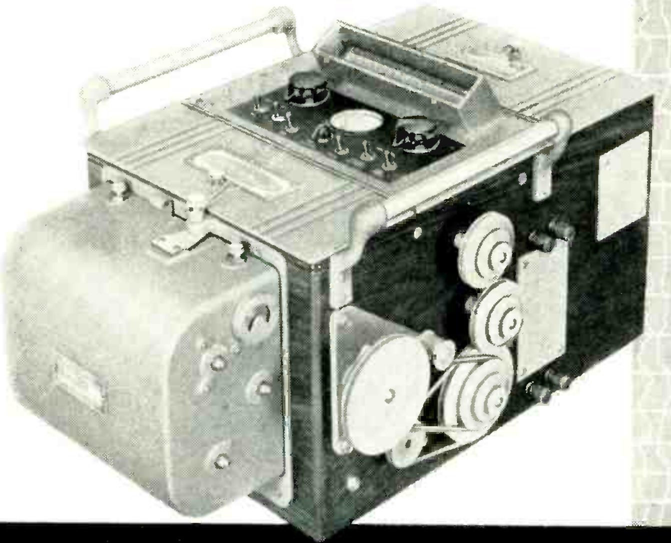
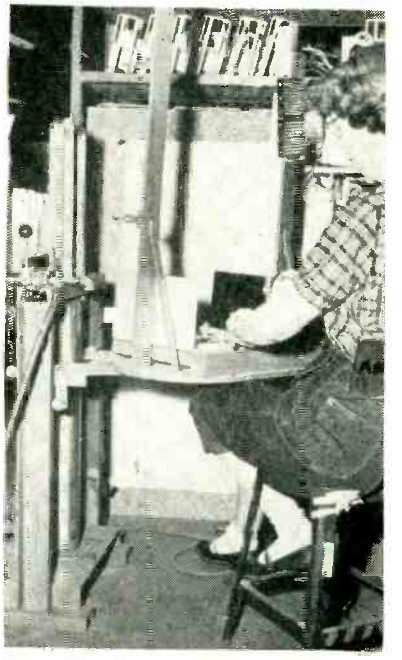
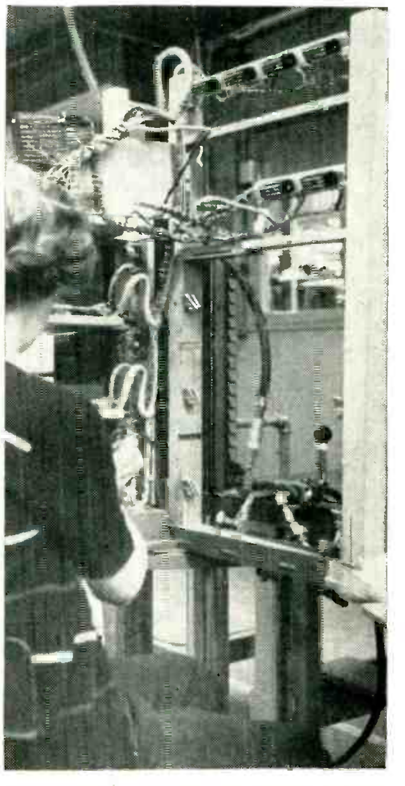




Using lift at knee level for initial stages of assembling parts on a panel



Completing assembly at bench height, using cleats and brackets on uprights to hold wiring harness and attached parts

when released, rolls out onto a dolly with pieces too heavy to handle.

Operated off the plant air line through a four-way valve, the elevator is equipped with ratchet safety stops so that the operator's legs won't be endangered in event of air pressure failure. Valve and

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for longer service life in switches,

relays and other electronic equipment

Bridgeport Phosphor Bronze (Alloys 35 and 36) has excellent resiliency, high flexural strength, good conductivity with superior corrosion resistance and ability to resist wear.

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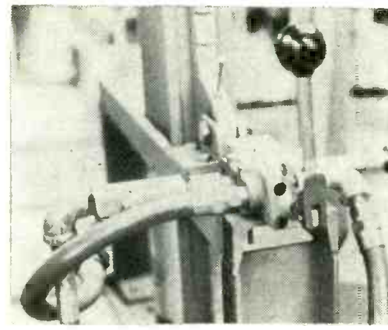


Two-way air valve with gearshift-type operating lever used for raising or lowering lift

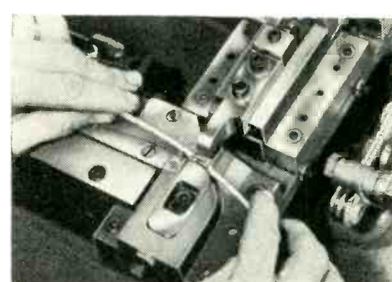
air cylinder are products of Ortho Pneumatic, Oakland, Calif.

The lift is made of three-inch channel iron, welded to a channel-iron frame and bolted to the floor. It is one of two developed by the firm's industrial engineering department and is not patented. A single control handle, within easy reach of the operator, raises or lowers the platform. The ratchet safety stop must be manually released before lowering is possible.

Versatility of the adjustable work-table has greatly reduced production costs on the small runs that are characteristic of this firm's products. In extreme cases, a variety of orders can be put through production on an individual basis without undue cost penalty for changing setups.

Conductor-Banding Machine

CONNECTIONS between conductors are made automatically with a new banding machine developed by the Crimpweld Corp., Warwick, R. I., using Autoband connectors that are produced in strip form and supplied on reels. The machine produces tight, permanent joints in No. 14 to No. 20 wires, as fast as



Method of using banding machine for splicing two wires together. Resulting joint is mechanically satisfactory for electronic circuitry

EXPANDED POLYETHYLENE ON "VIDEO PAIR"

BRINGS BETTER TV AT LOWER COST

New "video pair" manufactured by Western Electric for the Bell System uses cellular polyethylene on copper conductors, twisted together with two strands of fiber glass, also insulated with cellular polyethylene. A wrapping of polyethylene tape, two layers of copper tape, two wrappings of crepe paper and spiral wrappings of colored cord complete the assembly. The whole unit measures only ⅜ in. in diameter.

"Video pair" has a big job to do! The two slender copper wires carry impulses from camera to studio on remote pick-ups, and from studio to telephone central office for transmission via coaxial cable or radio relay.

Extruded insulation of cellular polyethylene now replaces the spiral plastic spacer and tape used on earlier models. The results—lower cost, superior transmission, and improved reception – all important to forthcoming color telecasts.

Cellular polyethylene consists of unconnected hollow cells. Its moisture resistance approaches that of solid polyethylene. It can be formed to about half the specific gravity of solid polyethylene, and provides reduced dielectric constant, lower line losses and lower costs for material.

Bakelite Company is a major producer of polyethylene. Learn more about the possibilities of BAKELITE Polyethylene for your insulating jobs. For technical information, write Dept. ZE-79.

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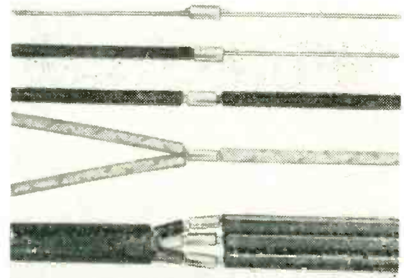


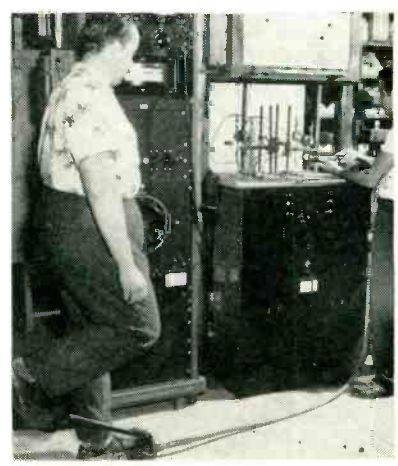
Examples of banded joints

they can be positioned in the full-vision rolling tool by the operator. The band gathers every strand of both wires and joins them in a union that meets an exceptionally strong pull test and easily withstands molding pressures.

Stranded wire may be banded to solid wires, or two separate wires may be banded to a single one. The bands can be numbered beforehand for identifying leads, if necessary.

Air-Operated Vise Seals Off Magnetrons

AFTER EVACUATION of magnetrons in a combination oven and exhaust station in the Hicksville, Long Island plant of Amperex Electronic



Method of using air-operated vise to seal off the metal tubulation of a magnetron after pumping. Assistant is operating control valve on floor at left

Corp., an air-actuated crimping tool resembling a vise is used to compress the metal tubulation to a feather edge with sufficient pressure to achieve a vacuum seal and cutoff simultaneously.

The operator uses both hands to hold the tool, since it is quite heavy

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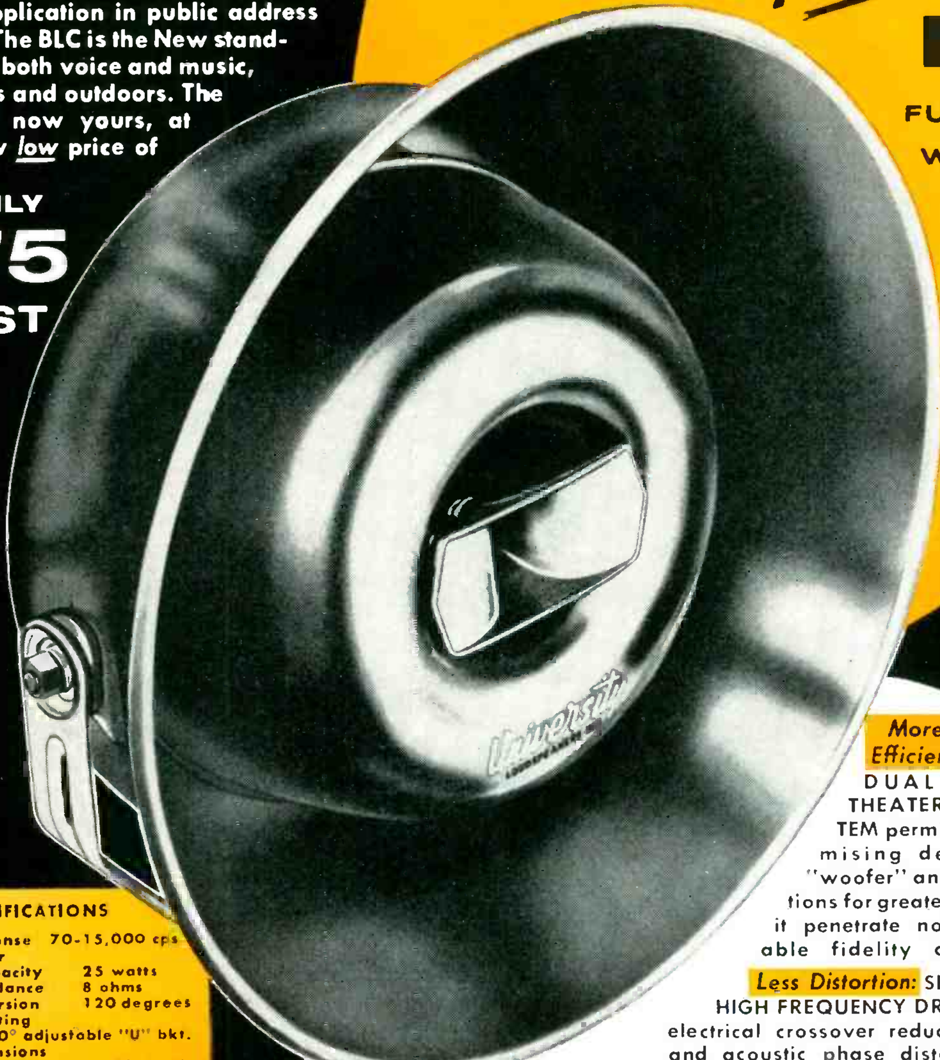
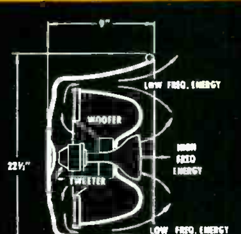


University

SPECIFICATIONS

Response	70-15,000 cps
Power Capacity	25 watts
Impedance	8 ohms
Dispersion	120 degrees
Mounting	180° adjustable "U" bkt.
Dimensions	22½" diameter, 9" depth



Ask your distributor for a convincing demonstration, and HEAR THE DIFFERENCE!

More Efficient: DUAL RANGE THEATER TYPE SYSTEM permits uncompromising design of the "woofer" and "tweeter" sections for greatest efficiency. Hear it penetrate noise with remarkable fidelity and intelligibility.

Less Distortion: SEPARATE LOW AND HIGH FREQUENCY DRIVER SYSTEMS with electrical crossover reduces intermodulation and acoustic phase distortions common to other systems which attempt to use two different horns on a single diaphragm.

Better Lows: BALANCED "COMPRESSION" TYPE FOLDED HORN, starting with eight inch throat and energized by top quality low frequency "woofer" driver provides more lows than other bulky designs.

Better Highs: DRIVER UNIT TWEETER with exclusive patented "reciprocating flares" wide angle horn transmits more highs with greater uniformity . . . high frequency response that you can *hear!*

More Compact: EXCLUSIVE WEATHERPROOF DUAL RANGE COAXIAL DESIGN eliminates wasted space. Depth of BLC is only 9"; can be mounted anywhere, even flush with wall or ceiling.

More Dependable: EXPERIENCED MECHANICAL ENGINEERING AND CAREFUL ELECTRICAL DESIGN meet the challenge of diversified application and environmental hazards. Rugged, and conservatively rated—you can *rely* on the BLC.

Write desk No. 18 for full descriptive literature

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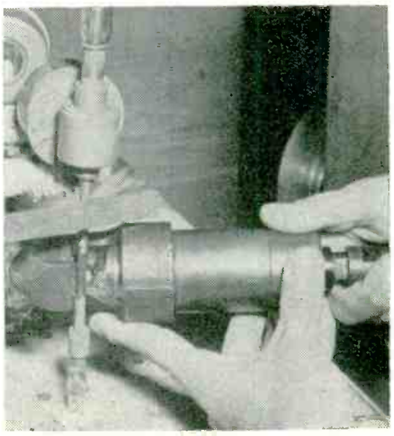


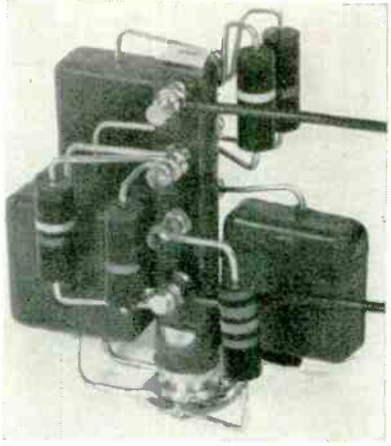
Closeup of air-operated vise

and must be held in a horizontal position. A foot-operated valve, generally operated by an assistant, controls the movement of the vise jaws.

Totem-Pole Jigs Cut Wiring Costs

By DEAN E. WISELEDER
Sangamo Electric Co.
Springfield, Ill.

THROUGH use of a new vertical terminal strip known as a totem pole, over 90 percent of the connections and leads for an amplifier were produced faster and more efficiently in the subassembly stage by semiskilled wiremen working from models and simplified diagrams, than could have been done by skilled wiremen using conventional wiring techniques. The use



Single four-terminal totem pole here provides mounting for complete parallel-T network. This subassembly is electrically tested before final assembly. Identifying numeral is on adhesive-tape tab on top of post

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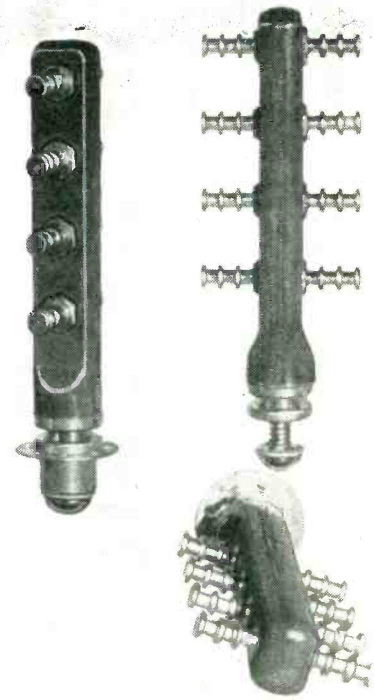
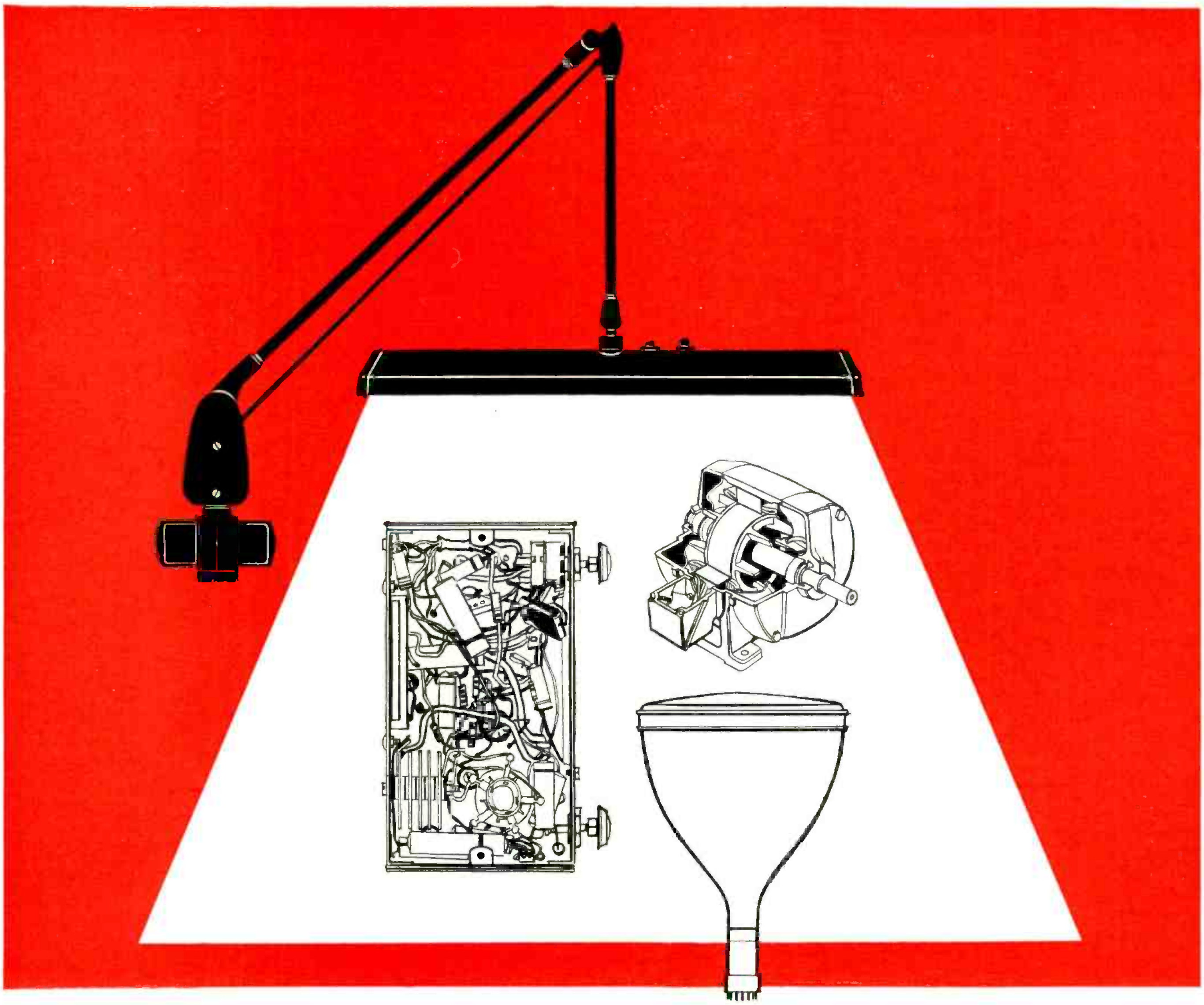


Totem poles may be assembled with or without ground terminal and spacer pillar. Terminals are of solid bronze, hot-solder-coated and staked into the melamine post

of semiskilled wiremen opens up a lower-cost and more widely available labor supply, cutting production costs and reducing assembly time for a job.

The new terminal provides adequate mounting support for small components such as resistors, capacitors, diodes and transistors at their operating point. Critical leads to components such as grid suppressor resistors can be reduced to pigtails. Space is saved through more effective under-chassis arrangement, thereby often reducing chassis size. Fewer leads, cables and soldered joints are needed. Approximately 5 ft of wire was saved per totem pole in one revised chassis. Cooling of under-chassis components is improved. Socket terminals and all other terminals are exposed for easier test, inspection and accessibility with tools.

In general, each subassembly includes one or more totem poles and includes the associated tube sockets as well, thereby assuring short leads and proper configuration of critical coupling or suppressor components. This also provides maxi-



from *Hydrazine...*
new light on old soldering problems

For greater efficiency and economy in the production of electrical and electronic components, a remarkable new series of soldering fluxes has been developed by McCord Corporation.

Based on compounds of hydrazine, these fluxes—called CORONIL—are non-corrosive and can be used without hazard. They remove oxides and other films from most commercially used metals such as copper and brass—as well as others—to permit more effective work and fewer rejects. In addition to their use by electrical and electronic equipment manufacturers, these hydrazine-based CORONIL fluxes are being successfully applied in the production of automotive radiators and other heat exchangers, carburetor floats, oil strainers, and various other products where safe, non-corrosive soldering is essential.

* * *

A new data sheet containing the latest information on hydrazine-based soldering fluxes is now available; it refers specifically to the removal of oxides and other films from copper and brass. **Write for your copy today.**

MATHIESON

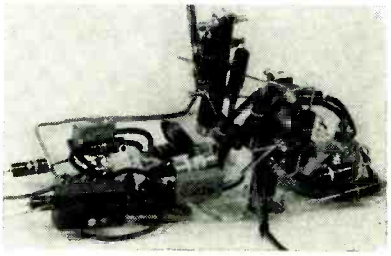
OLIN MATHIESON CHEMICAL CORPORATION
Baltimore 3, Maryland

2580

mum wiring economy because a high percentage of the connections made in the chassis are controlled by the tube sockets and totem poles and are therefore included in the subassembly.

Although the location of a totem pole on a chassis is rather well fixed, practically no planning is necessary except in the breadboard stage. Here the design engineer, using four-terminal units only, locates a sufficient number of them under the breadboard chassis to be sure that they will do three things:

(1) Support one or both terminals of coupling and suppressor components as near their socket terminals as possible. This usually means a totem pole between sockets of succeeding tubes, favoring the grid-plate terminals of the sockets.



Two totem poles and two tube sockets are required in this amplifier subassembly

(2) Support all components which can not be adequately supported by point-to-point wiring. This means complete elimination of conventional component boards and the cabling to them.

(3) Expedite breadboard modifications and testing by providing insulated terminals for test equipment, power supplies and extra components.

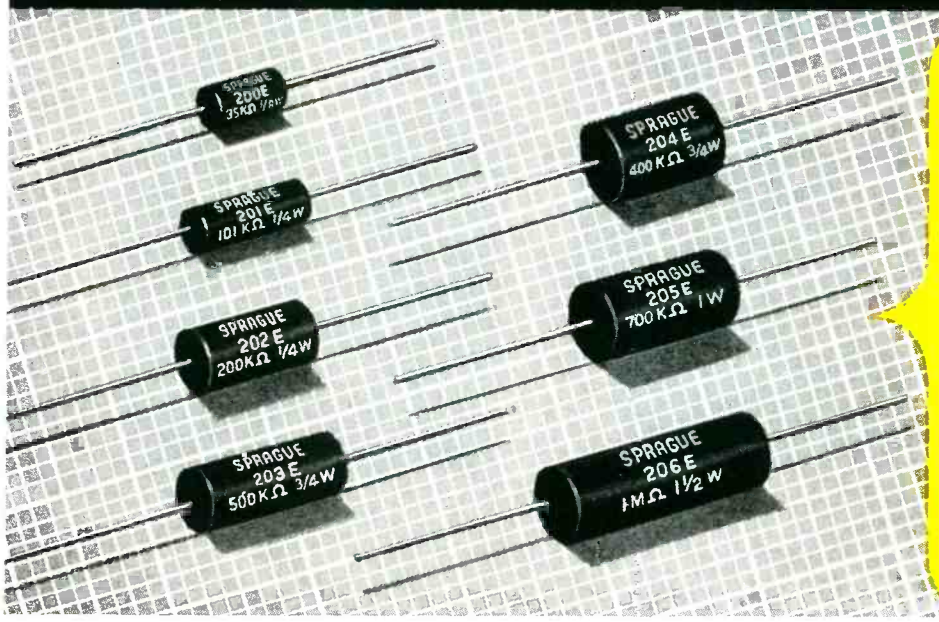
After a breadboard has received final approval for performance, the totem poles are examined to see which can be removed, combined or reduced to the three-terminal type. These changes are included in the preproduction model.

Skilled wiremen make the first units of each subassembly. These serve as models for production units which follow. A semi-skilled production wireman, ready to make a quantity of a subassembly, receives a model and an assembly diagram. The diagram includes a plan view of the component layout

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	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	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

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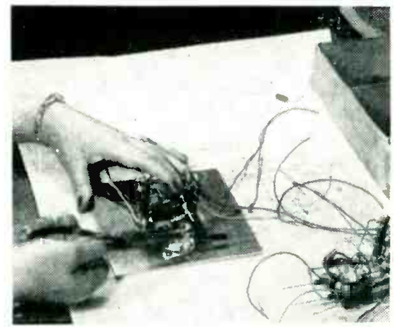


Jig facilitates production of two-post subassembly, using sample and diagram as guides. Note accessibility of terminals for inspection and wiring

With jigs removed, subassemblies are stored in cardboard box until needed in final chassis

plus a semi-pictorial wiring diagram. Code colors are added by the draftsmen in crayon for further simplification. With these tools the wireman can proceed with efficiency whether he prefers to work from the model, the diagram, or both.

When subassemblies are completed, they are removed from their jigs and stored in layers in a cardboard box until needed for final assembly. No trouble has been experienced in storing with the jigs removed. Extensive handling is unnecessary in this case because the storing and final assembly take place in the same building. Plywood and aluminum jigs have been equally satisfactory. Simplified wiring diagrams are used to complete the wiring on the chassis.

Totem pole jig wiring will show cost savings when production quantities exceed fifty units or

marion

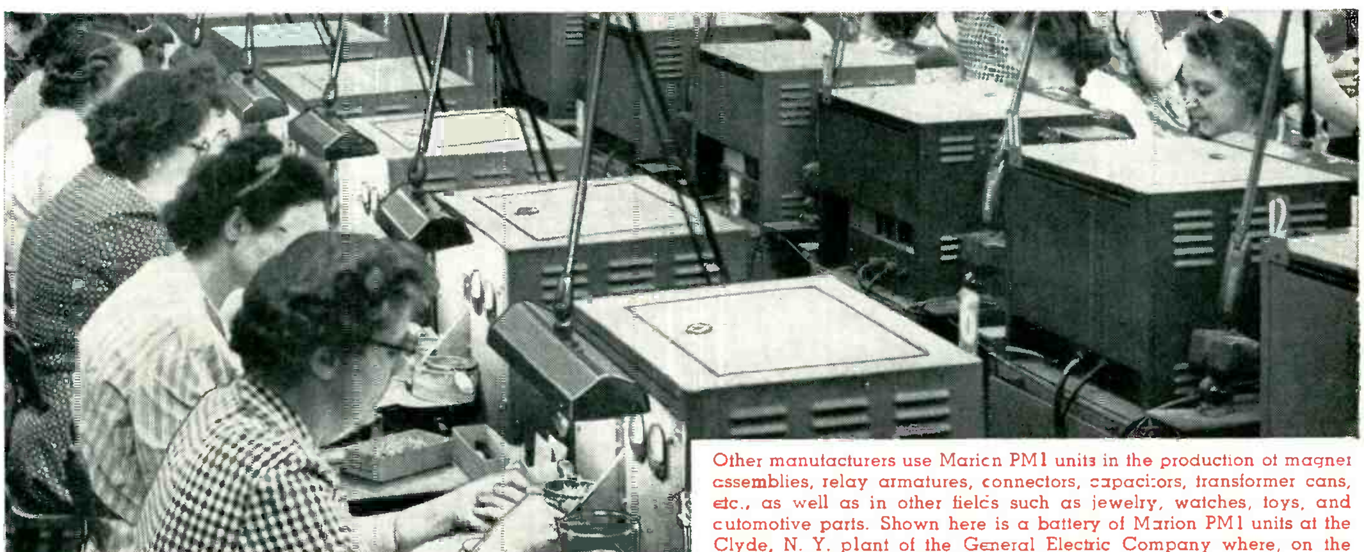
advancement in instrument design

MARION MODEL PM1 INDUCTION SOLDERING UNIT

Low cost, low powered and portable. . . . Size 15¾" x 21½" x 15". 150 lbs. Power supply: 115 volts 60 cycles. Draws 775 watts full load, 100 watts standby.

IMPROVED SOLDERING OF SMALL PARTS AND ASSEMBLIES

Typical of the Marion developments that have helped make Marion stand for "advancement in instrument design" is the Marion Model PM1 Induction Soldering Unit. Originally designed and presently used by Marion for true glass-to-metal hermetic sealing of Marion meters, it also has proven to be a valuable production tool for many purposes. Illustrated above, for example, is Marion's use of the PM1 in the soldering of magnet assemblies where quality and uniformity result.



Other manufacturers use Marion PM1 units in the production of magnet assemblies, relay armatures, connectors, capacitors, transformer cans, etc., as well as in other fields such as jewelry, watches, toys, and automotive parts. Shown here is a battery of Marion PM1 units at the Clyde, N. Y. plant of the General Electric Company where, on the whisker diode line, a small pellet of germanium metal is soldered to the end of a nickel pin.

The Marion Model PM1 speeds up production, reduces costs and improves quality. Heat is generated within the work itself — even in parts otherwise inaccessible. Oxidation, scaling and damage to surface finish are minimized. Soldering of an entire seam or several jig-located parts at one time is readily accomplished.

This is an example of how Marion's belief in "Advancement in Instrument Design" has produced a production tool which not only improves Marion instruments but also provides other manufacturers with better soldering equipment. **Marion Electrical Instrument Company, 401 Canal Street, Manchester, N. H.**

marion meters

Reg. U. S. Pat. Off.

MANUFACTURERS OF RUGGEDIZED AND "REGULAR" METERS AND RELATED PRODUCTS

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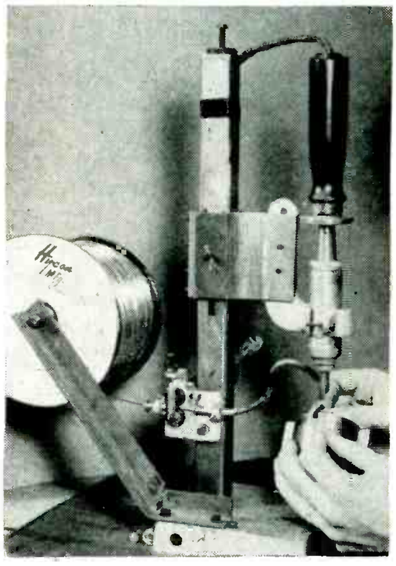
when repeat orders for smaller quantities are likely over a period of time. Most electronic equipment for government and industry falls within this range.

Soldering Stand With Automatic Solder Feed

SOLDERING operations on small parts for the 2.75-inch Mighty Mouse aerial rocket are performed with a soldering tool that leaves both hands of the operator free for handling the components. The



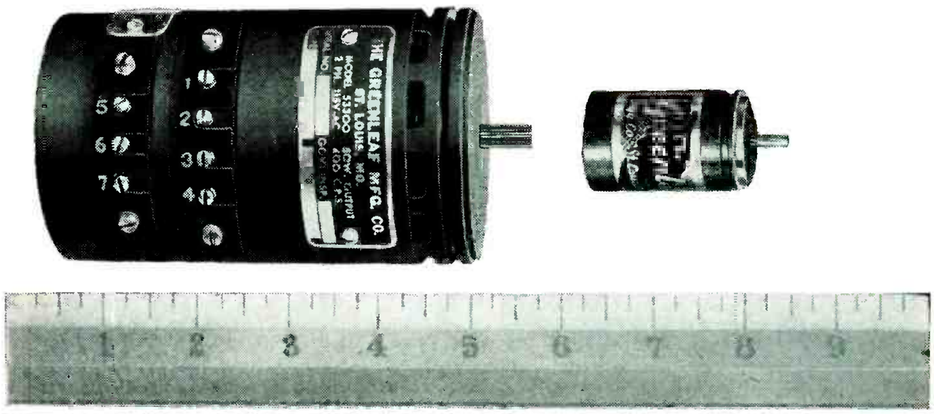
Overhead mounting of soldering iron. Action of foot pedal lowers iron and pulls down lever arm that rotates gears between which solder runs, so that wheels push solder through bent copper tubing to the work

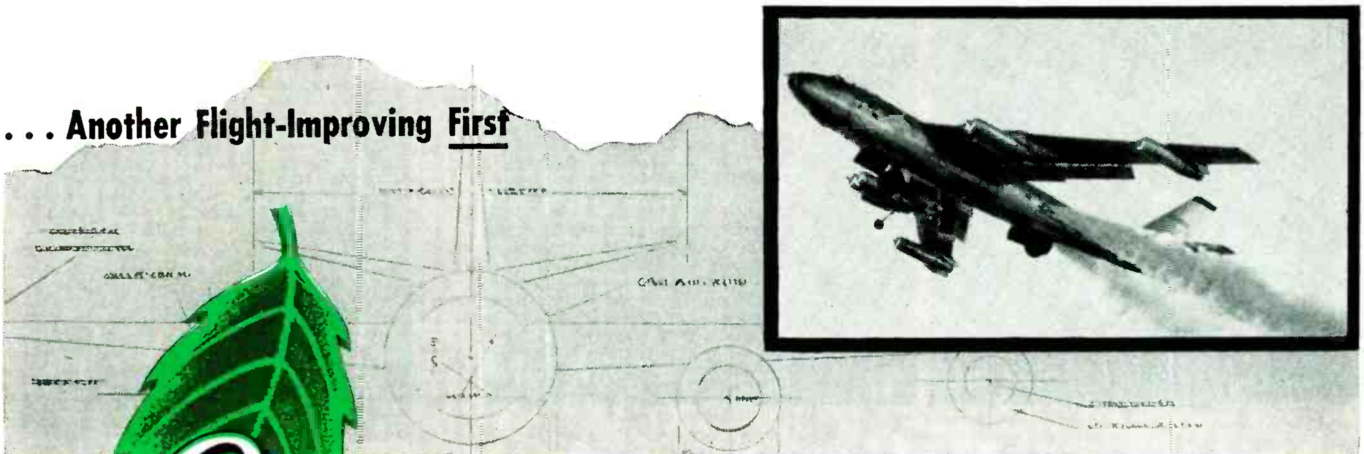
soldering iron is rigidly mounted under the bench in one installation, with the heated tip projecting up through an asbestos disk set in a hole in the bench. A foot pedal advances the solder and simultaneously brings the iron up to the correct position for the soldering operation. A curved copper tube can be easily bent to make the solder feed precisely to the desired point.

Another soldering setup that is also used in this Pasadena, California plant of Hycon Manufacturing Co. has the iron mounted above the bench, point downward. The parts to be soldered are held together on a small fixed anvil and the foot pedal is actuated to bring

We've Whipped TD*!

TD **Proofed Servo Motors**





. . . Another Flight-Improving First

by *Greenleaf*.. **WHERE QUALITY CONTROL WORKS ON THE PRODUCTION LINE**

* **TD MEANS** *TORQUE DECAY. TD in a single servo loop can keep an airplane grounded for hours, even days. TD is like Cancer in the human body. It is the gradual merciless wasting away of torque due to internal changes of components in a servo motor. It shortens life, destroys accuracy, ends efficiency.*

New Life for Servo Motors

Now Greenleaf offers you servo motors that are TD-proofed. Actually, Greenleaf methods and ingenuity have reduced TD by as much as 1500%. This is true for *all* Greenleaf electro-magnetic rotating devices.

This is another example that shows why Greenleaf is regularly selected as a prime or sub-contractor by the following: U.S. Air Force, U.S. Navy, McDonnell Aircraft, Boeing, Emerson Electric Company, Eastman Kodak, Avco Mfg. Corporation and other leading organizations.

See Greenleaf for Servo Motors and for Gyros, Pressure Transmitters, Accelerometers, Synchros, Air Speed Indicators, Actuators and other precision units and components.

Engineering
Development
Production

THE *Greenleaf*.. **MANUFACTURING COMPANY**

7814 Maplewood Industrial Court • St. Louis 17, Missouri

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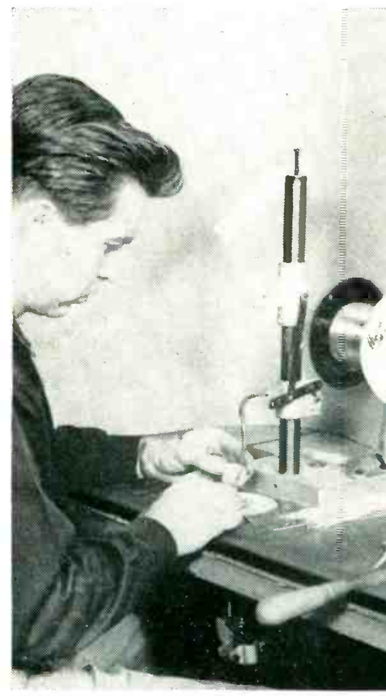
the iron down on the work and simultaneously feed solder to the work.

In both cases, the soldering stand is a commercial unit built by Electric Soldering Iron Co., Deep River, Conn., modified to meet the requirements for the job.



Soldering setup in which iron mounted vertically under bench moves up to work when foot pedal is pressed. For some operations, the iron can be rigid in this mounting with foot pedal serving only to feed solder

The setup permits mass production of rocket parts that meet the most exacting tolerances and critical inspections. Results are uniform because the operator's duties have become routine and the soldering iron angle is constant.

Automatic Metallizer for Picture Tubes

VIRTUALLY automatic production of the vacuum-metallized coating on the inner surface of television picture tubes can be achieved with a new self-contained metallizing unit developed by the F. J. Stokes Machine Co. The compact, completely self-sufficient package with integral vacuum-pumping system is mounted on four wheels for incorporation in

Exciting New Development

in Printed Circuits!

Photo courtesy
Methode Manufacturing Corp.
Chicago, Ill.

New CuClad* copper-clad laminate offers unequalled bond strength, heat resistance, solderability, punchability, electrical performance!

Here's the foil-clad laminate you've been waiting for! It's CuClad Lamicoid® —made possible by an entirely new concept in bonding material, specially designed equipment developed exclusively by Mica Insulator Company. This new bond and unique bonding method give you unequalled performance that's consistent and dependable from sheet to sheet, lot to lot.

*Trade-mark

You get all these advantages:

- **A STRONGER BOND WHICH *IMPROVES* WITH AGE AND HEAT**
- **BETTER HEAT RESISTANCE**
- **BETTER REACTION TO HOT SOLDER**
- **BOND ELECTRICALLY EQUAL TO LAMINATE**
- **IMPROVED ARC RESISTANCE**
- **SUPERIOR PUNCHABILITY**
- **UNIFORMITY**

and CuClad Lamicoid is competitively priced!

CuClad Lamicoid is available *NOW*, in several grades. Tell us your requirements or problems—or ask to have a Mico Sales Engineer call.

LOOK AT THESE TYPICAL PRODUCTION RUN VALUES ON 6028 XXXP CuCLAD LAMICOID:

BOND STRENGTH—Guaranteed min: 6 lb.; avg. 9 lbs. (90° peel at 2 lbs/min.)

SOLDER TEST—Guaranteed no blisters @ 230-240° C. for 10 seconds, 1" square floated on molten solder

HEAT RESISTANCE—Guaranteed no change at 150° C. for ½ hour in air-circulated oven, air flow parallel to specimen

PUNCHABILITY—Excellent

SURFACE RESISTIVITY, megohms
C-96/35/90 .... 7.3×10^{6}

VOLUME RESISTIVITY, megohm cm.
C-96/35/90 .... 3.7×10^{7}

WATER ABSORPTION
1/16" th., E-1/105 + D-24/23
copper on 0.1%
1/16" th., E-1/105 + D-24/23
copper removed 0.7%

MICO ELECTRICAL INSULATION®

MICA Insulator COMPANY

Schenectady 1, New York

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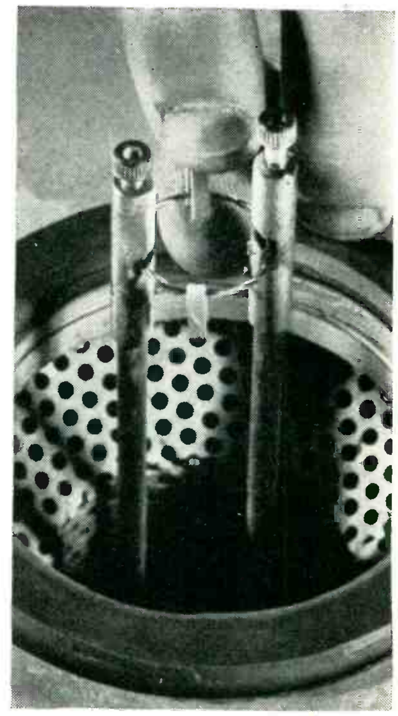
merry-go-round or in-line production setups, and can also be operated as a stationary unit to minimize vibration during the metallizing cycle.

Chief design feature of the new metallizer is completely automatic control over all stages of the metallizing cycle. Closing and opening



Loading bent aluminum strips on tungsten filament

of the valves, starting and stopping of the two vacuum pumps, and switching on and off of the vaporizing current are controlled by a standard sequence-type electrical timer, settings of which are adjustable to 10-second intervals over a 10-minute cycle.

Once the settings have been determined on the basis of preliminary tests, they need not be changed. One operator can easily supervise the operation of as many as 10 units in addition to loading and unloading tubes.

The production pattern reduces to this simple sequence:

1. The uncoated tube is lowered, neck down, into the vacuum-metallizing unit by an automatic lowering device. The operator then pushes one button to start the timer.

2. The rough pumping stage of

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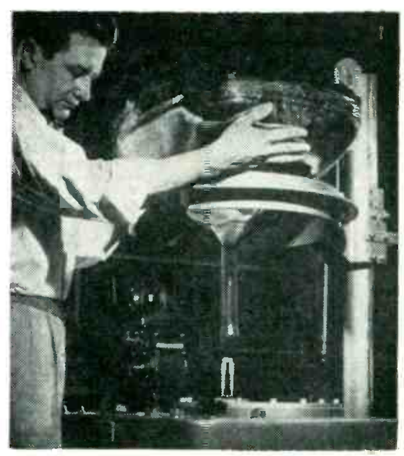
the cycle automatically begins. A vacuum valve opens between the evacuation chamber of the unit (into which the tube neck has been inserted) and the 10-cfm rotary mechanical vacuum pump which is running continuously. The pressure in the tube is reduced to about 200 microns in approximately 2½ minutes.

3. At this pre-set time, the 4-inch water-cooled oil-diffusion vacuum pump is cut in automatically and reduces the pressure within the tube to the desired pressure for vaporizing the aluminum to be deposited. This pressure is easily reached within 4 or 5 minutes.

4. At the appropriate pre-set time, the timer trips a switch which sends a 25-ampere pulse through a stranded tungsten filament. This filament spans the gap between two electrodes which extend up through



Placing picture tube in counterweighted yoke of automatic lowering device that lowers tube accurately into position, neck first

Pushing start button initiates complete sequence of metallizing

Good-ALL

MIFILM CAPACITORS WITH MYLAR* DIELECTRIC

Built to Your Specified Sizes

SUBMINIATURE SIZES OVER THE COMPLETE CAPACITY AND VOLTAGE RANGE. Typical is the .173″ dia. x ½″ long (.001 mfd, 600 VDC). We can put these subminiature capacitors into any case style or type of mounting and still provide the same extremely small space factor—approximately ½ of paper capacitors.

HERMETICALLY SEALED—METAL ENCLOSED. These MIFILM Capacitors are uneffected by extreme climatic changes.

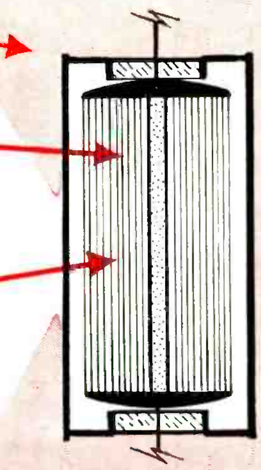
MYLAR* DIELECTRIC—retains extreme high insulation resistance over complete temperature range of −65° C to 150° C. Special sizes can be made to withstand even higher temperatures.

**DuPont trademark for polyester film.*

MIRACLE X IMPREGNATED—completely impregnated in this *high temperature impregnant* to prevent troublesome voids.

SPECIAL TOLERANCES as low as ±1%.

These same **MYLAR DIELECTRIC CAPACITORS** are also available in commercial type construction—Types 620 and 621. Specify type when ordering.



Types 612 and 613

EXTENDED FOIL CONSTRUCTION

612 One End Grounded
613 Both Ends Insulated

Write for complete catalog covering all types of Good-All long-life capacitors. We invite sample orders for your evaluation. Our engineers are always ready to work with you on any capacitor problem.

Types 614 and 615

TAB CONSTRUCTION

614 One End Grounded
615 Both Ends Insulated

Good-ALL CAPACITORS

So Superior... **They are being used extensively by leading Electronic, TV, and Radio Manufacturers throughout America.**

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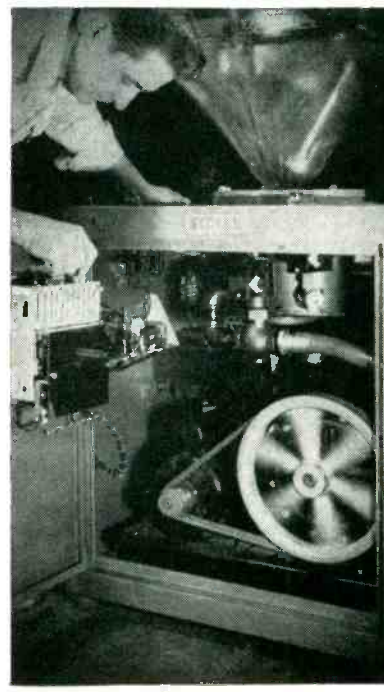
the neck of the tube. The filament carries several short bent strips of aluminum ribbon which supply the metal source for the coating to be deposited. Heated by this current, the filament melts the ribbon. At the low pressure now in the chamber, the molten aluminum vaporizes and takes flight in molecular form, depositing as a thin coating over all of the inner surface of the tube. Location of the metal source within the tube has been



Interior of metallizer. Operator is changing timer setting that controls duration of flashing current

carefully determined to provide uniform coverage by the metal film. The duration of the flash is controlled by a separate micrometer adjustment on the timer, calibrated in seconds, and lasts as long as desired to give the required thickness of coating. The power supply for the filament is a standard stepdown transformer and rheostat, which converts the normal 115-volt a-c supply to a low voltage, adjustable from 0 to 17 volts.

5. After flashing the filaments, the electrical timer closes all the vacuum valves and breaks the vacuum in the chamber and tube, which thus releases the tube. The automatic lowering device then


This BALANCED INSULATION
Gives you WINDINGS for MOTORS
—at Lowest Overall Cost
BELDEN MFG. CO.
FORMVAR
CHICAGO, U.S.A.
LOW IN EXTRACTABLES —best for use with FREON 12
RESISTS ABRASION —takes pounding pressure winding abuse
BEST IN SERVICE —resists softening under heat
WINDABILITY —smaller coils
FORMVAR MAGNET WIRE
by Belden
WIREMAKER FOR INDUSTRY

lifts the tube completely clear of the filament and thus indicates to the operator that the tube is ready for replacement. Another uncoated tube is then lowered into place, and the cycle repeats. Average length of one cycle is about 8 minutes—or better than 7 tubes per hour.

The mouth of the vacuum chamber is flared to facilitate admission of the neck of the tube as it is positioned by the tube-lowering device. A pressure-tight seal is made by a flexible rubber ring gasket around the rim of the chamber on which the tube seats.

A perforated scrap-collector cup within the vacuum chamber encloses the neck of the tube and traps any pieces of broken filament, aluminum ribbon or fragments of glass that might otherwise be carried over into the vacuum pumps and possibly cause damage to them. The vacuum chamber, about 9¾ in. deep and 12 in. in diameter, houses the poppet-type solenoid-operated vacuum valve of the diffusion pump.

Air Control Improves Quality of Relays

AIR CIRCULATION, temperature, humidity and cleanliness are automatically controlled at exact points essential to precision manufacturing of relays in the new Chicago plant of C. P. Clare & Co. The entire plant design is aimed at eliminating the hazards of dust and dirt as the major cause of electrical relay failures both in production and in the field.

Washable ceramic tile walls,

Production floor of new relay plant, showing method of installing fluorescent lighting on low ceiling to get shadowproof illumination

TV set costs go down–quality stays high with Tung-Sol "series string" TV tubes

2AF4 (Prototype—6AF4) Heater Current 0.6 A Heater Volts 2.35	**3BE6** (Prototype—6BE6) Heater Current 0.6 A Heater Volts 3.15	**5AQ5** (Prototype—6AQ5) Heater Current 0.6 A Heater Volts 4.7	**6AU7** (Prototype—12AU7) Heater Current 0.6 A Heater Volts 3.15*	**12B4A** (Prototype—12B4) Heater Current 0.6 A Heater Volts 6.3*	**12L6GT** (Prototype—25L6GT) Heater Current 0.6 A Heater Volts 12.6
3AL5 (Prototype—6AL5) Heater Current 0.6 A Heater Volts 3.15	**3CB6** (Prototype—6CB6) Heater Current 0.6 A Heater Volts 3.15	**5BK7A** (Prototype—6BK7A) Heater Current 0.6 A Heater Volts 4.7	**6AX7** (Prototype—12AX7) Heater Current 0.6 A Heater Volts 3.15*	**12BH7** (Prototype—12BH7) Heater Current 0.6 A Heater Volts 6.3*	**12W6GT** (Prototype—6W6GT) Heater Current 0.6 A Heater Volts 12.6
3AU6 (Prototype—6AU6) Heater Current 0.6 A Heater Volts 3.15	**4BQ7A** (Prototype—6BQ7A) Heater Current 0.6 A Heater Volts 4.2	**5T8** (Prototype—6T8) Heater Current 0.6 A Heater Volts 4.7	**6S4A** (Prototype—6S4) Heater Current 0.6 A Heater Volts 6.3	**12BQ6GA** (Prototype—6BQ6GA) Heater Current 0.6 A Heater Volts 12.6	**19AU4** (Prototype—6AU4GT) Heater Current 0.6 A Heater Volts 18.9
3AV6 (Prototype—6AV6) Heater Current 0.6 A Heater Volts 3.15	**4BZ7** (Prototype—6BZ7) Heater Current 0.6 A Heater Volts 4.2	**5U8** (Prototype—6U8) Heater Current 0.6 A Heater Volts 4.7	**6SN7GTB** (Prototype—6SN7GTA) Heater Current 0.6 A Heater Volts 6.3	**12BQ6GT** (Prototype—6BQ6GT) Heater Current 0.6 A Heater Volts 12.6	**25CD6GA** (Prototype—25CD6G) Heater Current 0.6 A Heater Volts 25
3BC5 (Prototype—6BC5) Heater Current 0.6 A Heater Volts 3.15	**5AN8** (Prototype—6AN8) Heater Current 0.6 A Heater Volts 4.7	**5V6GT** (Prototype—6V6GT) Heater Current 0.6 A Heater Volts 4.7	**12AX4GTA** (Prototype—12AX4GT) Heater Current 0.6 A Heater Volts 12.6	**12BY7A** (Prototype—12BY7) Heater Current 0.6 A Heater Volts 6.3*	**Using heaters connected in parallel*

Thermal characteristics of all the heaters are controlled so that heater voltage surges during the warm-up cycle are minimized, provided that these tubes are used with other types similarly controlled.

Heater ratings are based on 600 milliamperes of current with heater voltage adjusted for same power as in the prototype. All other characteristics and ratings identical to those of the prototype.

Use of these tubes provides completely satisfactory receiver characteristics during warm-up.

(Other types are in development)

All the economies of series string design, with no sacrifice in reception quality, are available to TV set manufacturers who engineer their sets around this new line of Tung-Sol Receiving Tubes.

The competitive position you achieve through savings in transformer and circuitry costs will be strengthened by the long life and high performance of these Tung-Sol Tubes.

The statistical quality control methods by which Tung-Sol maintains outstanding uniformity in tube production, make these new types your best assurance of utmost economy in series string TV set manufacture. For more information, write to Commercial Engineering Department, Tung-Sol Electric Inc., Newark 4, New Jersey.

Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Philadelphia, Seattle.

TUNG-SOL 50 ACHIEVEMENT YEARS 1904 1954

Tung-Sol makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

TUNG-SOL Radio and TV Tubes, Dial Lamps acoustical steel ceilings and asphalt tile floors enclose the windowless production area to assure maximum cleanliness with minimum maintenance. All dirt, odors and heat created by manufacturing processes are drawn off at the source through under-floor air exhausts. Air is electrostatically cleaned with a bank of self-cleaning electronic precipitators and then heated or cooled, humidified or dehumidified before it is circulated through the plant. To increase the supply of fresh air

Sheet metal hood mounted on vertical pipe draws soldering fumes off through underfloor ducts to maintain cleanliness during relay manufacture

to working areas, about six times the usual number of directional grilles are mounted in the plant ceiling. This is comparatively low, being but 9¼ feet from the floor.

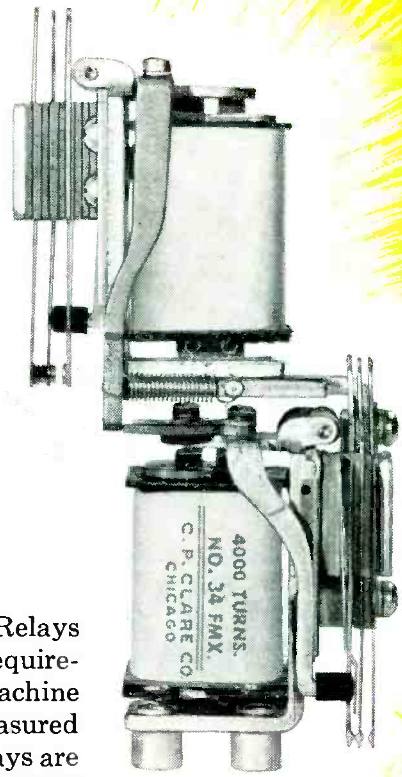
Since all supplies of power and air for benches and machines are carried through an elaborate system of ducts and outlets in the floor, there is nothing suspended from the ceiling to catch and hold dust.

The lighting system selected for hand assembly of the many small parts going into precision relays consists of slim-line fluorescent tubes in continuous rows on four-foot centers. This provides 75 foot-candles at workbench level.

Power Transformer Tester

A UNIVERSAL test panel in the incoming inspection department of Motorola's Chicago plant permits checking any of about 200 different types of power transformers for adherence to specifications. Eight

New CLARE Type LG Relay increases life expectancy of electromechanical latching relays to millions of operations



TYPICAL CIRCUIT FUNCTIONS

1. **Hold contacts operated any length of time without consuming power.**
2. **Operate contacts over one lead; release them over another.**
3. **Act as overload relay—electrically reset from remote point when tripped.**
4. **Act as interlocking relay pair on either a-c or d-c—or on combination of both.**

CLARE Type LG Electromechanical Latching Relays were designed to meet the punishing service requirements of an internationally known business machine manufacturer. Where other such relays measured their life cycles in thousands, Type LG a-c relays are still operating satisfactorily at well over 15,000,000 operations.

The assembly shown consists of two CLARE Type GAC a-c relays with interlocking armatures. They are aligned one above the other on a common mounting bracket to save chassis space. The assembly may also consist of two Type G d-c relays, or one a-c and one d-c relay.

Relay operation is as follows:

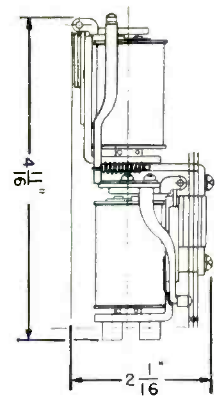
1. When either relay is energized while the other, deenergized, relay is latched up, it will unlatch the other relay, allowing it to restore, and will latch itself up.
2. When either relay is energized while the other is already energized, it will operate its own contacts without latching up, and without affecting the other relay. It will release as soon as its coil circuit is opened. The two relays, however, can be interlocked electrically so that both coils cannot be energized at once.
3. When either relay is deenergized while the other relay is energized, the other relay will become latched up.

For full information on this new relay or for consultation on any relay problem, we invite you to contact your nearest CLARE sales engineer or write to C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13, Ontario. Cable Address: CLARELAY.

Write for Bulletin 118

CLARE RELAYS

FIRST *IN THE INDUSTRIAL FIELD*



Specifications

MECHANICAL:

COILS:
D-c, single-wound, up to 25,000 ohms; double-wound—(concentric only) to 5000 ohms each winding.

MAGNETIC CIRCUIT:
Armature and heel piece of low-loss iron provide efficiency comparable to that of Type G or Type GAC relay. Cores of a-c coils are of laminated silicon steel. Copper shading rings fitted to pole faces to prevent armature chatter.

ARMATURES:
Single-arm. A-c relays have precision-reamed, heavy-duty armature bearings and stainless steel bearing pins.

RESIDUALS:
Fixed (plate) or adjustable (lock screw) on d-c relays.

ARMATURE LATCH:
Arm projects downward from armature of upper relay and engages latch projecting outward from armature of lower relay. Stop on lower latch prevents overthrow. Retractile spring helps restore upper armature when latch is disengaged. Latching members specially treated by most modern metallurgical methods for maximum wear resistance.

CONTACTS:
Forms A to E available. Maximum of 6 springs per relay.

WEIGHT:
Net (approx.) 1 lb. Shipping—2 lbs.

ELECTRICAL:

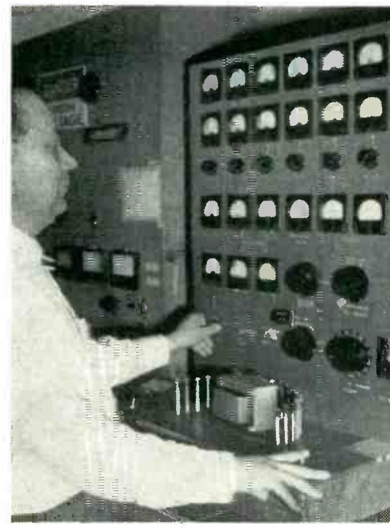
COIL VOLTAGE:
(Maximum) a-c, 220 volts, 20 to 120 cycles; d-c, 220 volts.

COIL RESISTANCE:
A-c, wound to number of turns specified, plus or minus 5%; d-c, resistance as specified, plus or minus 5%

COIL DISSIPATION:
(Maximum) For continuous duty: a-c, 10 va; d-c, 6 watts.

AMPERE TURNS REQUIRED:
(d-c relay) with two Form C contacts, 500.

HIPOT TEST:
Standard, 1000 volts rms.



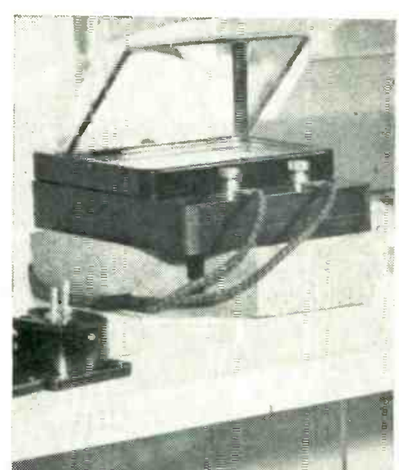
Universal power transformer tester

ammeters and eight 100-watt rheostats permit individual loading of secondary windings. Other meters measure primary voltages, secondary voltages and breakdown voltages.

High binding posts are arranged in a semi-circle around the metal grounding plate on which the transformer under test is placed. Transformer leads are connected to the correct posts according to previously prepared tables, for making a test.

Calibrating Meters

DELICATE and costly high-precision meters are protected during production-line calibration by placing them horizontally on a shelf over the workbench and mounting a



Method of mounting standard meter with mirror on shelf above production bench

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to the time interval you need from ½ microsecond to 0.1 second and:

Measure Pulse Width, Frequency, Period . . . Delay Sweeps, Calibrate Sweeps . . . Introduce Variable Time Delay in Control Sequences . . . Use for any Job Requiring Calibrated, Variable Time Intervals or Time Comparison . . .

CHECK THESE FEATURES:

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- 1% Absolute Accuracy
- 0.3% Differential Accuracy (short term)
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- Positive and Negative Trigger Outputs
- 117 Volts, 50-60 CPS

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mirror at an angle of 45 degrees above each meter so that a seated operator can read directly at eye level. A sponge rubber pad under each meter provides added protection against vibration and shock. This setup is used by the Bayamon, Puerto Rico plant of Triplett Electric Co. of P. R. Inc.

Meter calibration position

The calibrating procedure involves placing each meter movement in turn in a test fixture located between two large demagnetizing coils, and varying coil current appropriately to adjust the permanent magnet in the movement until the reading of the meter under test corresponds with that of the standard at preselected points in the operating range.

Selecting Coil Forms for Threaded Cores

By Hugh T. Blair

President, Resinite Corp.
Division of Precision Paper Tube Co.
Chicago, Illinois

THE THREE basic types of threaded coil forms used with shallow-thread or V-type iron cores are shown in Fig. 1. In general, these coil forms should be custom-made to fit the particular iron core application. This is necessary to insure perfectly round windings and uniformity of windings to the iron core, as well as accurate alignment of the core itself.

The triangular or cloverleaf form is illustrated in Fig. 2 before and after forming. Dimensions are for a standard ¼-28 screw having a

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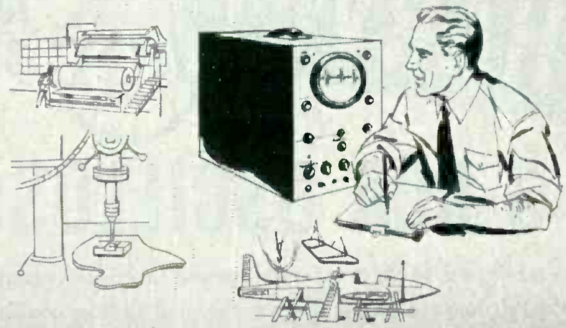
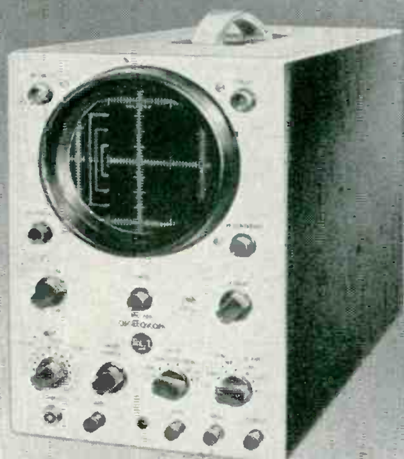
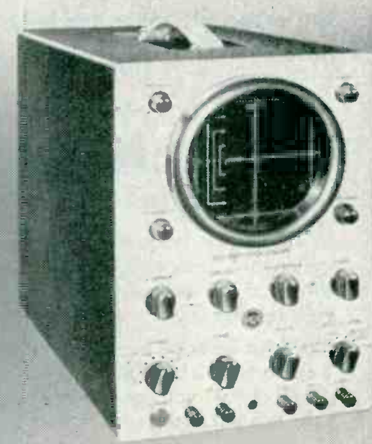






New RCA WO-78A 5" OSCILLOSCOPE FEATURING DUAL BANDWIDTH

VERTICAL RESPONSE: Wide-band, flat within −1 db from 3 cps to 4.5 Mc; sensitivity, 0.1 v p-p/in. Average rise time 0.1 μsec. with overshoot less than 5%. Frequency-compensated, voltage-calibrated attenuator. Narrow-band, flat within −3 db from 3 cps to 500 Kc; sensitivity, 0.01 v p-p/in.

HORIZONTAL RESPONSE: flat within −6 db, from 3 cps to 1 Mc; sensitivity, 0.2 v p-p/in.

FULL-SCREEN DEFLECTION over entire rated frequency ranges.

PUSH-BUTTON voltage calibration.

HIGH INPUT IMPEDANCE, 10 megohms input resistance; 14 μμf input capacitance, with low-capacitance probe.*

HORIZONTAL SAW-TOOTH SWEEP, 10 cps to 100 Kc.

PHASE CONTROL for phasing sync and sweep voltages.

SYNC LIMITER provides automatic leveling.

FLAT-FACED POST-DEFLECTION TYPE TUBE enclosed in mu-metal shield. Operates at post-ultor voltage of 3000 v. for very sharp trace. RCA-5ABP1 (medium persist.) supplied. User may install 5ABP7 (long persist.), or 5ABP11 (short persist.).

COMMERCIAL CAMERA ADAPTORS fit cathode-ray-tube bezel.

Suggested User Price $425.00

RCA WO-56A 7" OSCILLOSCOPE, WITH IDENTICAL VERTICAL AND HORIZONTAL DIRECT-COUPLED PUSH-PULL AMPLIFIERS

FREQUENCY RESPONSE, V and H: Flat within −2 db from 0 to 500 Kc, within −6 db to 1.0 Mc. Vertical sensitivity 0.03 v p-p/in. Horizontal sensitivity, 0.06 v p-p/in. Rise time approx. 0.45 μsec. with overshoot less than 2%. Frequency-compensated attenuators.

BUILT-IN VOLTAGE CALIBRATION

HIGH INPUT IMPEDANCE, 10 megohms input resistance; 9.5 μμf input capacitance, with low-capacitance probe.*

HORIZONTAL SAW-TOOTH SWEEP, 3 cps to 30 Kc, with preset TV "V" and "H" positions.

SYNC: Internal "+" and "−", external, and line.

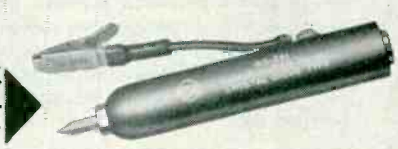
PHASE CONTROL for phasing sync and sweep voltages.

Suggested User Price $274.50

RCA WG-291 DEMODULATOR PROBE

"Slip-on" probe for use with these RCA 'scopes. Input frequency 0.5–250 Mc. Input capacitance 2.25 μμf. For modulation frequencies, 30–5000 cps. Max. input voltage 20 v rms. Max. dc rating, 250 v.

Suggested User Price $7.95



RCA WO-88A GENERAL-PURPOSE LOW-COST 5" OSCILLOSCOPE

VERTICAL RESPONSE: Flat within −3 db from 0 to 500 Kc; sensitivity, 0.07 v p-p/in. Average rise time approximately 0.5 μsec. Direct-coupled vertical amplifier. Frequency-compensated, voltage-calibrated attenuator.

HORIZ. RESPONSE: Flat within −6 db to 200 Kc; sensitivity, 1.7v p-p/in.

BUILT-IN VOLTAGE CALIBRATION

HIGH INPUT IMPEDANCE, 10 megohms, input resistance; 9.5 μμf input capacitance, with low-capacitance probe.*

HORIZONTAL SAW-TOOTH SWEEP: 15 cps to 30 Kc.

SYNC: Internal "+" and "−", external, and line.

PHASE CONTROL: for phasing sync and sweep voltages.

Suggested User Price $149.50

*Furnished with instrument.

For design, production, and maintenance—specify an RCA oscilloscope. See your RCA Distributor for complete details.

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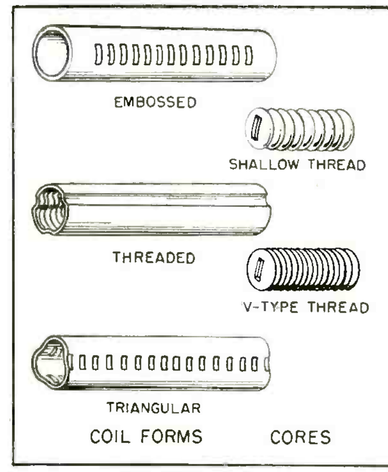

FIG. 1—Types of internally threaded coil forms and mating threaded iron cores

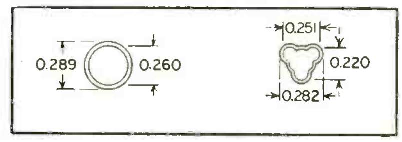

FIG. 2—Typical triangular or cloverleaf type coil form

major diameter of 0.249 inch plus or minus 0.001 inch. Due to the shape of this type of form, extreme care must be taken in production to avoid its being placed on a mandrel larger than the iron core. This is important because a slightly loose coil winding and slightly undersize core will give practically no torque. Conversely, a slightly oversize core and tight winding will bind, because reduction of torque depends on returning of the tube to its original shape or size, which the tight winding prevents.

A typical embossed form before and after forming is illustrated in Fig. 3. With this type, the form is the correct size before forming, since there is no decreasing or deforming of the diameter in manufacture. Strain to control torque

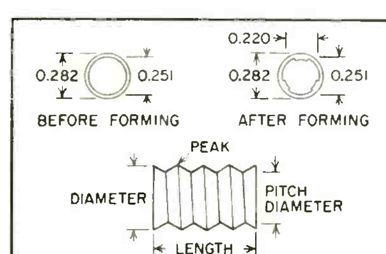

FIG. 3—Typical embossed form and V-type core

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does not depend on the return of the form to its original size when an iron core running to the high side of tolerance is used. An iron core running to the low side has three-point control and cannot lose torque or strip.

An iron core running to low limits is compensated for by the bosses at 0.220-inch diameter riding between threads at one place and over and between threads at two other points in any given 360-degree section. An oversized core is easily adjusted, as the embosses are merely forced back within close tolerances, automatically adjusting torque by insertion. Control of the land on the thread peak is not required, since this has no bearing on the controlled torque—as long as it is controlled within reason.

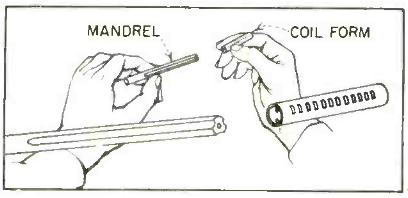


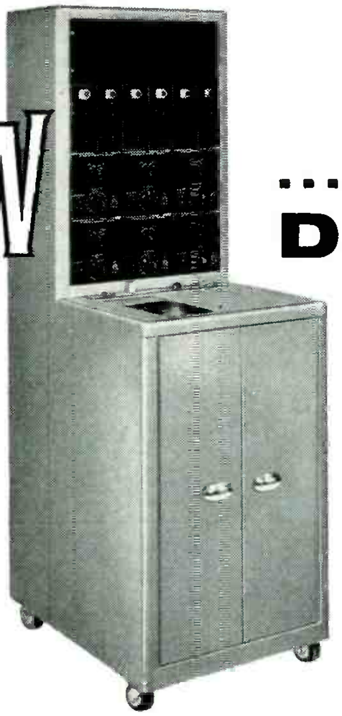
FIG. 4—Recommended winding arbor

With an internally threaded form, the depth of thread is a maximum of 0.006 inch. Only the outer 0.006 inch of the peak of the iron core engages the thread of the tube. The width of the thread in this type of coil form is necessarily very narrow. Precaution must be taken with regard to any increase in the radius at the peak (caused by wear of grinding wheels in thread grinding), since this might result in binding.

In the case of resin-impregnated tubes, which like the iron cores are abrasive, the possibility of undue wear on grinding and tapping tools exists. This can be controlled in the manufacture of the iron cores by close inspection of peak and by holding the land to a minimum. The danger here is in causing a weak point on the iron core as the result of two abrasive materials working against each other. In this event, before the core is inserted to the correct position in the coil, the peak may either be worn to a point where the iron core will bind

The new Type M Dynograph Recorder is a high speed direct writing oscillograph providing exceptionally high, absolutely stable, d-c or a-c amplification. It may be used with reluctance type pick-ups without auxiliary equipment. The exceptional stability, sensitivity, and versatility of the Dynograph allow simultaneous direct recordings of a very wide variety of transient variables such as temperature, speed, position, pressure, acceleration, vibration and strain.

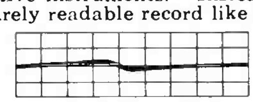
The Type M employs individual plug-in amplifiers; and input panels provide all connections for various types of signal pick-ups. It is the most advanced equipment for your direct-writing recording problems.



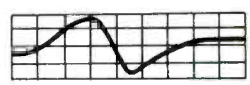
NEW ...OFFNER TYPE M DYNOGRAPH RECORDER

WHY THE DYNOGRAPH? For almost every application of direct writing oscillographs, those who have compared features of competitive instruments have chosen the Dynograph—because:

The Dynograph provides thirty times the d-c sensitivity of competitive instruments.* Instead of a barely readable record like this:



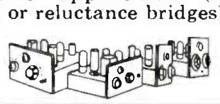
The Dynograph gives a large, easily read record like this:



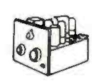
Yet while competitive recorders drift 1 mv per hour* or more

the Dynograph is absolutely non-drifting,

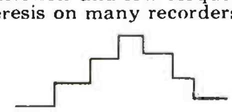
Other recorders require additional amplifiers or preamplifiers for moderate gain d-c; for high gain d-c; for carrier applications (strain gauges or reluctance bridges).



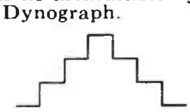
With the Dynograph, one amplifier covers all applications—and does a better job on each!



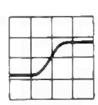
Pen friction and low torque gives hysteresis on many recorders.



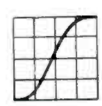
There is no measurable hysteresis on the Dynograph.



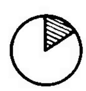
Limited pen travel makes recording of large dynamic variations difficult.



Over 8 cm of pen excursion is available in the Dynograph.



Even at moderate sensitivities, other assemblies require considerable warmup time for stabilization.



The Dynograph is stable as soon as it is working.

* Based on manufacturer's published claims.

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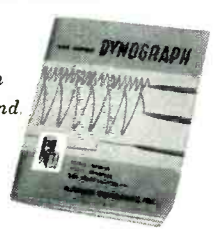
Eight page, 2 color bulletin describes technical details and application information. Write for your copy of Bulletin L-742.



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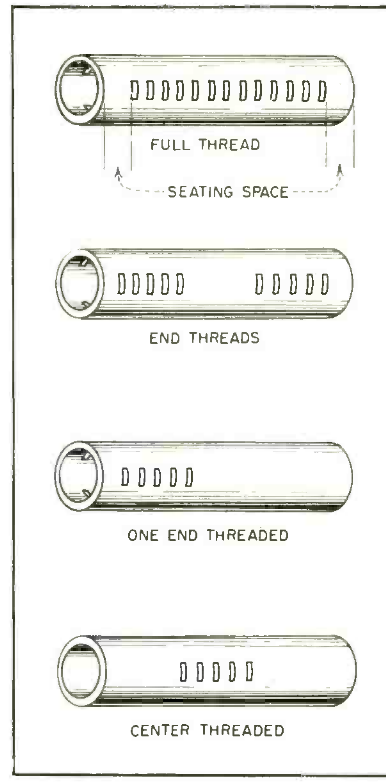


FIG. 5—Methods of positioning embossed threads on coil forms

under tension of the winding or become loose because of change in diameter due to wear at these weak points.

Specifications for iron cores should cover exact major diameter with tolerances, threads per inch, type of thread (full, shallow, etc) and breaking torque (on hex-hole or screwdriver slot).

Design Details

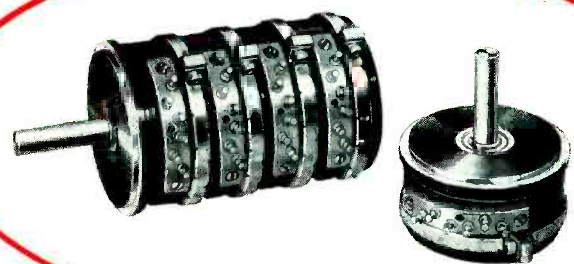
Figure 3 also illustrates the important factors in fitting a round into a round. Even a variation of 0.001 inch in core diameter makes a big difference in fit. The peak is also important, in that it will wear rapidly if sharp and thin. A peak of 0.007 to 0.015 inch is recommended. Increasing the pitch diameter will provide more material in the core and give more land at the peak. Always specify the length of the iron core to be used. This is a matter of friction; the longer the core, the greater the resistance.

The correct winding arbor must be used with any threaded form. Oversize arbors distort the thread formation during winding. Undersize arbors may cause collapse of the coil during the winding operation. A winding arbor should give

new TIC STANDARDIZED LINE *of* BALL BEARING *precision potentiometers*

FEATURE:

- A complete range from ⅞″ to 3″
- High accuracy
- Compact size
- Ball bearing for rigid, low friction support
- Servo mounting AIA proposed std. dim.
- Linear or non-linear functions



ST18

The dependable precision and stability built into TIC potentiometers is inherent in the new standardized line. In keeping with the trend to miniaturization of servo drive assemblies, these compact low torque potentiometers require minimum power from the driving source. Applications in airborne electronic equipment, guided missiles and computers as well as broad industry applications in conjunction with automatic control now enjoy simplified production through standardized assemblies.

Specifications of ST18, for example, offer:

Resistance Range: 100 ohms to 100K.

Independent Linearity: ±0.5% of total resistance, standard.
±0.2%, special.

Electrical Rotation: 320° ±2°, standard. Special angles and closer tolerance available.

Power Rating: 3 watts @ 25°C.

Torque: 0.5 oz. in., standard. Lower torque available.

Specifications common to the entire line of standardized potentiometers:

Ball bearings for rigid, precise shaft support at low friction level.

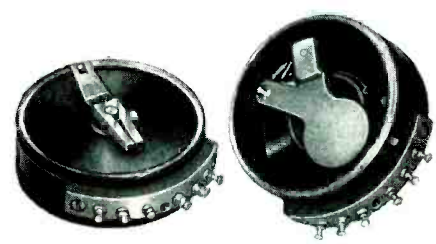
Ambient temperature range: −55°C. to +80°C., standard. Special to +140°C. in all sizes.

Temperature coefficient resistance wire: 0.002% per degree C.

Taps available.

Rugged construction, low noise and long life plus conformity to stringent military specifications for humidity, salt spray, shock and vibration are but a few of the features of the new TIC standardized line.

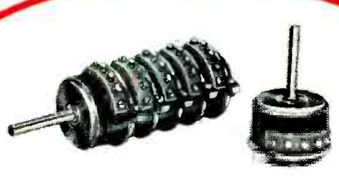
Versatility of unitized construction is available in the type STC18 permitting variable ganging and individual phasing as required. Modified for plug-in convenience — specify TYPE RVBC 1⅝.



STC18 UNITIZED CONSTRUCTION

TIC offers Type ST09 (⅞″)
ST11 (1″)
ST15 (1½″)
ST18 (1¾″)
ST20 (2″)
ST30 (3″)

All in either linear or non-linear functions



ST09

Specifications of ST09

Electrical Rotation: 320° ±5°. Special angles and

Resistance Range: 100 ohms to 50K.

Independent Linearity: ±1% of total resistance standard. ±0.3% special.

Electrical Rotation: 320° ±5°. Special angles and closer tolerances available.

Power Rating: 2 watts @ 25°C.

Torque: 0.5 oz. in., standard. 0.1 oz. in., special.

The TIC policy of setting and maintaining the highest standards of precision potentiometer manufacture assures your confidence and satisfaction. Whether for standardized potentiometers or custom design your inquiry is invited.

TECHNOLOGY INSTRUMENT CORP.

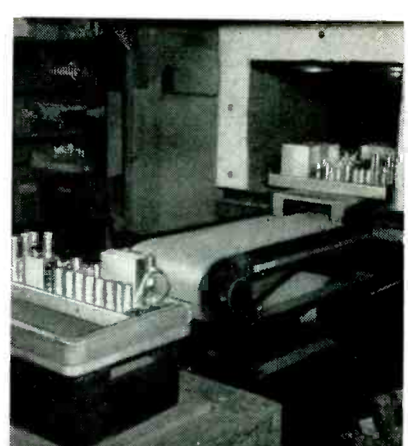
533 Main St., Acton, Mass. COlonial 3-7711 West Coast Eng'r'g. Facility, P. O. Box 3941, North Hollywood, California, POplar 5-8620

a close fit to the major inside diameter of the tube. For embossed forms, three grooves should be milled in the winding arbor at 120 degrees to accommodate the bosses, as in Fig. 4. This offers free support to the coil form, with no distortion of the bosses. The end of the winding arbor should be tapered slightly to facilitate placement and removal of the coil form.

Custom-made core forms can increase the efficiency of iron-core insertion production up to 20 percent, because broken cores are eliminated, freezing of cores due to cross threading and improper starts is averted, and threads are positioned in accordance with the particular requirements. This latter point is illustrated in Fig. 5.

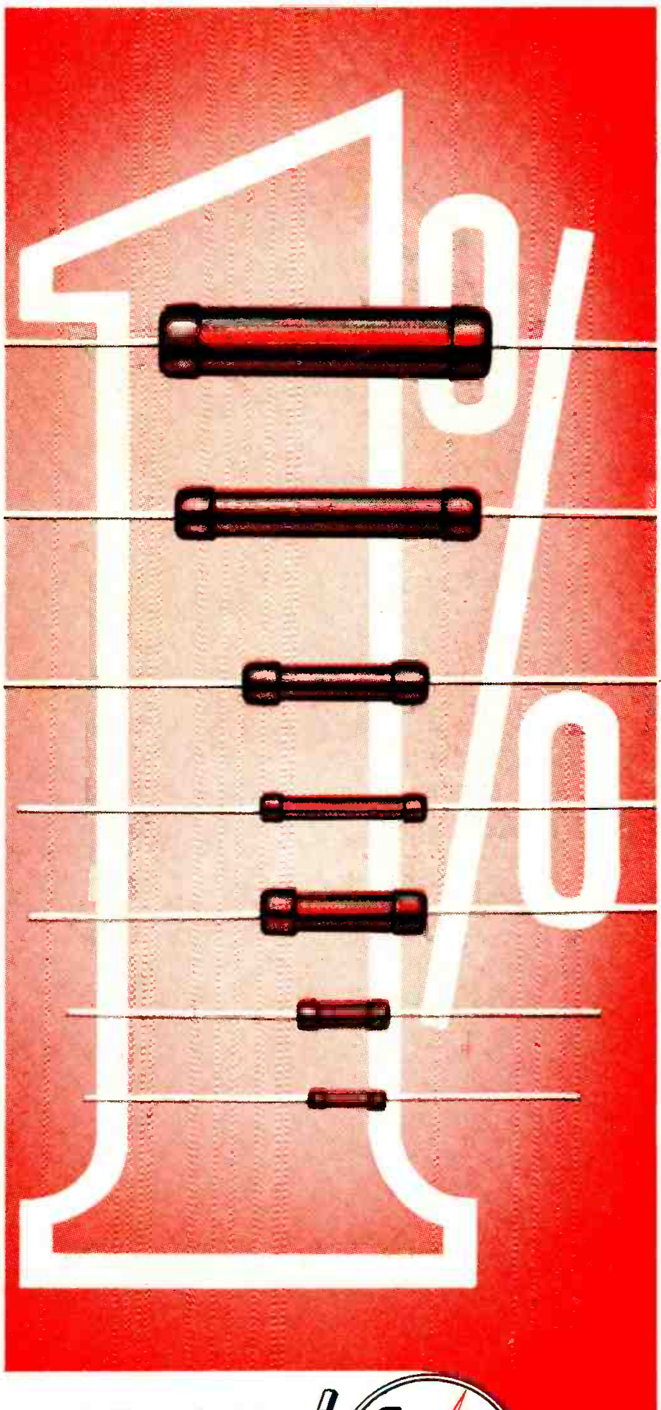
Vibration and Heat Test for Two-Way Radio

MOBILE two-way radio communication equipment is put through a combination of vibration and heat cycling to bring out defects that might cause early failure of the equipment, in the Communications and Electronics Division plant of Motorola Inc. in Chicago. Each unit in turn is placed on a Syntron vibrator for one-half minute. A wood rail mounted on the platform of the vibrator prevents the chassis from sliding off. After this, the chassis is lifted onto a conveyor belt for its trip through an oven containing 24 250-watt infrared heat lamps. For some tests the lamps are cycled on and off every 20 minutes during a 2-hour trip through the oven.



Vibrator at input of heat-cycling oven

ALLIES' Precision Deposited Carbon RESISTORS

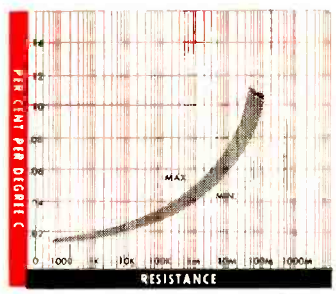


Ambient Temperatures from −70° to +250° C

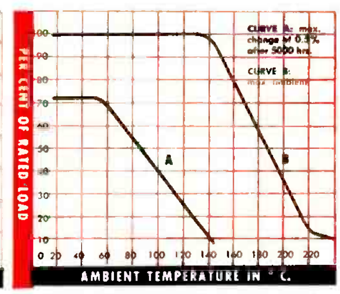
One Per cent Standard

Allies' Products precision carbon deposit resistors are replacing wire wound resistors in many circuits requiring high precision at low cost.

Allies' Products resistors are the standard of many computor and missile manufacturers.



Typical temperature coefficient characteristics for Allies' Products carbon deposit resistors.



Typical derating curve for ½ watt Allies' Products carbon deposit resistors.

VALUES and SIZES

RESISTOR	WATTS	OHMS
APT-5	5	20 ohms to 20 meg. ± 1%
APT-2	2	10 ohms to 50 meg. ± 1%
APLT-1	1	100 ohms to 50 meg. ± 1%
APT-1	1	10 ohms to 10 meg. ± 1%
APCT-1	1	25 ohms to 10 meg. ± 1%
APBT-1	1	10 ohms to 50 meg. ± 1%
APLT-½	½	10 ohms to 10 meg. ± 1%
APST-½	½	5 ohms to 10 meg. ± 1%
APXT-½	½	5 ohms to 2 meg. ± 1%
APT-¼	¼	1 ohm to 3 meg. ± 1%
APYT-¼	¼	5 ohms to 1 meg. ± 1%

ALLIES' A P PRODUCTS CORPORATION
1028 CONNECTICUT AVE. N. W. · WASHINGTON 6, D. C.

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NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

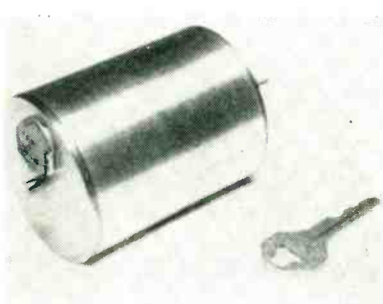
65 New Products and 57 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

OTHER DEPARTMENTS
featured in this issue

SIGNAL GENERATOR
for one color presentation

KAY ELECTRIC CO., Pine Brook, N. J. Model Uni-Chrome Chromabar is for single color presentation. Colors generated are: green, yellow, red, magenta, blue, cyan, white and black. A switch on the panel selects any color desired. Black and white bars are provided simultaneously with each other and a dot generator providing small, sharp dots is built in to permit checks on convergence and linearity of color receivers. Output at video frequency is variable to 1.4 v peak-to-peak positive and negative, into a 75-ohm load. It includes a crystal controlled color subcarrier and built-in horizontal sync generator. Price is $395.

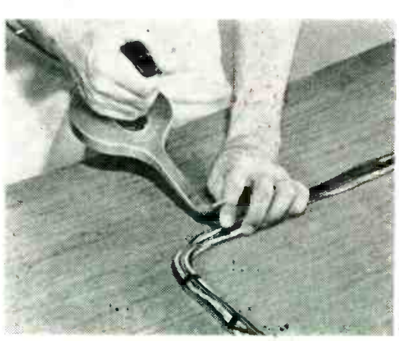
TRANSDUCER
for industrial automation



GENERAL CYBERNETICS ASSOCIATES, P. O. Box 987, Beverly Hills, Calif. Model 154 linear motion transducer is completely free from changes in scale factor with variations in frequency, excitation voltage and temperature over wide ranges of these parameters. It is designed for application in industrial automation as an electronic gage, monitor and control system senser. It operates from excitation voltages of 28 v to 115 v, 60 to 600 cycles. Output voltage is a function of input voltage and ranges from 3 v with a 28-v input to 30 v with 115-v input. Output voltage is linear with armature displacement from 0 to 0.12 in. with 0.25-percent accuracy and up to 0.25 in. with 0.5-percent accuracy. This output is symmetrical about a mechanical null position or can be in one direction.

TAPING GUN
with slender curved tip

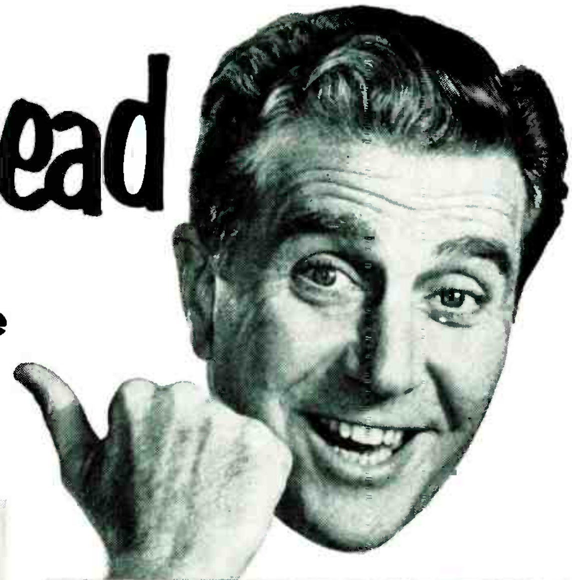
MINNESOTA MINING AND MFG. CO., 900 Fauquier St., St. Paul 6, Minn. Electrical harness wrapping can be speeded up from 2 to 10 times using plastic tape dispensed by the model E-2 taping gun. It is specifically designed for $\frac{3}{4}$-in.-wide Scotch brand plastic electrical tape No. 33. Weighing less than 20 oz with a 36-yard roll of tape in the circular magazine, the lightweight gun makes it possible to bundle the wires and cut the tape in a single easy motion taking about 1 second. In use, the tape protruding from the end of the gun is stuck to the wires by the thumb, threaded around the bundle by the curved tip, and then cut with a touch of a thumb button. The end of the tape is pressed down to complete the wrap. The slender 10.5-in., curved tip serves as a convenient needle to thread the tape around wires on a cable layout board or in spots that would be difficult to reach.



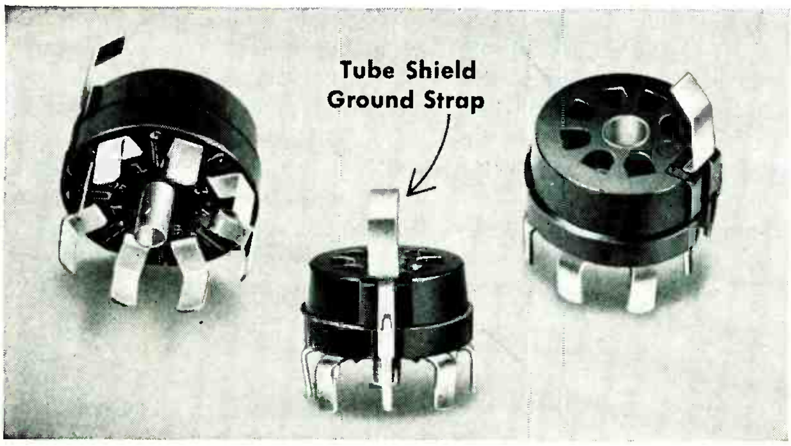
CERAMIC CAPACITORS
are voltage-sensitive

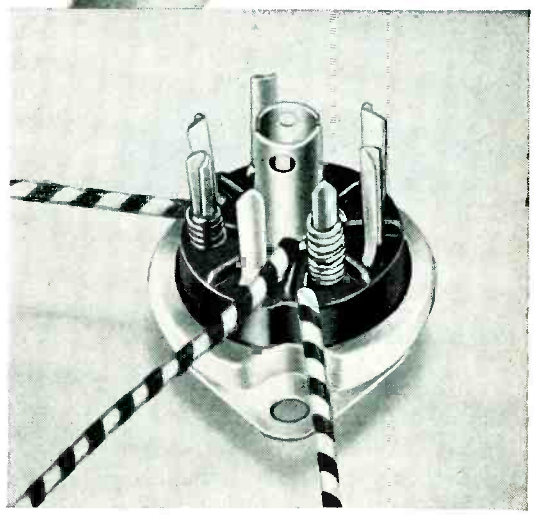
MUCON CORP., 9 St. Francis St., Newark 5, N. J., announces development of voltage-sensitive capacitors, a group of subminiature cera-

Big Savings Ahead



2 New SYLVANIA SOCKETS save Assembly Time . . . Cut Costs . . . Improve Performance!

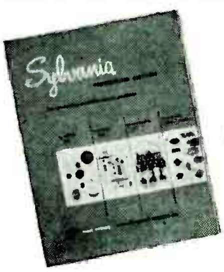




1. **New Sylvania 7-pin Miniature Printed-circuit Sockets.** Contacts and center shield are shaped so that sockets can be stacked one upon another for automatic feeding and assembly. Small slots are used on the circuit board to receive the contacts, resulting in stronger chassis construction. Only one socket assembly need be stocked since terminals can be interconnected by printing the circuit on the chassis board rather than using a metallic connector on the socket itself.

Insulator is molded of general-purpose or low-loss phenolic. Contacts are brass or phosphor bronze, plated to suit your specification. Supplied with or without center shield. Now available in 7-pin construction with 9-pin miniature and other types to follow. Tube Shield Ground Strap can also be furnished.

2. **New Sylvania Solderless-type Sockets** for wire-wrapped connections are now being made in all 7 and 9-pin miniature sizes. Contacts are shaped to provide reliable connections with the use of present wire-wrapping tools.



See the full story of Sylvania's Fabricating Services in Sweet's Catalog—Product Design File. Look for $\frac{1b}{Sy}$

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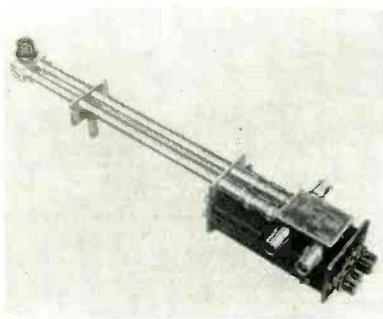
LIGHTING · RADIO · ELECTRONICS · TELEVISION

mic capacitors whose capacitance may be varied by a change in applied d-c potential. The capacitance may be decreased as much as 60 percent by the application of potential up to 500 v d-c. Inasmuch as these units are also temperature-sensitive, two types are available: type VSR, whose voltage sensitivity is maximum at room temperature, and type VSE whose voltage-sensitivity is maximum at approximately 70 C. The latter is intended for use in a controlled environment, such as a small crystal-type oven, to avoid problems caused by variations in ambient temperature. Body sizes start at approximately ⅛ in. square by 0.080 in. thick; leads are normally No. 26 gage tinned copper wire arranged axially. Capacitance values of approximately 300 μμf and larger may be obtained.

BALANCED MODULATOR

for pulse applications

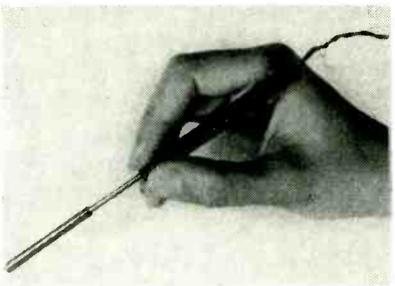


GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1000-P7 balanced modulator has a modulation-frequency response flat from d-c to 20 mc, thus making it suitable not only for short pulses but for any wide-band modulation. The usable carrier-frequency range extends from 60 to 2,300 mc and 100-percent a-m can be obtained throughout this range. Double-sideband suppressed-carrier modulation, and pulse modulation with 60-db carrier suppression between pulses are also possible throughout the entire carrier frequency range. Television video is easily handled by the balanced modulator even through the uhf tv band. Other applications include tests on microwave relay systems using multiplex pulse-code modulation, on omnirange and DME equipment, on telemetering circuits and on high-resolution radar.

SOLDERING TOOLS

have lead-pencil weight

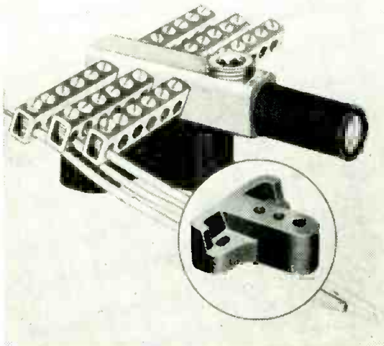
TELEVISION ACCESSORIES Co., Box 6001, Arlington 6, Va. Weighing as little as ¼ oz, the new line of ORYX miniature soldering instruments offer unusual advantages to manufacturers of precision equipment. A length of only 6 in. combined with a weight comparable to that of an ordinary lead pencil means increased production by reducing hand fatigue. These soldering instruments have no ceramic or mica formers to flake or break. They heat in as little as 20 sec and are available in a variety of voltages and tip styles as small as $\frac{1}{16}$ in. diameter. The ORYX soldering tools, a product of Great Britain, are used throughout the world by manufacturers, laboratories and service technicians. Write for a catalog sheet and full details on the model 6 transistor soldering tool.



NEUTRAL BAR

is strong and adaptable

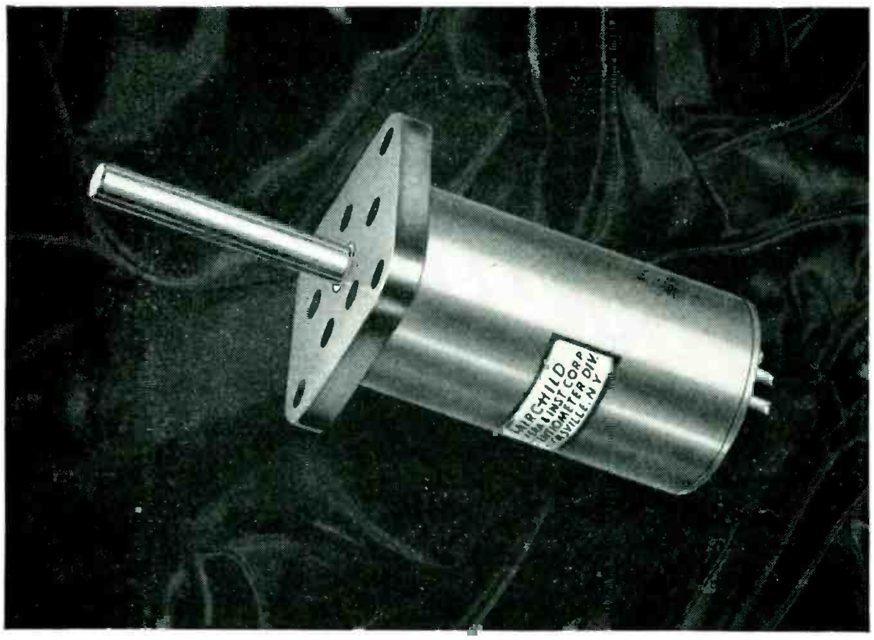
ILSCO COPPER TUBE AND PRODUCTS, INC., Mariemont Ave., Cincinnati 27, Ohio. The CAN neutral bar is compactly built and actually saves many minutes of time as compared to the old style washer head screw neutral plates commonly used. By forging the circuit bars into the main line connectors at a 20-deg angle for easy wire insertion of every branch circuit wire these neutral bars have been developed into units of unusual strength and adaptability. The illustration shows the neutral bar on a plastic block to be used for mounting. (It is sold with or without the mounting block). Quick, excellent connections are assured as wires are inserted in the V-shaped hole when the screw is pulled down. Larger wire range is offered as circuit taps take No. 14-6 and the main line load is 250 MCM-6. A 100-percent extra hard drawn seamless copper tubing is used to build CAN neutral bars for better conductivity and required maximum strength. Samples, detailed information and prices will be furnished on request.



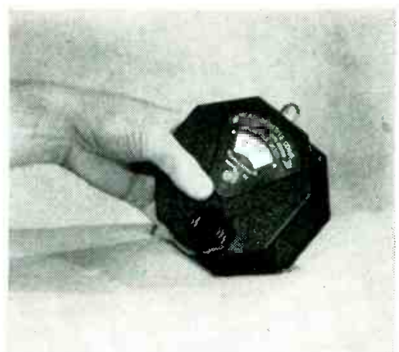
CARRIER AMPLIFIER

has wide frequency range

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasa-

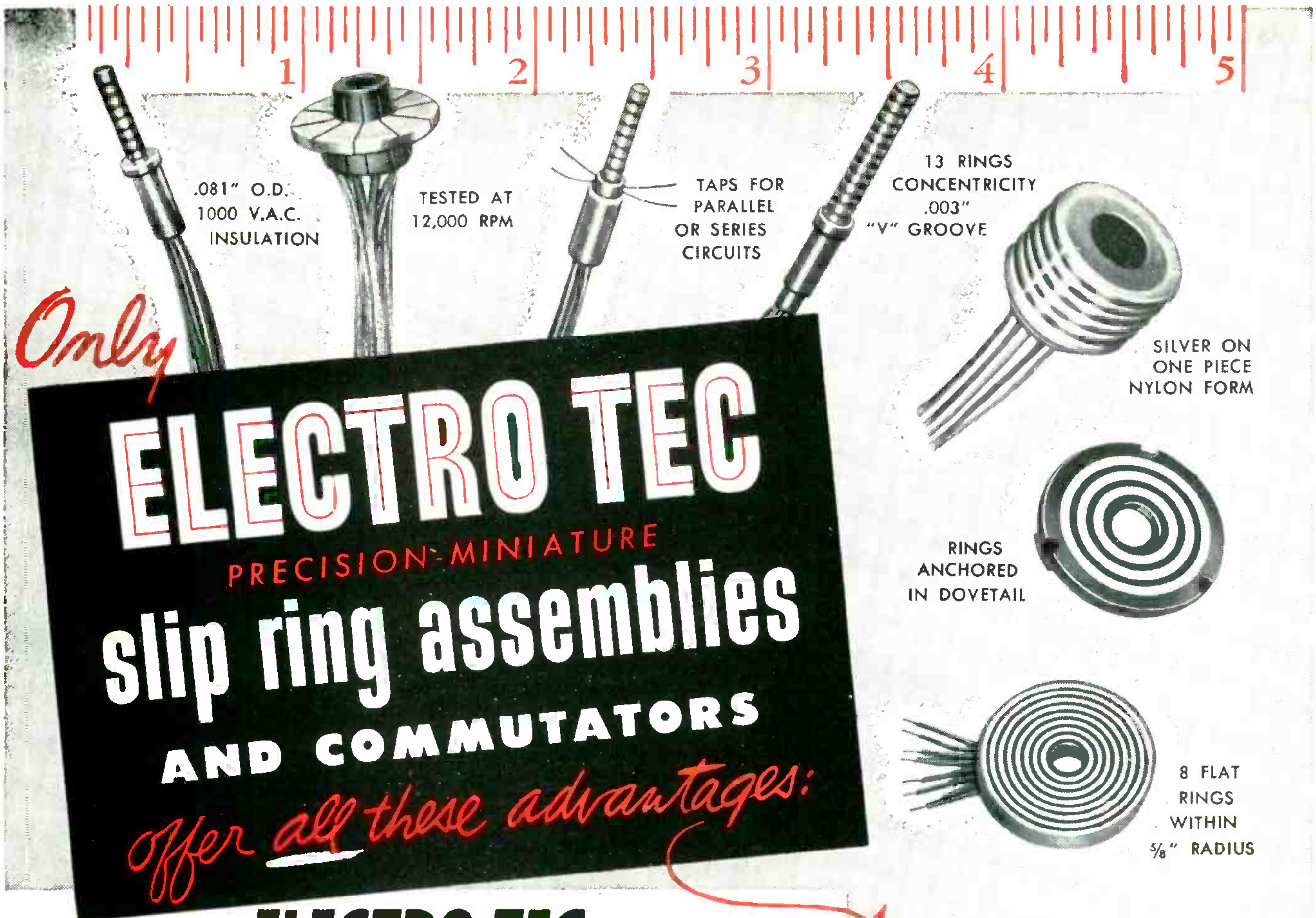


dena 8, Calif. Type 1-127, a 4-channel carrier amplifier, has a flat frequency response from 0 to 3,000 cycles. Industries, especially in the aircraft, guided missile and atomic energy fields, will find the amplifier system particularly useful for reproducing outputs of resistance or reluctance type transducers in the frequency range of 0 to 3,000 cycles. The instrument contains a regulated power supply, 20-kc oscillator, 4-carrier amplifiers with associated bridge balancing and demodulator circuits, control and metering system, and a calibrating system. For nominal amplifier sensitivity, a 1-mv modulation signal causes full-scale output of ±50 ma. The amplifier is provided with a gain control to adjust for full scale when an input of 1 mv is applied with any source impedance from 60 to 1,000 ohms.



GRID-DIP OSCILLATOR
for uhf-band applications

MEASUREMENTS CORP., Boonton, N. J. Model 59-UHF megacycle meter covers the range of 430 to 940 mc. It incorporates a unique oscillator with a split-stator tuning capacitor arranged so that a fixed coupling point is at the center of the oscillator inductance. Coupling sensitivity is excellent and grid current variation is minimal over the entire band. The oscillator output is either c-w or 120-cycle modulated. Linear calibration is provided with a calibration point every 10 mc (individually calibrated) and accuracy is better than 2 percent. The unit has many uses, such as measuring resonant frequencies of passive circuits; as an auxiliary signal generator for alignment and tuning of uhf receivers and trans-



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Diameters of these assemblies range from .045" to 24" cylindrical or flat. Cross-sections may range from .005" to .060" or more. Rings are polished to a jewel-like finish and can be held to 4 micro-inches or better. Even the smallest sizes withstand a 1000 V.A.C. breakdown test. Most types easily withstand rotational speeds up to 12000 rpm.

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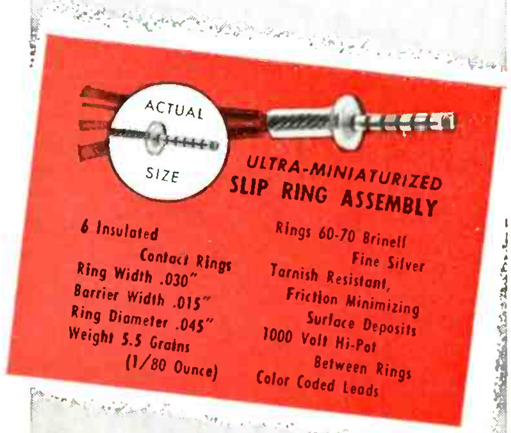

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ELECTRO TEC CORPORATION

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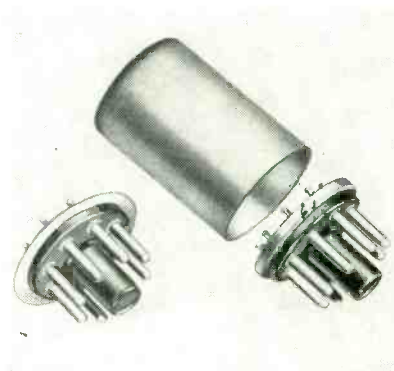
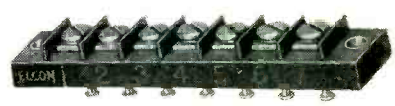
mitters; as an oscillating or absorption marker for use with a sweep-frequency-generator; and as a low-sensitivity receiver or field-strength meter for tracing sources of spurious oscillations in receivers and transmitters. It is encased in an octagonal metal box 2½ in. deep and 4⅝ in. wide.



PLUG-TERMINALS meet MIL-T-27 requirements

TRIAD TRANSFORMER CORP., 4055 Redwood Ave., Venice, Calif. Type A-4098 hermetic seal terminals are fitted with an octal plug which mates with a standard octal socket. They feature gold alloy plated solid brass pins to promote easier soldering and prevent corrosion and are available with either rolled or flat flanges. The rolled flange will fit either a 1-in. or 1⅛-in. o.d. round can.



TERMINAL BLOCK with from 1 to 7 contacts

ELCON ELECTRONICS, INC., 840 Fifth Ave., Brooklyn 32, N. Y. The molded feed-through terminal block illustrated is available with from 1 to 7 contacts (⅞ in. to 2¾ in. long). It features one-piece solid terminals of brass, gold plated over silver plate. Plated brass bushings molded into mounting recesses provide added strength for mounting and reduce breakage. They are supplied in four different JAN specification thermosetting materials and a choice of seven mansoL

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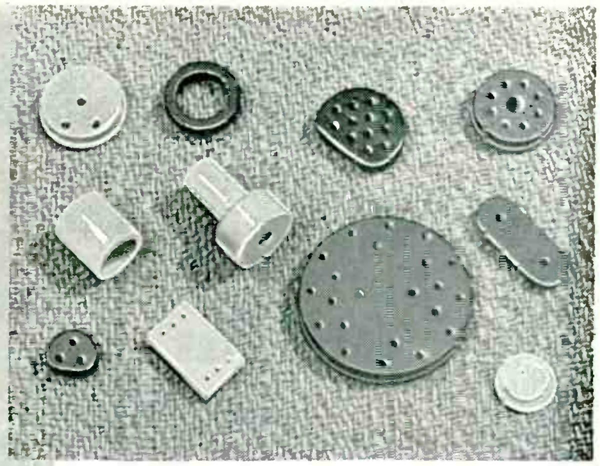
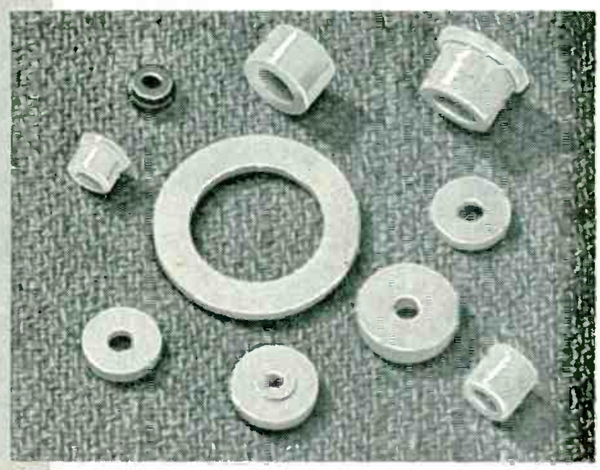
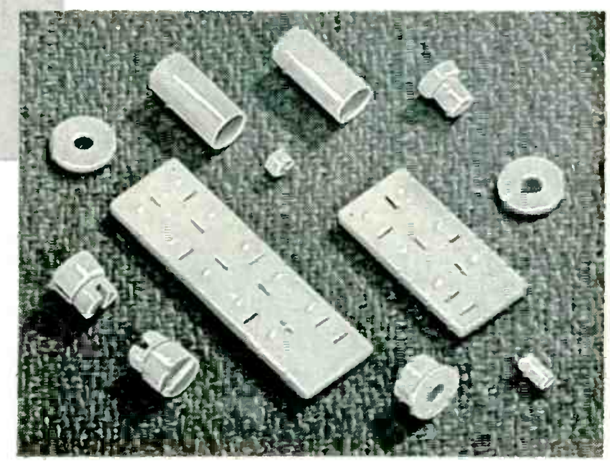


GLASS PREFORMS — The ideal preforms for *Iron Sealing*, and *Kovar Sealing*, matching the expansion of these *metals* over their entire working range. They resist mercury attack, have ample mechanical strength, and seal readily. Our laboratory is prepared to assist you in selecting the proper glass for any metal.



FORMULA 800 PREFORMS — An Epoxy Resin in preforms to improve production efficiency. Possesses extremely high bonding strength, with no shrinkage, on metals to metals and metals to non-metals. This is a new chemical resistant material of construction that warrants consideration when the properties of *standard* resin cements and coats are *not* adequate for the service desired.



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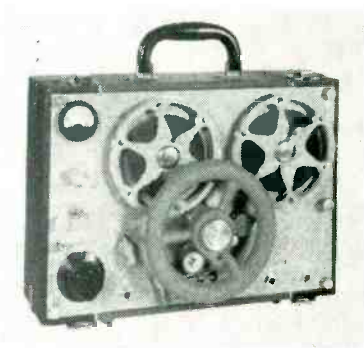
terminal types including turret, bifurcated, solder cup (for No. 14-Awg wire) and taper pin. Breakdown voltage is 3,200 v rms 60 cycles at sea level.



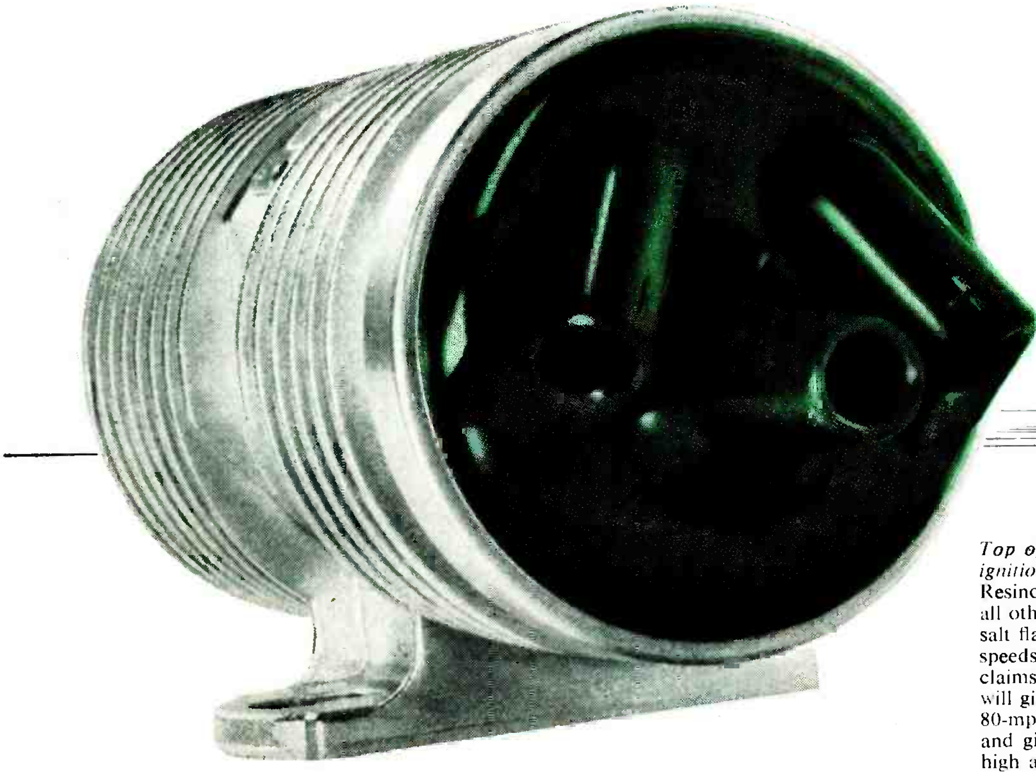
TAPE RECORDER
is portable, battery-operated

AMPLIFIER CORP. OF AMERICA, 398 Broadway, New York 13, N. Y. The VU Magnemite, battery-operated, spring-motor recorder is designed for extreme simplicity of operation. One, two, three and four-speed models are available utilizing consecutive speeds from $1\frac{7}{8}$ ips to 15 ips. Models employing speeds of $7\frac{1}{2}$ and 15 ips meet primary as well as secondary NARTB standards and record or play-back frequencies up to 15,000 cycles. The unit discussed measures $6\frac{1}{2} \times 9\frac{1}{2} \times 14$ and weighs only 19 lb complete with flashlight-type batteries which have an operating life of 100 hr. Constant tape speeds with low flutter of ± 0.1 percent over the full winding cycle is achieved by a centrifugal ball-bearing balance triply compensated flyball governor on the spring motor. Equalization for different speeds is automatic.

SCOPE CALIBRATOR
measures peak-to-peak voltage

SERVICE INSTRUMENTS CO., 422 S. Dearborn St., Chicago, Ill., is manufacturing an oscilloscope calibrator for quickly and accurately measuring peak-to-peak voltages. The system employed is a comparative method where the line voltage is calibrated and compared in amplitude to the unknown waveform on the scope. Two mounting bars are provided so that the meter can be

Takes 22,000 sparks per minute at 140-mph... without electrical loss!



Top of Wells' new "Super Go" ignition coil, C-1850, is molded of Resinox 3700. This coil out-performed all others in racing car tests on Utah salt flats . . . losing no spark power at speeds up to 140-mph! Manufacturer claims this coil on passenger cars will give same heat and spark at 80-mph as at 40-mph, saving gas and giving same pickup at both high and low speeds.

RESINOX 3700

Wells Manufacturing Company of Fond du Lac, Wisconsin, needed an ignition coil top that combined tremendous arc and heat resistance with outstanding dimensional stability and toughness. After extensive tests, they selected Monsanto's thermosetting molding powder, Resinox 3700. Speed test results proved the wisdom of their choice!

Resinox 3700 is the ideal all-around material for magneto ignition, motor control and electronic circuits, and other electrical applications.

1. It combines high arc-resistance with excellent dimensional stability. Eliminates undesirable after-shrinkage.
2. It has relatively good impact resistance and outstanding moldability, including good transfer molding properties.
3. It offers superior heat resistance.

Perhaps Resinox 3700 is exactly what *you* need to solve an electrical equipment problem. Write today for full information!

Resinox: Reg. U. S. Pat. Off.

MONSANTO ®

SERVING INDUSTRY...WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2505, Springfield 2, Mass.
Please send me complete information on Monsanto's new Resinox 3700 arc-resistant material.

Name & Title ______________________

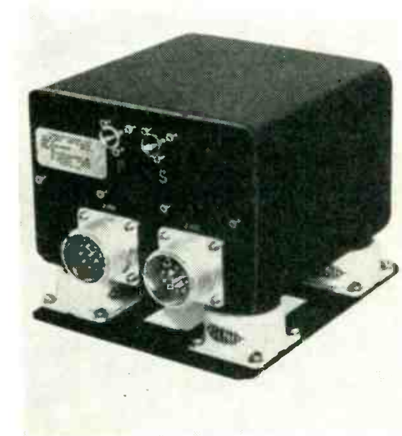
Company ______________________

Address ______________________

City, Zone, State ______________________

Want more information? Use post card on last page.

permanently connected to the scope, and thus, essentially adds peak-to-peak measurements to the scope. When the meter is turned off, the input is connected straight through, and the unknown waveform is applied directly to the scope input.



MACH NUMBER COMPUTER
is light and accurate

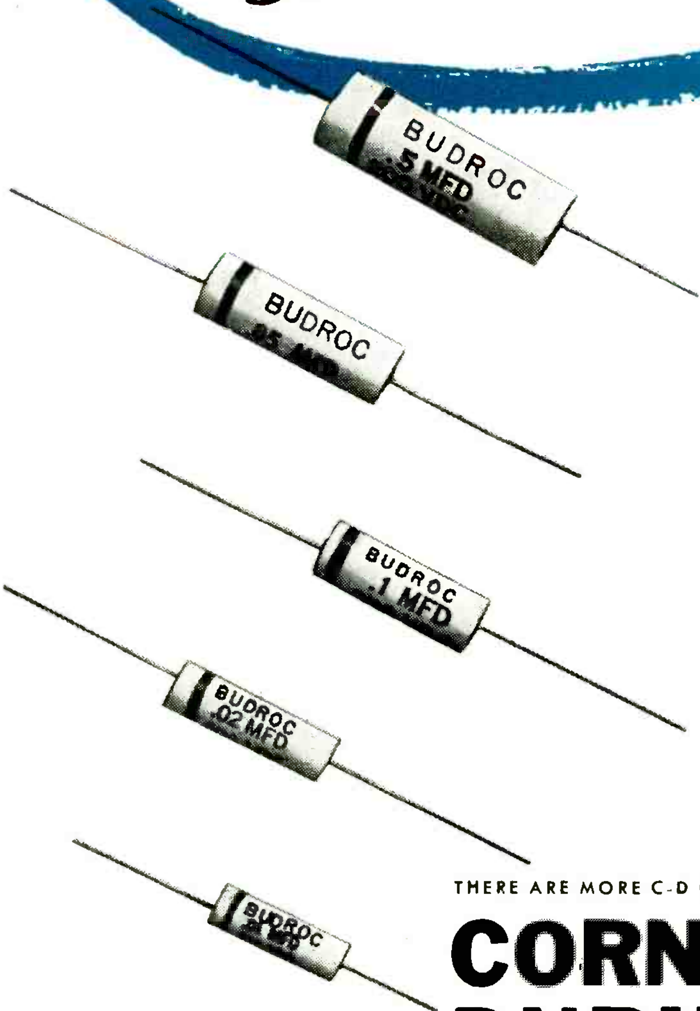
SERVOMECHANISMS, INC., 500 Franklin Ave., Garden City, L. I., N. Y. The CA-500 force-balance mach number computer, requiring no external pressure transducers or vacuum tubes, is designed for use in commercial and military aircraft. It weighs only 4½ lb and provides accuracy of 0.01 mach for 95 percent of lab test points. It measures approximately 5½ × 5½ × 4 in. high. The unit features simple design and maximum versatility. It is a precision 400-cycle instrument and solves the equation for mach number through the utilization of a force-balance linkage, mechanically comparing differential and static pressures.

MODULATION METER
for 25 to 500-mc range

LAMPKIN LABORATORIES, INC., R.F.D. No. 1, Bradenton, Florida. Model 205-A f-m modulation meter has a frequency range of 25 to 500 mc. While primarily designed for 2-way radio maintenance, it has many uses in the laboratory. It measures f-m deviation ±0-25 kc, with an accuracy within 10 percent at full scale on a 3-in. meter cali-

Another C-D "first"

Consistently Dependable Cornell-Dubilier Budroc* steatite-cased capacitors



The outstanding capacitor for high fidelity and high frequency applications

To the long list of Cornell-Dubilier "firsts" add another important development: the C-D Budroc* steatite-cased tubular capacitor. It is unquestionably the finest paper tubular ever made for the initial equipment manufacturer.

Budroc capacitors are non-inductively wound and housed in a tube of the finest ceramic (steatite) completely fabricated in our own plant, under close and constant supervision and quality control from start to finish. The specially developed C-D end fill will not soften, melt or flow at any rated operating temperature.

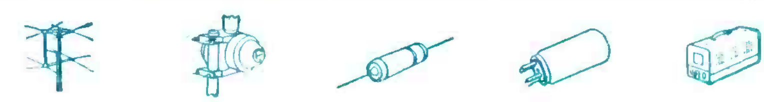
Send for engineering samples of this superb humidity proof, new C-D capacitor! Use our Technical Advisory Service for your special application problems. Bulletin NB-154 on request.

Cornell-Dubilier Electric Corp., Dept. K 104 South Plainfield, New Jersey.

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

CORNELL DUBILIER *Capacitors*

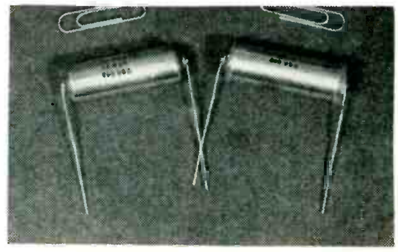
PLANTS IN SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I. INDIANAPOLIS, IND.; FUQUAY SPRINGS AND SANFORD, N. C.; AND SUBSIDIARY, THE RADIART CORPORATION, CLEVELAND, OHIO



*®

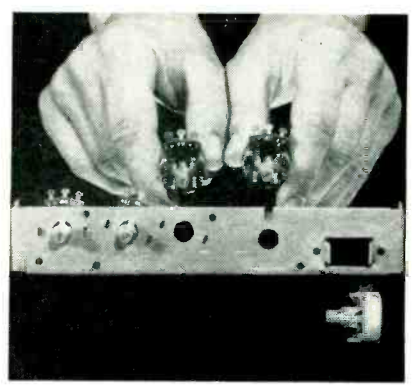
Want more information? Use post card on last page.

brated in kilocycles. It can also be used as a relative field-strength meter, and has a built-in speaker and a jack for an oscilloscope. Its small size (7 in. × 12 in. × 7¼ in. deep) and light weight (less than 14 lb) make it ideal as either a laboratory or portable instrument.



TINY TUBULARS
with right angle leads

GENERAL ELECTRIC Co., Schenectady 5, N. Y., has added to its line these subminiature metal-clad tubular capacitors with right angle leads. The leads are welded to the silicone bushing stud at right angles rather than axially. The units with right angle leads are especially suitable for printed circuit applications. Because the leads do not have to be bent during assembly there is less chance of breakage. Calculation of bend angles has been eliminated. The right angle leads may be obtained on standard metal-clad tubular capacitors.



CONTROL
needs no mounting hardware

CENTRALAB, A Division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis. The Snap-Tite model 2 control completely eliminates all mounting hardware, twisting of tabs and mounting tools. The control is simply pushed into the

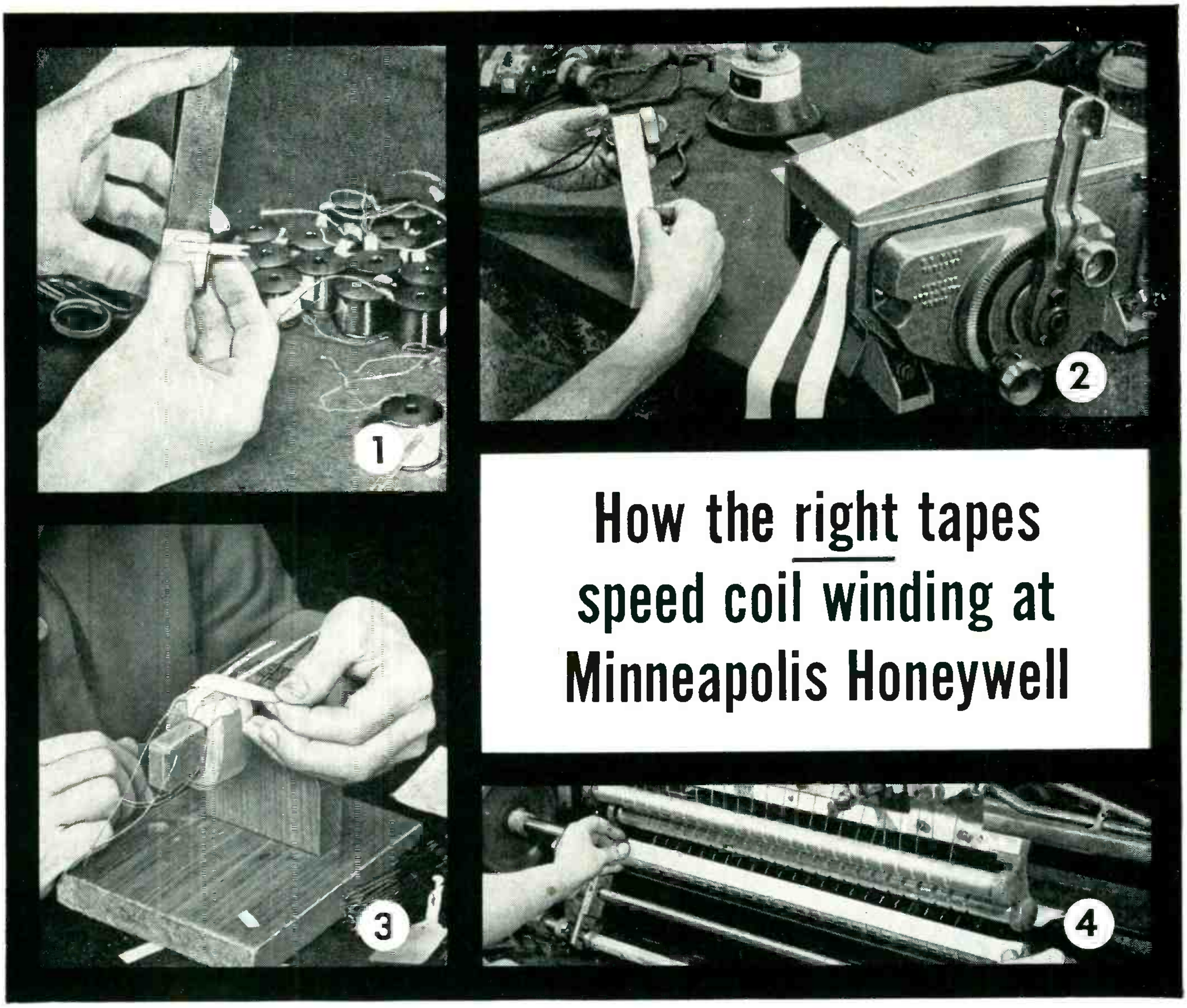
mounting hole where it snaps securely in place. Six spring clips grip the panel tightly. Snap-Tite controls are primarily designed for fine-adjustment applications in tv and electronic equipment, the units having a short knurled and slotted shaft for fingertip or screwdriver adjustment. The shaft is molded of high impact plastic for best electrical insulation and mechanical strength, and extends ½ in. from the face of the mounting panel. Complete details are given in bulletin EP-55.

MINIATURE PENTODE
for use as wide-band amplifier

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass. Type CK6485 miniature pentode is now available for all applications where the tube must be capable of good life while operating under very small or zero cathode current. Electrically it is like the 6AH6 which has high mutual conductance and a good figure of merit. A recently published bulletin gives mechanical and electrical data and characteristics charts.

H-V CONVERTER
weighs less than 3 oz

PRECISE MEASUREMENTS CO., 942 Kings Highway, Brooklyn 23, N. Y., has available a tiny h-v connector that delivers any voltage from 0 to 7,000 v by simply connect-



How the right tapes speed coil winding at Minneapolis Honeywell

When one of the world's largest manufacturers of electronic controls counts on "Scotch" Electrical Tapes for coil winding applications, you know there's a reason.

They're certain they're getting the *right* tape, for one thing. "Scotch" is the brand name for the most complete line of pressure-sensitive electrical tapes on the market.

And Honeywell is certain every roll of "Scotch" Electrical Tape will perform exactly as expected, too, because more quality-control tests are made on these tapes than on any other available brand.

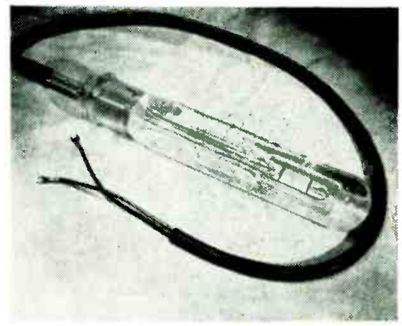
Applications like these are typical:

1. "Scotch" Electrical Tape No. 11 insulates and holds coil lugs in place.
2. "Scotch" Electrical Tape No. 29 fastens down valve coil leads for gas furnaces.
3. "Scotch" Electrical Tape No. 38 anchors and insulates five leads to relay coil.
4. "Scotch" Electrical Tape No. 38 holds start and finish leads on stick-wound relay coils.

WANT TO KNOW which "Scotch" Electrical Tapes are *right* for your coil-winding operations? Write Minnesota Mining and Manufacturing Co., Dept. E-34, St. Paul 6, Minnesota.

REG. U. S. PAT. OFF.
SCOTCH BRAND *Electrical Tapes*

ing one or two dry cells to the input. It works equally well on a-c. Circuit diagrams supplied with each unit show suggested hookups, including stabilizer circuits that provide a regulation of 2 percent or better and use only a few simple components. Applications include Geiger counters, phototubes, photoflash outfits, dust collectors and megohmmeters.



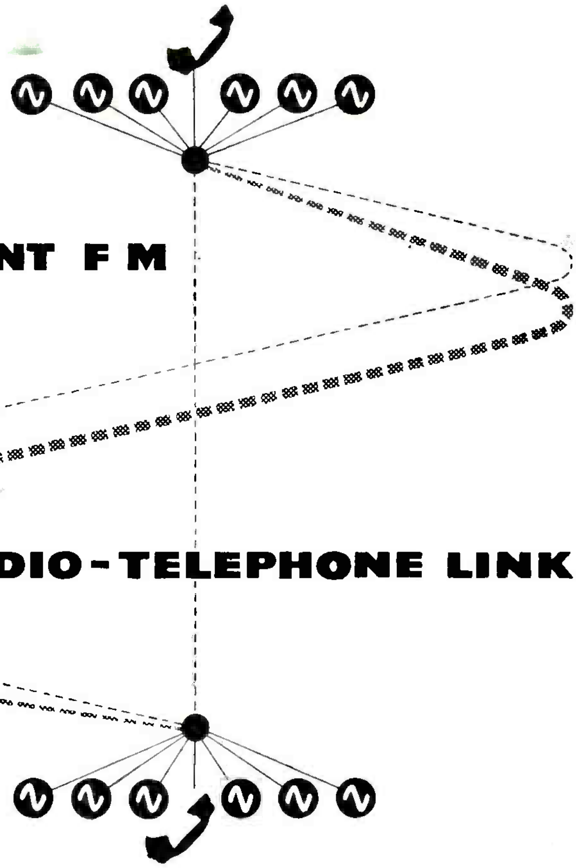
CONDUCTIVITY CELL
for lab applications

INDUSTRIAL INSTRUMENTS, INC., 89 Commerce Road, Cedar Grove, N. J. Improved model conductivity cells of the jacketed type for dip-use are now available for laboratory applications. The cells are designed for conductivity measurements under specific temperature requirements. A Pyrex glass tapered stopper is incorporated as an integral portion of the cell, while an oversize special test tube serves as a jacket. The cell is available in constants from 0.01 to 100.

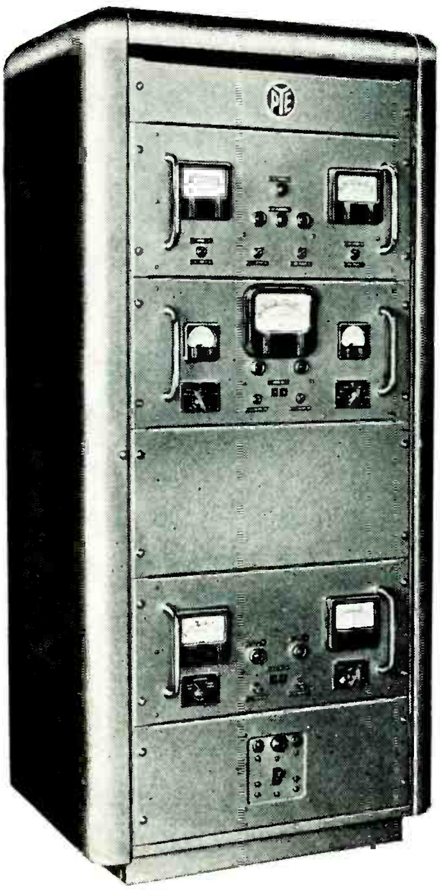
A-C DECADE BOX
for wide resistance

ELECTRO-MEASUREMENTS, INC., 4312 S. E. Stark St., Portland 15, Oregon. A versatile new a-c decade box provides more than a mil-

POINT-TO-POINT F M



VHF RADIO-TELEPHONE LINK



This Equipment will provide first-class single channel point-to-point facilities and, at the same time, possesses the necessary capacity for extension to six channels if required.

ABBREVIATED SPECIFICATION

Frequency range: 60—216 mc/s
Transmitter output Power: 10 watts or with Amplifier Unit — 50 watts
Maximum Deviation: 50 kc's
Receiver Bandwidth: 6 db down ± 120 kc/s
Overall Transmitter-Receiver Performance
Frequency Response: 300 c/s — 6 kc/s ± 3 db; 6 kc/s — 36 kc/s ± 1 db
Intermodulation Level: At least — 55 dbm for 2 tones applied each at 0 dbm

PYE Telecommunications
CAMBRIDGE ENGLAND

Pye (New Zealand), Ltd., Auckland C.I., New Zealand.	Pye Canada, Ltd., Ajax, Canada.	Pye-Electronic Pty., Ltd., Melbourne, Australia.	Pye Ireland, Ltd., Dublin, Eire.
Pye Radio & Television (Pty.) Ltd., Johannesburg, South Africa.	Pye Limited, Plaza de Necaxa 7, Mexico 5.	Pye Limited, Tucuman 829, Buenos Aires.	Pye Limited, 5th Ave. Building, 200 5th Ave., New York.

PYE LIMITED • • CAMBRIDGE • • ENGLAND

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NEW PRODUCTS (continued)

lion 1-ohm resistance steps from zero to 1,199,999 ohms. The Dekabox is mounted on a compact, adjustable mounting base that may be set to the most convenient angle for reading the six decade dials which display the value of resistance in a single horizontal line. All resistors are precision wire-wound units adjusted to within ±0.05 percent of their rated value and have special windings to minimize frequency error. Temperature coefficient of individual resistors is less than ±0.002 percent per deg C. All switch contacts are solid silver for minimum contact resistance, and all switch plates are made of ceramic material specially treated for maximum insulation resistance. A circuit diagram and all resistance and rated current values appear on the front panel with the laboratory-type binding posts.

SQUELCH UNIT
is completely self-contained

THE HAMMARLUND MFG. CO., INC., 460 W. 34th St., New York 1, N. Y., has designed a Codan squelch unit that activates a normally silent Super Pro-600 receiver at a predetermined signal strength. The unit's threshold of operation is adjustable to any predetermined level within the range of r-f signal inputs of 0.5 to 100 μv. A change in signal carrier level of 2 db or less will complete the switching action of the squelch regardless of threshold setting. Once the receiver is operating it will function as long as the signal continues. The unit is completely self-contained and is available separately for use with

WHAT ARE YOUR
SLIP RING ASSEMBLY
REQUIREMENTS?

"This ad appeared in Electronics Buyers Guide 1954 issue on page 452 with page number references omitted for the following items.

Antenna Pedestals	page D11	Plating, Metal on Plastic	D117
Brushes, Metal Graphite	D20	Rings, Collector	D134
Controls, Servo	D40	Slip Ring Assemblies	D137
Harnesses, Wire	D64	Switches, Rotary & Band	D142
Housings, Antenna	D65	Switches Telemetering	D143
Mounts, Antenna	D108		

list them on the dotted lines:

size... ______________________________

____

Complete PMI Slip Ring Assemblies we have made range in size from .080" diameter by .450" long to 40" diameter by 8' high, weighing as much as 3100 lbs. We can make them smaller or larger — tailored to your exact requirements.

application... ______________________________

____

PMI Slip Ring Assemblies surpass severe shock, vibration and water test conditions of MIL-E-2036A and MIL-T-17113 . . . provide trouble-free operation at 60,000 feet, resist fungus and corrosion.

electrical data... ______________________________

____

PMI Slip Ring Assemblies have a Voltage Range from microvolts to more than 20,000 volts corona free; Current Range from microamps to more than 600 amps; number of circuits more than 500; typical Brush life 14 million linear feet; Frequency from DC to more than 60 mc.; Noise Level under all customer specifications has been met or bettered.

quantity... ______________________________

____

Production on small Synchro Slip Ring Assemblies runs as high as 1000 per day. Ample manufacturing facilities make low-cost large runs possible.

mail this page TODAY *for immediate attention to your problem...*

NAME.. **POSITION**....................................

COMPANY.. **ADDRESS**....................................

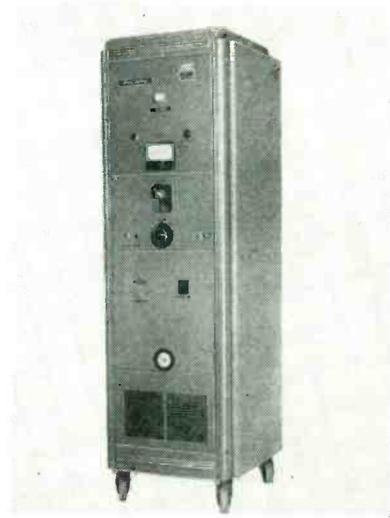
If your requirements are in the specification stage or in production, PMI engineers will submit, at your request, a design layout or evaluate your present design layout for possible measures of economy or efficiency. Our diversified experience in designing and manufacturing Slip Ring Assemblies can save you time and money. Mail this page today.

PMI P M INDUSTRIES, INC., - STAMFORD • CONN.

DESIGN • DEVELOPMENT • PRODUCTION • ELECTRO-MECHANICAL ASSEMBLIES

Want more information? Use post card on last page.

the Super Pro-600 communications receiver. It is packaged as an adapter with plug to match one of the existing tube sockets. It receives its power from the receiver.



DIELECTRIC HEATER
is crystal controlled

ERDCO ENGINEERING CORP., Addison, Ill., has developed a dielectric heater to be used with automatic machines for more efficient plastic sealing, packaging, dehydration, food processing, deinfestation, tobacco processing and instantaneous drying of foundry cores. It is a new r-f generator which is crystal controlled and cannot deviate from the assigned frequency. All shielding is completely eliminated. Standardized units are now in production in 1, 2, 3 and 5-kw output. The company is presently engineering units in sizes up to 100 kw. The electronic unit illustrated is composed of 3 chassis, each of which may be removed or replaced individually. The entire unit is housed in a cabinet that occupies only 23 in. × 24 in. floor space. The simplified controls are designed to provide easy operation, with complete operator safety and trouble-free maintenance.

PHOTOELECTRIC CELLS
use junction transistors

STANDARD TELEPHONES AND CABLES LTD., Warwick Road, Boreham

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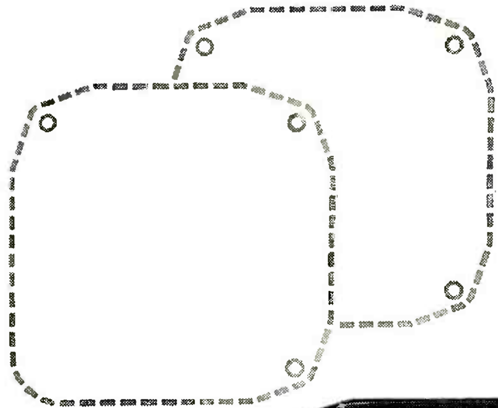
new **ARC**

course indicator gives you

two  **instruments**

in  **one!**

ARC #16706

TYPE 15D EQUIPMENT

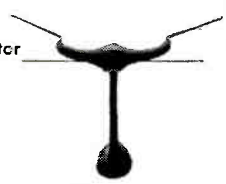
Compact . . . Lightweight . . . CAA Certificated

For Airborne Reception of Omni-Directional Ranges • Visual-Aural Ranges • Runway Localizers Simultaneous Voice • GCA Voice

R-13B Receiver with D-10A Dynamotor B-13 Converter, E-14 Rack and M-10 Mounting

Course Selector and Cross-Pointer Meter in a single unit

C-22A Control Unit, M-18 Mounting



A-13B Antenna

Now users of the light, compact ARC Type 15D navigational receiving equipment can employ a single panel instrument that performs the work of two units previously used. The cross-pointer meter and the course selector have been combined into one part that fits a standard 3⅛" instrument hole.

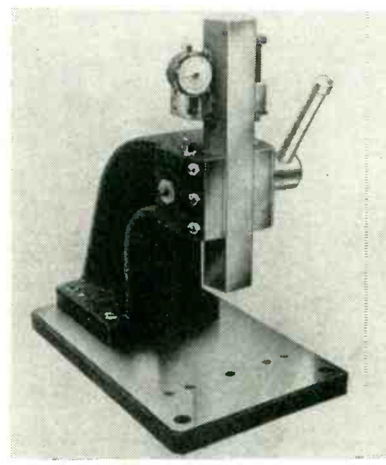
This saving in instrument panel space is important, particularly now that dual VOR installations are so popular. In addition to the space saving, installation costs are cut.

Ask your dealer to specify the new #16706 Course Indicator as part of your 15D installation – whether single or dual. The indicator may be purchased separately for use with older Type C and D equipment. Write for complete data.

Aircraft Radio Corporation

BOONTON • NEW JERSEY

Wood, Hertfordshire, England, is manufacturing a line of photoelectric cells in which germanium junction transistors are the light-sensitive elements. The light-sensitive germanium is enclosed in a hermetically sealed metal case which has a window at one end. When light strikes the germanium through this window, the current passing through the germanium increases in direct proportion to the quantity of light which reaches it. The cells are more sensitive to normal light than most gas-filled or vacuum-type cells, and can be used where the amount of light to be measured is low. They have an output of current sufficient to operate a cold-cathode trigger tube.



ARBOR PRESS
of close tolerance design

QUEENS TOOL ENGINEERING AND MFG. CO., 15 Front St., Rockville Center, N. Y. The Micro arbor press is a precision bench tool designed specifically for use by instrument makers where close tolerances are involved in the press fitting of bearings and gears in gear chains such as are used in cameras and computers. The end use is not single purpose in that it does an excellent job of piercing, broaching, forming and burnishing. Complete technical specifications are available from the company.

REGULATOR
is a-c line voltage unit

THE POWER EQUIPMENT CO., Detroit, Mich., has introduced a new

ACCELERATE YOUR DEVELOPMENT OR PRODUCTION PROGRAM

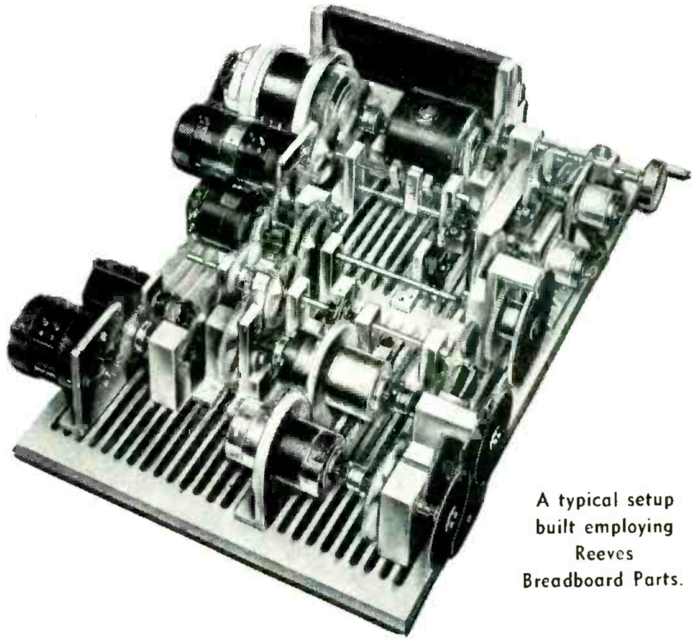
with cost cutting

REEVES

Instrumentation

Breadboard

Parts



A typical setup built employing Reeves Breadboard Parts.

ELIMINATE DRAFTING TIME

With Reeves Breadboard Parts you can build working models or permanent setups directly from schematics.

ELIMINATE DESIGN TIME

Reeves Breadboard Parts are so versatile that most types of high precision equipment such as servomechanisms, control devices and computers can be developed without designing and fabricating special parts.

REDUCE ASSEMBLY TIME

Slotted mounting plates, shaft hangers and component hangers give the Reeves breadboard method of assembly its speed and versatility. Components can be mounted quickly and easily in any desired position.

REDUCE MODIFICATION TIME

Reeves Breadboard Parts eliminate the enormous waste incident to making modifications of experimental models built with special parts.

STANDARD AND MINIATURE SIZES AVAILABLE

Reeves Breadboard Parts are available in standard ($\frac{1}{4}''$ shaft) and miniature ($\frac{1}{8}''$ shaft) sizes. The latter are ideal for applications where small size and light weight are important factors.

SEND FOR YOUR FREE FULL SCALE MINIATURE BREADBOARD TEMPLATE.

With the breadboard template you lay out a tentative setup using cutouts of the components. It's easy. It's practical. When the cutouts have been secured in place, turn the template over to the shop and you should have your setup in a matter of hours.

Reeves® INSTRUMENT CORPORATION

201 East 91st Street

New York 28, N. Y.

Telephone: TRafalgar 6-6000

Name ....

Position ....

Company ....

Company Address ....

☐ I am interested in further information concerning Reeves products

☐ I would like to have the Miniature Breadboard Template

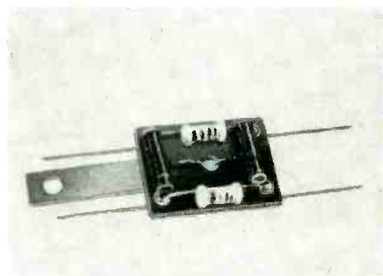
☐ I would like a copy of the Standard and Miniature Breadboard Parts Catalogue

REEVES INSTRUMENT CORPORATION

A Subsidiary of Claude Neon, Inc.

201 East 91st Street, New York 28, New York   Telephone: TRafalgar 6-6000

group of a-c line voltage regulators as separate items in five popular ratings. The regulator is exceptionally small in size and weight. The self-saturating power circuit was designed for a very low output impedance which permits transient overloading without undue loss of regulation. The control section is basically a magnetic amplifier with a cold-cathode-type tube used as a voltage reference. Safety factors are designed into the iron core components of this group of regulators, which provide trouble-free operation.

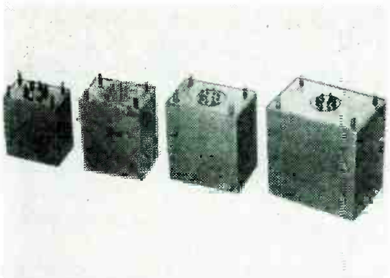


HIGH-PASS FILTER
reduces tv interference

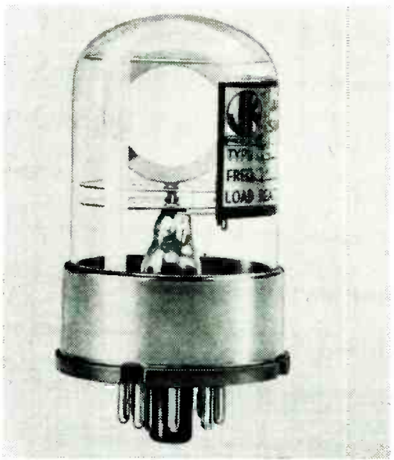
REGENCY, a division of Industrial Development Engineering Associates, Inc., Indianapolis, Ind. Model HP-45 high-pass filter reduces tv interference caused by interfering transmitters. It is a constant-K type filter with a cutoff frequency of approximately 45 mc in a 300-ohm balanced line. Attenuation at 29 mc is approximately 20 db. At frequencies of 14 mc and below, the attenuation is 40 db or more. Signals above 55 mc are passed through the filter without loss. Installation of the filter is easy and each unit is accompanied by an instruction sheet. List price is $1.65.

MAGNETIC AMPLIFIER
for servo motor uses

THE UNITED TRANSFORMER CO., 150 Varick St., New York 3, N. Y., has released a new series of magnetic amplifiers for servo motor applications. Four sizes have been made available, which will handle 2, 4, 6 or 9-w servo motors when used with a 115-v, 400-cycle supply. These units are extremely compact, hermetically sealed, and magnetically shielded. The output is sinu-



soidal, amplitude variable, and phase reversible. Control is provided by a dual triode such as a 12AU7 operating at 400 cps or higher. The signal to the triode grids can be polarity reversible d-c or phase reversible 400 cycles. Response time is approximately 7.5 milliseconds.



QUARTZ CRYSTAL
has outstanding stability

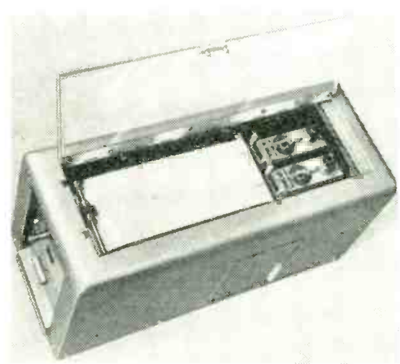
JAMES KNIGHTS CO., Sandwich, Ill., has developed a precision quartz crystal design which, according to tests, varied in frequency less than 1 part in 100,000,000 when measured continuously for 2 weeks. Considered in terms of the measurement of time, this corresponds to a rate of change of less than 1 second in more than 3 years. The G-12A Glasline crystal was developed to meet demands for better frequency control necessary to minimize the rapidly increasing congestion in the radio spectrum.

SIGNAL GENERATOR
is accurate to ± 2 percent

GRANCO PRODUCTS INC., 36-17 20th Ave., Long Island City 5, N. Y. Model SU-200 portable uhf signal-

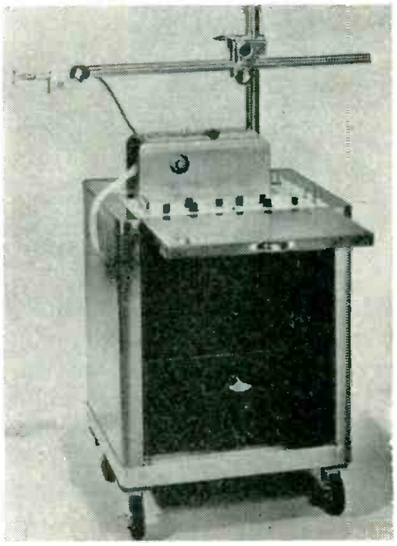
Want more information? Use post card on last page.

gain generator features coaxial tuning elements, continuous and precision tuning over the entire uhf band, calibration in both frequency and channel designations, and balanced detector meter circuit and gain control. Frequency range is 440 to 910 mc and to an accuracy of ± 2 percent, indicated by a single direct-reading scale. The instrument measures gain, tracking, calibration, accuracy and range of uhf tuners, converters, antennas, strips, boosters and receivers.



RECORDER
with nylon gear drives

EDIN CO., Worcester, Mass., has announced the model 8082, two-channel oscillograph recorder. Noise has been eliminated by the use of nylon gear drives. Recording shifts to any one of six speeds, from 2.5 to 100 mm per second, may be made easily, higher or lower, on this model, while the unit is operating and while it is turned off. A deposited-metal drive roll and positive nonslip paper adjustments permit the use of rolled or folded paper with equally high efficiency. The unit transcribes in ink, drawn through a non-clog ink system, on true circulinear coordinates.



TENSION ANALYZER
applicable to all textiles

BRUSH ELECTRONICS CO., 3405 Perkins Ave., Cleveland 14, Ohio, has announced a new tension analyzer for accurately measuring and recording instantaneous tension loads in filamentary materials. The complete unit is equally applicable to all textiles and to fine wire of reasonable flexibility. The tension analyzer will measure both static tension levels and dynamic tension variations while the material is running at high production speeds. In operation, the filamentary material, whose tension is to be measured, is placed over the three pulleys of the transducer. The tension in the material causes mechanical displacement of the center pulley. These displacements, both static and dynamic, are converted into electrical signals which are amplified and recorded on the direct writing oscillograph. Special hardware and fittings have been designed so that the transducer may be positioned on any plane at any level, from approximately 1 ft to 8 ft above the floor.

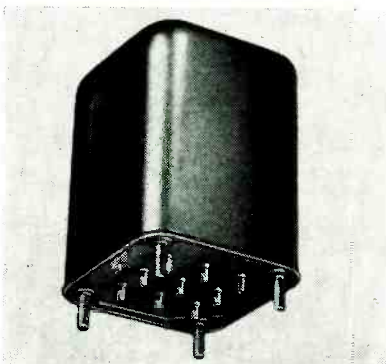
SERVO MOTOR
features high performance

INFRA ELECTRONIC CORP., 553 Eagle Rock Ave., Roseland, N. J., has announced a new servo motor de-

signed to give maximum flexibility for ready adaptation to many military and commercial applications. The type M-130 servo motor, built in the popular 1.062 o.d. size, features a hermetically sealed stator providing high operating stability, and a high torque-to-inertia ratio for rapid acceleration and deceleration service as encountered in servomechanism and computing applications. The unit is designed to be inoperative under single-phase conditions, and a sloping speed-torque characteristic provides viscous damping in control applications.

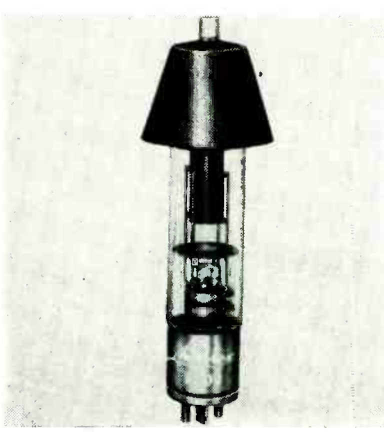
REFERENCE CAVITIES cover 6 frequencies

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass., announces a new line of high-precision reference cavities covering six different frequencies. The cavities are essentially fixed-frequency, vacuum-sealed, transmission-type tubes. They are used primarily as frequency determining references and frequency stabilizers in radar beacon applications. Temperature stability from 100 C is ± 0.3 mc; 0 C to −55 C is ± 1.0 mc. By cushioning the tube within the block, resonant frequency is held to ± 0.1 mc under vibration and shock up to 50 g.



OUTPUT TRANSFORMER
for ultralinear operation

Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill., has announced a high-fidelity output transformer, BO-13, designed for ultralinear operation. It features sealed-in-steel construction. Extremely compact, its drawn steel case measures only 3 11/16 in. × 3 5/16 in. × 4 11/16 in. high. It has pin-type terminals and is designed with studs for flush chassis mounting. Complete details, including performance curves, are given in bulletin No. 33.



RECTIFIER
for h-v and current operation

Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y., announces a new mercury vapor rectifier tube, to meet the demand for a comparatively inexpensive

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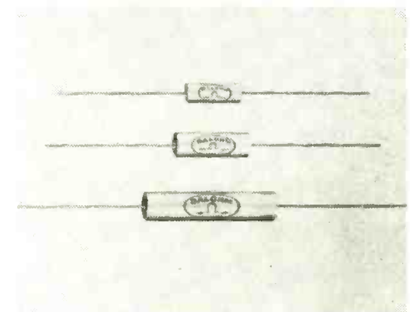
long-life rectifier for relatively h-v and current operation. Designated as type 6508, it meets the demand for many industrial and communications applications. Type 6508 is intended to be used instead of standard tubes which have not been used in many applications because of initial and replacement cost. This new rectifier has a peak inverse voltage rating of 21 kv and a voltage drop of 15 v. The cathode is directly heated, oxide coated.

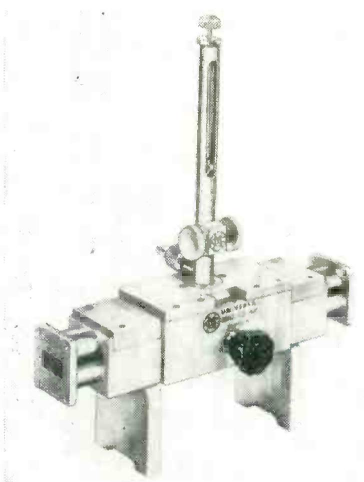


RESISTORS
in three wattage ranges

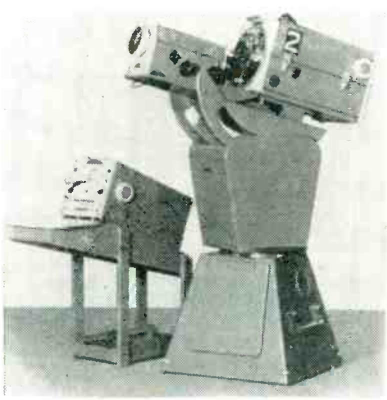
DALE PRODUCTS, INC., Columbus, Neb., announces the production of a new hermetically sealed, ruggedized, deposited carbon resistor for the ultimate in precision. Type HC Dalohm resistors are completely solder sealed in a newly developed envelope of nonhygroscopic ceramic, and are ruggedized for incorporation into snap-in component clips. They are production tested for resistance to thermal shock, salt-water immersion and humidity. The resistors are available in 3 wattage ranges ($\frac{1}{2}$, 1 and 2) and in resistance ranges to 200 megohms. Standard tolerance is 1 percent.

SLOTTED SECTIONS
are precision built

UNIVERSAL MICROWAVE CORP., 380 Hillside Ave., Hillside, N. J., offers a new series of precision slotted sections. The units are constructed of normalized aluminum precisely machined and fitted with watch-like precision. The carriage is of hardened and ground high quality tool steel. Its unique support and the elimination of backlash in the drive mechanism offers exacting measurement regardless of carriage posi-



tion. The slotted sections are available in 4 waveguide sizes ranging in frequency from 2.60 to 12.40 kmc. They are designed to accommodate a broadband probe which can readily be replaced with a special micrometer probe quickly to change the unit to a variable susceptance transformer.



TV CAMERA
for one-hand operation

General Precision Laboratory Inc., Pleasantville, N. Y. A new tv camera enables an operator on one-chain show to handle all camera work from the control room with one hand. Image orthicon camera is mounted on remote control pan-and-tilt pedestal, with a GPL-Watson vari-focal lens. This zoom lens, with a 5-to-1 ratio and total range of 3 to 30 in., is operated by two buttons on the pan-tilt handle of the remote controls box (left). The camera can be made to pan and tilt to follow action, zoom in for extreme closeups or out for full scene, or switched instantly to any of 6 preset positions by pushing but-

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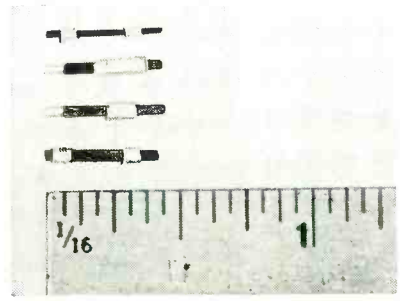
tons. Focus and iris adjustment are also handled at the one-hand operating center.

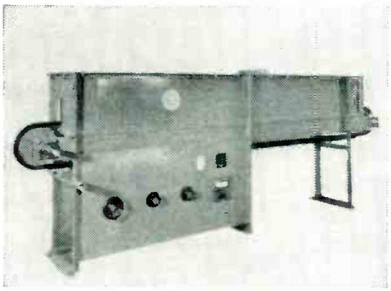


TINY CAPACITORS
made to close tolerances

ANCHOR RADIO CORP., 2215 S. St. Louis Ave., Chicago 23, Ill. The new Tekaps capacitors are most practical in values of 0.5 $\mu\mu$f to 10 $\mu\mu$f. They are extremely small and easily manufactured to close tolerances, 10 percent being standard. They have a zero temperature coefficient from —60 C to over 300 C; a dielectric constant of 2.0 at all operating frequencies; a power factor of 0.0005 at all operating frequencies and a moisture absorption factor of zero. Silver-plated terminals allow soldering directly into circuits but leads can be furnished if desired.

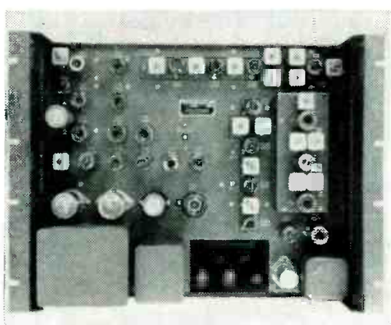
POWER SUPPLY
has large capacity

UNIVERSAL ELECTRONICS CO., 2012 South Sepulveda Blvd., Los Angeles, Calif. Model 3100A power supply is precision regulated to better than 0.1 percent for line variations from 105 to 125 v a-c or for zero to full load output current. Voltage range is 0 to 300 v d-c at 0 to 1 ampere. Output impedance is guaranteed to be less than 0.8 ohm from 2 cycles to 10 kc, but may be made either positive or negative by setting of load compensation potentiometer. Also furnished is a stabilized 0 to 150-v bias output and a 6.3 v a-c output at 8 amperes. Panel size is $8\frac{3}{4}$ in. $\times$ 19 in., rack mounting, or with steel cabinet.



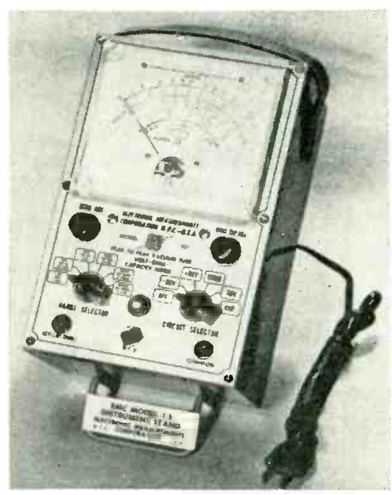
ANNEALING OVEN
for crt button stems

STEINER-IVES CO., 309 Springfield Rd., Union, N. J. To reduce heat strain in crt button stems an annealing oven has been developed that holds the stems in a vertical position during the heating process. The oven is of a conveyor type and has 3 heat zones, each of which can be controlled separately (or as a unit) to provide the proper heat curve. Speed of operation can be varied by means of variable rheostat controls and the electronic pyrometer-type controls hold the temperature variance to a minimum. Hourly production of annealed stems is about 300. The oven, designated K-1, reduces shrinkage, practically eliminates spoilage from nonuniform heating and improves the quality of the stem.



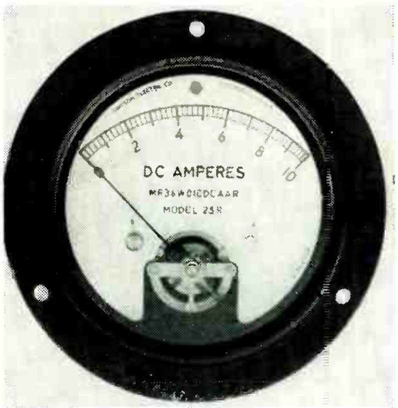
RECEIVER
for tv rebroadcasting

CLARKE INSTRUMENTS, Division of NEMS, Inc., 919 Jesup-Blair Drive, Silver Spring, Md. Model TR-1 has been designed specifically to meet the requirements for a high-quality receiver for use in direct pickup and rebroadcast of tv signals. The mechanical construction is the same as that normally used in tv transmitter input equipment. Bathtub construction provides maximum accessibility to all tubes and controls, the other components being readily accessible on terminal boards located on the rear of the chassis. Three outputs are provided—video, audio and sync. The video signal is available at the normal level and polarity provided by network interconnection. The response of the receiver extends to 4 mc, and it is adaptable to color reception without modification. The sound channel, separate from the video channel, features wide frequency range and low distortion. The third output provides a stripped-sync signal free of noise. Effective afc makes the receiver very stable, with oscillator drift held to a very low value. Complete specifications and prices are available.



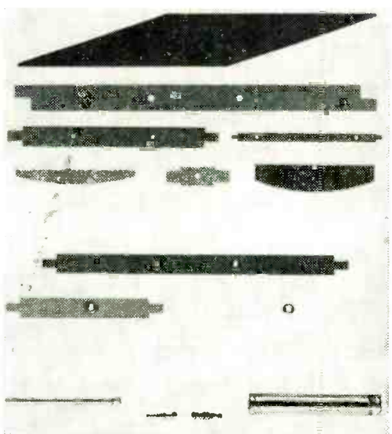
VTVM
measures complex waveforms

ELECTRONIC MEASUREMENTS CORP., 280 Lafayette St., New York, N. Y. Model 107 vtvm directly measures capacitance, resistance and complex waveforms peak-to-peak. It measures capacitance from 50 $\mu\mu$f to 5,000 μf, inductance from 1.4 henries to 140,000 henries in 4 ranges, in 6 ranges all peak-to-peak voltages of complex waveforms between 0.2 v and 2,800 v, rms values of sine wave voltages between 0.1 v and 1,000 v, resistance from 0.2 ohm to 1,000 megohms. The supplied d-c probe has a 1-megohm isolating resistor. The vtvm uses an electronically balanced push-pull circuit and peak-to-peak rectification, and 1 percent multipliers for voltage, capacitance and resistance measurements. Also incorporated is a zero center position for f-m discriminator alignment.



PANEL METERS
are sealed-ruggedized

SIMPSON ELECTRIC CO., 5200 W. Kinzie St., Chicago 44, Ill., has announced new sealed-ruggedized panel meters made with d-c ranges showing any practical scale from 300 μa to 800 ma. The meters are available in two sizes—2½ in. and 3½ in.



VACUUM COATINGS
of metallized glass

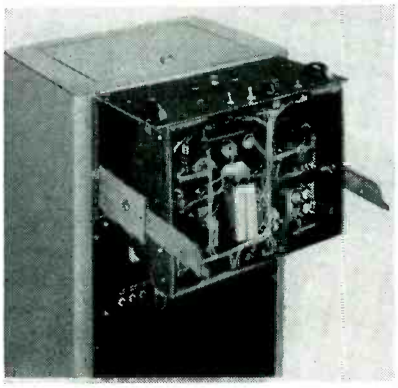
METAVAC INC., 45-68 162nd St., Flushing 58, N. Y. A variety of metals are applied by high vacuum evaporation to form precision resistance films. Evaporated metal films deposited on glass are extremely stable, controllable as to resistance and reproducible. Thickness of a few millionths of an inch make these elements ideally suited for microwave resistors even at the highest practical microwave frequencies. The company has been awarded Signal Corps approval on rectangular elements to MIL-A-11052A. Other rectangular as well as coaxial and disk elements are custom fabricated to customer requirements.

PULSE TRANSFORMER
is hermetically sealed

BERKSHIRE LABORATORIES, 506 Beaver Pond Road, Lincoln, Mass. Type PT-4 hermetically sealed pulse transformer is a versatile four-winding unit with 2:2:1:1 turns ratios. Measured characteristics includes 120 ohms characteristic impedance, 0.03-μsec rise time, 20-percent droop at 1 μsec, 40-percent droop at 2 μsec. As a pulse or trigger generator it may be used in many different blocking oscillator circuits. It may also be used for coupling and impedance matching. The core is of the wound type, using high quality magnetic material, uncut. The windings are brought out to 8 terminals provided with solder lugs. The transformer is designed and constructed to meet MIL-T-27 specifications.

CHASSIS SLIDES
are ultrathin

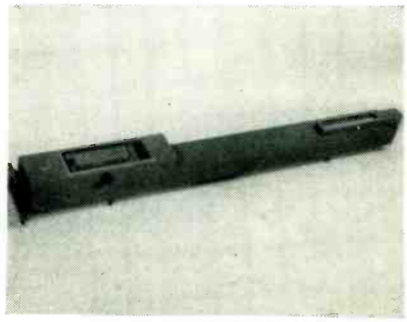
CHASSIS-TRAK CORP., 6252 E. Iona Road, Indianapolis 3, Ind., announces a new series of ultrathin (9/32 in.), heavy-duty chassis slides. Four stock sizes fit all standard electronic chassis, cabinets and



racks. They feature automatic out position locks (especially useful for sloping cabinets) and instant push-button return or chassis removal from cabinet for bench servicing or unit replacement. The slides support 175 lb in the full extended position and allow the chassis to be tilted back for servicing bottom components. They are permanently dry lubricated and meet JAN slide specifications. All attaching hardware, installation templates and instructions are included with each pair of slides.

RESISTOR
is epoxy-encapsulated

CINEMA ENGINEERING CO., Division of Aerovox, Inc., Burbank, Calif., has added an encapsulated resistor to its line. The wire-wound resistive element is precisely positioned in the epoxy body for consistent and accurate capacitance effect to chassis. The unit itself is mounted directly on the chassis with two 8-32 machine screws. Terminals are turret type. Resistance values are 0.1 ohm to 3 megohms. Type 38042 resistor measures 2 in. × 1 in. × 1¼ in. It offers complete closure from the elements, the terminals being the only exposed metal parts.

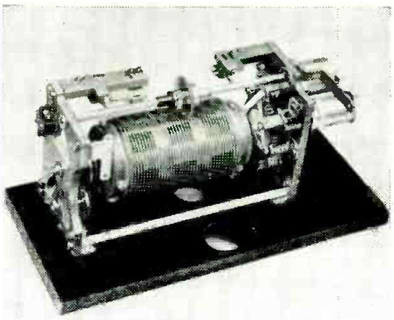


TERMINATIONS
for calorimetric wattmeter

Cubic Corp., San Diego, Calif., has extended its series of primary standard calorimetric wattmeter terminations to cover the spectrum from 100 to 26,500 mc. Model MC-1B, with associated adapters, covers the range from 2,600 to 26,500 mc; the MCX-1A, a coaxial type, covers from 100 mc to 3,000 mc, and the MCL-1A L-band termination, with adapters, covers from 1,120 to 2,600 mc. All models feature a very low residual vswr, primary standard accuracy, and direct-reading of average power up to 600 w, over a plurality of expanded scales. The wattmeter terminations are supplied with an associated liquid circulator which can be modified, on request, to permit metering of high average powers.

SELENIUM RECTIFIER
is constant-voltage type

Richardson-Allen Corp., 39-15 Main St., Flushing, N. Y., offers a rectifier rated at 28 v 30 amperes which is adjustable from 21.8 to 30.8 v. An electronically controlled saturable-core reactor is used to obtain fast recovery and close regulation. Recovery times is 0.2 sec and regulation of 0.2 percent with a fixed load and variable line of ± 10 percent or a fixed line and variable load of 3 to 30 amperes; for no load the regulation will be slightly higher. Output is filtered for a maximum of 0.5 of 1-percent ripple. The unit is designed to be operated from a line source of 115 v, single phase, 50-60 cycles. Ambient temperature range is from — 20 C to + 25 C.



TANK COILS
operate at 1,000 rpm

WHITE INDUSTRIES, 421 W. 54th St., New York, N. Y., is manufacturing high precision electronic tank coils. They contain about 225 miniature precision parts, some of which are manufactured to as low as 1/10,000 tolerance. These extremely flexible tuning units operate at approximately 1,000 rpm and have a built-in brake to prevent coasting. Low operating torque (3 in.-oz has been made possible by meticulous assembly of close tolerance parts.

CRT TESTER
is quick-action device

AUTHORIZED MANUFACTURERS SERVICE CO., 919 Wyckoff Ave., Brooklyn, N. Y., is producing a lightweight, portable crt tester. Model 101 is so designed as to provide a positive test indication within 90 seconds for continuity and emission. All phases of potential trouble and breakdown are clearly outlined on the front panel. No additional computations are necessary. Com-

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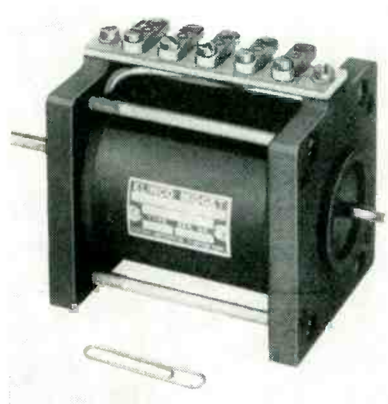
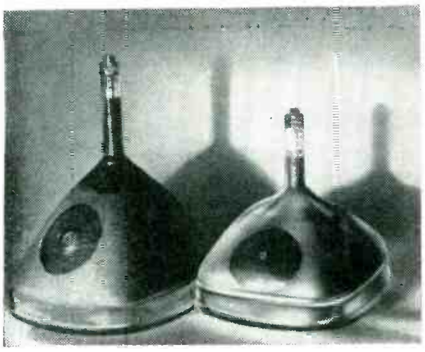
plete facilities are available for the testing of open connections, shorted elements, leakage, cathode emission and indication of gaseous tubes. Tests can be made with the crt in carton, tv set, cabinet or on the bench. Compactly engineered, the model 101 can be easily taken from shop to homes. It weighs only $5\frac{1}{2}$ lb and its overall size is 8 in. × 9 in. × 3 in.



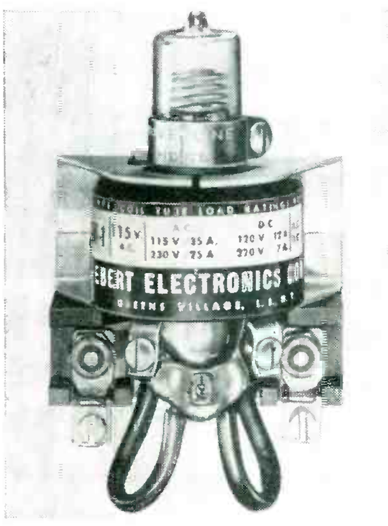
A-C MOTOR has low-inertia rotor

THE ELECTRIC INDICATOR CO., INC., Springdale, Conn. This precision-built two-phase two-pole induction servo motor with double-ended shaft has a low-inertia squirrel cage rotor designed to eliminate cogging at low speeds. The type DPJJD-764-38 provides a high torque-to-inertia ratio, low starting voltage, and linear torque-speed characteristics with maximum torque at stall. It can be wound with 2 or 4 poles. Characteristics at 60 cycles are: 5 w output, 5 in.-oz stalled torque, and control phase stalled impedance 5,000 ohms. Weight is 23 oz. The unit can be made to operate from a single phase source by splitting the phase with a capacitor. It is available for 400 cps operation, or can be designed to meet specifications.



PICTURE TUBE
is shorter and lighter

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., announces the 17-in. monochrome picture tube 17AVP4. It is 3⅜ in. shorter in overall length and approximately 4 lb lighter than present 17-in. tubes. The tube incorporates a new 90-deg deflection bulb with a 1-in. shorter neck length and achieves maximum compactness with conventional viewing area. It has electrostatic focus and magnetic deflection and is the ideal tube for modern, low cost, compact, tv designs.



MERCURY RELAY
is improved s-p type

EBERT ELECTRONICS CORP., 212-26 Jamaica Ave., Queens Village 28, N. Y., has available an improved mercury plunger relay. The mercury cup, which plays a most important part in the relay's mercury-to-mercury operation, is now made of

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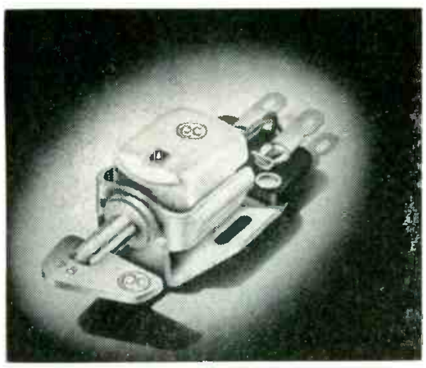
virtually indestructible alumina. The design of the Bakelite blocks has been changed for greater ease of installation. The special Burndy connectors may now be set in either of two directions for load line connection, depending on space and circuit considerations. Finally, the label has been completely redesigned to show all tube load ratings for inductive and noninductive loads at a glance. The relay is totally enclosed in an hermetically sealed glass tube, thus permitting safe operation in explosive atmospheres. The EM-1 (normally open) illustrated is rated at 35 amperes at 115 a-c and 25 amperes at 230 v a-c. The heavy duty model, HD-1, is rated at 60 amperes at 115 v a-c and 35 amperes at 230 v a-c. Horsepower ratings are 2 hp at 115 and 230 volts a-c and ½ hp at 120 and 220 volts d-c.

CALIBRATOR is triple-purpose unit

BALLANTINE LABORATORIES, INC., Boonton, N. J. Model 420 calibrator is a triple-purpose instrument combining highly stable d-c and a-c voltage sources and having an output range of 0 to 10 v for 3 selectable outputs: d-c, rms and peak-to-peak of a 1,000-cps sine wave. A decade control provides steps of 1,000 mv to which is added the setting of a 10-turn potentiometer. Dividing factors up to 1,000 are obtained with a 4-position push-button switch. This control combination has a setting resolution of 0.01 percent for outputs above 10 mv and of 1 μv below 10 mv. Long-term accuracy is 0.5 percent and short-term stability is better than 0.05 percent per hour, while distortion and hum on a-c are less than 0.5 percent. Internal impedances on a-c are very low thus minimizing loading errors.

SELF-CLEANING SWITCH
for testing equipment

INDUSTRIAL INSTRUMENTS, INC., 89 Commerce Road, Cedar Grove, N. J., has available a precision self-cleaning switch designed for use in test equipment. It is a 12-position, continuous rotation, detent-action type with phosphor bronze wiper contacts. Internal resistance of the unit is extremely low permitting its use in the most precise equipment.



TURNOVER PICKUP
has new stylus combination

PICKERING & CO., INC., Oceanside, L. I., N. Y. The model 260 turnover pickup cartridge is now available with a diamond stylus for long-playing recordings and a sapphire stylus for standard 78 recordings. The diamond stylus is of 0.001 in. radius for l-p records and the sapphire stylus is of 0,0027 in. radius for standard groove 78-rpm

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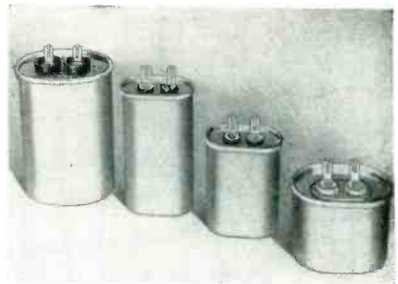
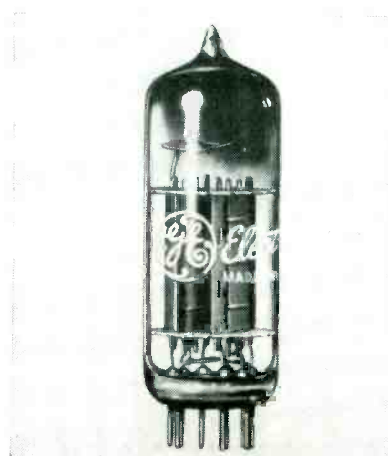
records. Except for the sapphire stylus, this unit is identical in all respects to the model 260 double diamond turnover pickup which features: lower overall distortion, higher compliance, lower moving mass, minimum tracking force and higher output.



A-C CAPACITORS
for space conservation

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., announces a new series of oval and flat-oval shaped capacitors designed for a-c applications where need for space-conservation is a factor. The four new styles, identified as KK, KA, KD and KV are all metal-cased paper dielectric capacitors. Each is smaller in size and lighter in weight than comparable rectangular shaped cases. Many newly developed features make them ideal for use in motor-starting and motor-running applications, fluorescent lighting, power-factor correction, and all general purpose a-c applications.



TWIN TRIODE TUBE
for digital computer use

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Type GL-6463 is a miniature twin triode tube whose higher perveance and plate current will allow the design of electronic computers faster than many in current use. It was developed primarily for amplifier or counter service in digital computers. Plate dissipation of 4 w per plate and 7 w total for the tube assures long and dependable operation. Average characteristics (each section) under conduction conditions are: plate voltage, 100 v; grid voltage, approximately 0 v (with grid current adjusted for approximately 200 μa); plate current, 29 ma. Under cutoff conditions plate voltage is 200 v; grid voltage, 11 v; and plate current, 1.0 ma. Average characteristics (each section) in amplifier service with 250 v on the plate and cathode bias resistor, 620 ohms: amplification factor, 20; plate resistance, approximately 3,850 ohms; transconductance, 5,200 μmhos; plate current, 14.5 ma.

CLASS-B IGNITRON for industrial control

NATIONAL ELECTRONICS, INC., Geneva, Ill. Type NL-1051 is a metal, water-cooled, mercury pool tube designed especially for welder control and similar a-c control application. Its rating is approximately equivalent to a 300-ampere magnetic contactor. It utilizes a thermostat mount brazed to an all-copper cooling system that provides exceptional cooling efficiency. The inner can, copper cooling coil and thermostat mount being brazed together in a single unit assure a rugged, dependable and adjustment-free temperature control system that operates directly on inner can tem-

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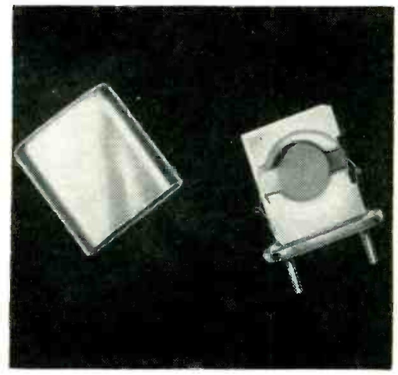
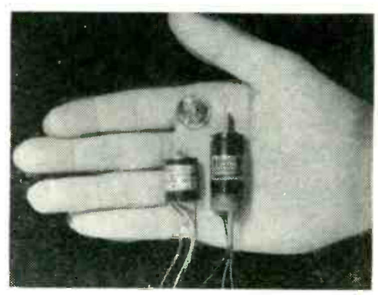
perature. Complete technical information is given in a recent data sheet.



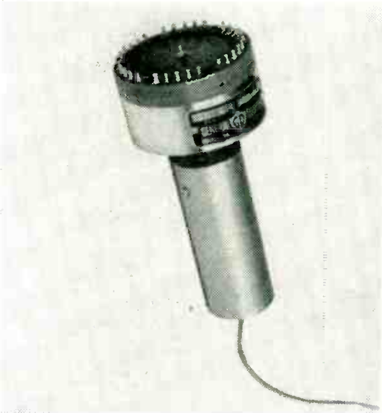
SHOCK-PROOF CRYSTAL
for low-frequency ranges

REEVES-HOFFMAN CORP., Cherry and North Sts., Carlisle, Pa., announces a 1-mc crystal unit in an HC-6 holder which assures the utmost stability in low frequency ranges. The crystal is firmly secured against shock in a nylon mount without hampering its oscillating quality. This radically different nylon mount allows the company to go down to 500 kc, AT cut, in an HC-6 holder. The 1-mc shockproof crystal is built to meet all the requirements for the following MIL types: CR18, 19, 27, 28, 35, 36 and 48/u.



SERVO SYSTEM PARTS
are truly miniaturized

KEARFOTT CO., INC., 1378 Main Ave., Clifton, N. J., has available a complete line of servo system components measuring only ¾ in. in diameter but providing performance equal to or better than similar units twice as large. They feature straight-through bore and integral stator-housing construction providing very high accuracy. Windings are hermetically sealed. The servo motor illustrated has the following performance characteristics: no load speed, 6,500 rpm; stall torque, 0.1 in. oz; power input per phase, 1.5 w; voltage input per phase, 18 v; and weight, 1.2 oz.



SAMPLING SWITCH
for multichannel use

GENERAL DEVICES, INC., P. O. Box 253, Princeton, N. J. The new 4000 series multichannel Roto-Speed switch unit involves unique wiper design and selected contact material. It is d-c motor driven at any standard voltage, has a compact planetary gear reduction unit and provides sampling at rates up to about 100,000 contacts per minute. It features sturdy soldering terminals and semimolded contact plates as well as individually machined contact pins to achieve the highest performance. It is small in physical size and may be obtained with up to 90 shorting contacts. The unit shown has 60 contacts with alternate contacts brought to the terminals. It is available with subminiature connectors in place of terminals. A similar drive unit in the 6000 series is available without motor drive.

Literature

Products Catalog. E. F. Johnson Co., Waseca, Minn., has issued a 20-page general electronic products catalog No. 975. It illustrates and describes a line of capacitors, inductors, sockets, insulators, plugs, jacks, knobs, dials, pilot lights and amateur equipment. Included are an alphabetical index and prices.

Rectangular Miniature Connector. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. New illustrated literature includes schematic drawings, electrical and mechanical specifications, contact availabilities and complete description of Continental connector series 20T. The reverse page of the bulletin shows special design receptacles specially fabricated by Continental for customers with unusual requirements.

Time Delay Relays. The A. W. Haydon Co., 230 N. Elm St., Waterbury, Conn., has released a revised bulletin on its line of miniature hermetically-sealed time delay relays for either a-c or d-c units. Time delay settings are available from 2 sec to 3 hr. Bulletin TD400 gives design features and mentions detail characteristics and factors which might determine type of timer to be used.

Resistor Engineering Guide. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Over 130 types of the resistors and special products manufactured by the company are listed in a revised 1954–1955 Official Resistor Engineering Guide. Data given for each type include JAN or MIL equivalent, rated wattage, standard tolerances, temperature rise at rated load per deg C, temperature coefficient, maximum operating temperature, ohmic valves available, dimensions and approximate prices.

Reclaiming Solvent. Ram Chemicals, 200 E. Olive St., Gardena, Calif. A descriptive data sheet deals with De-Solv 292 which permits the reclaiming and salvaging of electronic components from reject units encased with epoxy or polyester resins. The solvent discussed has been found suitable for use on parts based on nylon, Formvar and linen wrapped wires; all metallic components; ceramic capacitors and resistors; as well as miniature and subminiature electronic tubes. It is not harmful to phenolic base systems such as printed circuits.

D-C Power Supply. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif. Bulletin No. L453A illustrates and describes the model MR532–15 magnetic amplifier regulated power supply. Regulation of the unit described is ±1.0 percent from 5 to 32 v d-c. Special features and tabular technical data are included.

Microwave Gas Tubes. Roger White Electron Devices, Inc., Route 17 and Erie R.R., Ramsey, N. J. A 6-page folder, bulletin A-20, covers a line of backward wave oscillators, traveling-wave amplifiers and microwave gas control tubes. Included are information on the nature and purpose of microwave gas tubes, and descriptions of absorption attenuators, reactance modulators and switches, and phase shifters. Specifications are given.

Literature Index. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Bulletin 100-C lists all the current company literature. Numbers and titles of all catalogs, bulletins, specification sheets and instrumentation data sheets are included.

Custom Wire Leads. Manger Electric Co., Miller St., Stamford, Conn., announces publication of a catalog of its services. These include end stripping, center stripping, counterstripping, stripping of shielded wire and multiple conductors, coding, terminating, solder dipping, straightening, packing, shipping, wire supply and engineering.

Invoice Preparation. Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y. The complete preparation of an invoice from the pricing to the final printing is presented in "Application of the UNIVAC System to Invoicing." The 24-page brochure describes the electronic data processing system that replaces most of the manual and mental processes required from the maintenance of a master price list to the printing of an invoice. Flow charts, sample

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forms, and the equipment used in the UNIVAC invoicing application illustrate the test. Ask for brochure EL 180.

R-F Filters. Balco Research Laboratories, 49-53 Edison Place, Newark 2, N. J. The complete line of r-f filters—low-pass, high-pass, band-pass, band-rejection and complementary—is described with the characteristics of each in a new 4-page bulletin. Actual size photographs of units and typical response curves illustrate what can be done in extremely compact units to give maximum attenuation over the desired stop band with minimum insertion loss and vswr over the pass band.

Rotating Coil Deflection Yoke. Syntronic Instruments, Inc., 100 Industrial Road, Addison, Ill., has released a catalog page picturing and describing its new rotating coil deflection yokes with deflection angle up to 52 or 70 deg. Complete data include four advanced design features, three dimensional drawings and tables of electrical and mechanical characteristics with full explanations to assist design engineers. A table listing a wide variety of coil inductance combinations is also shown.

High-Voltage Connector. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y., has published 2 pages in color with schematics, mechanical and electrical ratings, photos and detailed description of the new series FHL Continental connector designed for h-v operation. It shows the equipment designer a miniature component that is excellent for these critical applications: voltage breakdown at sea level, 4,000 v rms; at 60,000 ft, 1,800 v rms.

Beryllium Copper Strip. American Silver Co., Inc., Industrial Division, 36-07 Prince St., Flushing 54, N. Y. A new 4-page bulletin covers the principal beryllium copper alloys. Basic information is provided for those who have never before worked with beryllium copper. Included here are the precision mill limits to which beryllium copper strip is produced by the company—thicknesses as low as 0.0005 in., and thickness tolerances as close as + 0.0001 in. Charts and graphs describe engineering properties and metal tempers supplied. One section discusses, in simple nontechnical terms, how to heat treat these alloys. Listed also are typical industrial applications of very close tolerance and thin gage beryllium copper strip.

Automatic Wave Analyzer. The Davies Laboratories Inc., 4705 Queensbury Road, Riverdale, Md. Completely automatic reduction of vibration, seismic, power-line transient noise, shock and similar data can now be made on the new heterodyne type automatic wave analyzer covered in bulletin 54-C. The analysis discussed is a Fourier analysis—amplitude versus frequency. The complete unit described consists of 6 basic units which are available individually as well as in an assembly—input switching panel, oscillator-controller, modulator-filter, recorder, power supplies and rack.

Temperature Test Chamber. Statham Development Corp., 12411 West Olympic Blvd., Los Angeles 64, Calif. A 4-page bulletin illustrates and describes the model TC-2 temperature test chamber that is completely portable and ideally suited to production line tests of small products such as basic instruments, electronic subassemblies and components. Specifications operating instructions and maintenance information are given. Also included is a replacement parts list.

Electronic Generators. Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N. J. A 16-page catalog covers a line of variable frequency and variable phase regulated electronic audio power generators. The company's products and services are illustrated and described. Specifications and prices are included.

Transformer Catalog. Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill. Catalog CT-554 lists the full line of the company's Sealed-in-Steel transformers. The 32-page book

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contains detailed descriptions of over 500 stock transformers for military, new equipment, general replacement and power and control circuit applications. A simplified classification system makes it easy to locate any particular unit and the dimensions of all cased units are shown diagrammatically. Almost 100 new transformers are listed, including many not previously available as stock units.

Thermocouple and Extension Wire. The Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill., has issued a new bulletin illustrating and describing its complete line of Serv-Rite thermocouple wire and thermocouple extension wire. Listed are the various sizes, metals, insulations and prices. Included also are general application data for the various type wires.

Wind Speed and Direction Recorder. Beckman & Whitley Inc., 913 San Carlos Ave., San Carlos, Calif. A new leaflet describes model 170-2 instrumentation for meteorological research—particularly microclimatology. The literature shows how the equipment serves these applications by combination of low threshold, rapid transient response, and self-contained portability. Linearity data are given in curve form, and the data sheet contains complete specifications on the wind-speed recorder, wind-direction recorder and the accessories. It also includes specifications of recording meters required. Ask for Form 170.

Vector Impedance Bridge. Republic Engineering Co., Inc., Beltsville, Md. A 4-page folder illustrates and describes the model 100-B vector impedance bridge for use in laboratory, field requirements, quality control and production testing. Chief features, a long list of applications, technical specifications and price are included.

Electrical Indicating Instruments. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A new 4-page technical brochure is devoted to the company's line of standard range electrical indicating instruments. The instruments illustrated and described are available in round, square and rectangular models, and are adaptable to most panel uses. Included are technical specifications, dimensional drawings and ordering information.

Variable Toroids. Burnell & Co., Inc., 45 Warburton Ave., Yonkers, N. Y., has published a technical bulletin on a new series of Rotoroids (variable toroidal inductors) that provide a continuous 3-to-1 maximum-to-minimum inductance range with 180-deg shaft rotation. The hermetically sealed units described employ a permeability tuning method and require no d-c saturating current. The choice of nominal inductance is virtually unlimited.

Induction Heating Equipment. Electric Arc, Inc., 152 Jelliff Ave., Newark 8, N. J. The newly developed Kilotron, a high-frequency (400 kc) induction heater, is the subject of an interesting 4-page brochure. Coverage is factual and includes discussion of the range of production line application of this relatively new and advanced technique. The description of the equipment covers both the 10 kw and 20 kw models of the Kilotron.

Sound Equipment. David Bogen Co. Inc., 29 Ninth Ave., New York 14, N. Y., has published a new catalog of p-a amplifiers, sound systems and sound accessories. A new addition is a section, "Hints for Selecting the Proper Sound System", which discusses the more important factors involved in determining what equipment to use. Ask for catalog PA554.

Modular Electronic Unit. The Epsilon Co., 48 Circuit Ave., Newton Highlands 61, Mass. A single-page bulletin introduces the Concentri-Tube for electronic packaging. It illustrates a single-tube plug-in unit for 7 or 9-pin miniatures. Mechanical, thermal and electrical features are outlined. By panel mounting of the Concentri-Tube units discussed, chassisless construction becomes feasible in many applications—particularly those in which a panel would normally serve primarily as a

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structural member only. Multiple-tube units having similar features to those described are available to order.

VHF Signal Generators. Hewlett-Packard Co., 3099D Page Mill Road, Palo Alto, Calif., has available a 4-page folder illustrating and describing models 608D and 608C vhf signal generators. Outstanding features, complete technical specifications and prices are given for both instruments.

Receiving Tube. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A recent mailing piece illustrates and describes the improved 6BQ6GTA receiving tube that features wafer stem construction, no waste envelope space, high temperature top can solder, one-piece beam confining plate, and a plate designed with folded edges that prevent bulb bombardment. The tubes discussed give top performance in tv circuits.

Bridges, Slidewires and Ratio Sets. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Complete information about Wheatstone and Kelvin bridges, slidewires and ratio sets for d-c resistance and conductance measurements is now available in a series of data sheets, group E-53, recently published in booklet form. The group of data sheets fully describes the use of these instruments for research, testing and teaching in laboratories, plants and schools. They list all pertinent data, and show adequate photographs and circuit diagrams illustrating design and operating features. Complete specifications for each instrument as well as for recommended accessories make the selection of equipment easy. How-to-order instructions and a listing of replacement parts complete the sheets.

Solder Reference Text. Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill. An 80-page treatise, entitled "Solder—its fundamentals and usage," is intended to rectify the basic literature inadequacies on solder and to provide the solder user with a thoroughly scientific study of the industrial application and usage. Charts, tables and photographs are included.

Metal Powders. Plastic Metals Division, The National Radiator Co., Johnstown, Pa. Bulletin No. 1 provides a brief introduction to the art of powder metallurgy. It also describes the general types of metal powder offered by the company and stresses the large number of grades required for different applications. Also included are references to some of the other major uses for metal powders such as in cutting tools, chemical applications, flame-cutting, welding rods, pyrotechnics and the fabrication of special electronic and magnetic parts.

Crossover Networks. The R. T. Bozak Co., Stamford, Conn., has released a data sheet on crossover networks for their B-302, B-305 and B-310 speaker systems. The networks described have a slow crossover rate of 6 db per octave, which is permitted by the fact that the Bozak B-199A woofer, B-209 midrange, and B-200X dual tweeter are all direct-radiating units with equal velocities of sound propagation.

Boron-Carbon Resistor. Shallcross Mfg. Co., Collingdale Pa. Engineering bulletin L-33 gives charts, tables and dimensions on all performance characteristics of Borohm boron-carbon resistors. In preparing the bulletin, samples were chosen at random from production runs of ½, 1 and 2-watt Borohm types designed to MIL-R-10509A styles RN20R, RN25R and RN30R. The resistors described were subjected to standard temperature cycling, load life, short-time overload, moisture resistance, vibration, low temperature exposure and temperature coefficient tests as prescribed by MIL-R-10509A. Average electrical performance data for each resistor style was then computed. The results of these tests are compared side by side with MIL requirements in the new bulletin.

Laminates for Printed Circuits. The Richardson Co., 2661 Lake St., Melrose Park, Ill. A new, 4-page bulletin gives information on grades T-725 and T-812 copper clad Insurok laminates for use in printed circuits. The two electrical grades described are high quality, paper-base phenolic laminates which are bonded to copper foil of 0.0014 in. and 0.0028 in. thicknesses. The bulletin devotes one page to important design considerations in the production of printed circuits and gives complete specifications on the two laminates: characteristic properties, punching information, and sheet size and thicknesses.

Vibration and Shock Control. Robinson Aviation, Inc., Teterboro, N. J. Advanced developments in vibration and shock control mounting systems are now being released in semimonthly bulletins. These technical bulletins entitled "Vibration and Shock Control Trends" are in the form of 2-page news sheets containing illustrations and detailed information about latest models of mountings and equipment installations. Performance, construction, load ranges dimensions and other engineering data are included in each bulletin. Specific mountings described cover airborne, shipboard, mobile, industrial and packaging applications.

Conelrad Alarm. Trinity Industries, P. O. Box 71, Redwood City, Calif. A single-page bulletin illustrates and describes the Wiens Conelrad alarm, a concise, long life unit which attaches readily to any radio receiver for immediate operation. The unit discussed will give a visual indication whenever the radio station goes through the required FCC radio alert procedure. In addition to the visual indication, the audio volume of the station, in case of loudspeaker muting will automatically come up to full audio output and the radio tone signal will serve as a second alarm indication. Technical data and price are given.

Miniature Electrical Resolver. Ford Instrument Co., Division of The Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N. Y. A 2-page bulletin illustrates and completely describes a new size 15 Telesyn resolver. Of miniature size and light weight (5 oz), the resolver described continuously performs trigonometric operations involving resolution of input voltages in sine and cosine components. It has many computer, controls system and data transmission applications. Full data on the different models available, specifications, dimensions and information on operation and construction are provided in the bulletin.

Stainless Steel Fastenings. Star Stainless Screw Co., 195 Union Ave., Paterson 2, N. J., has released a complete list of government specifications for stainless steel fastenings. Included are the latest specifications applying to U. S. Military, U. S. Army-Navy Aeronautical, U.S. Navy, U.S. Army, and Federal production. Star is in a position to supply all specified fastenings for immediate delivery.

Magnetic Computer Tape. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. "Sound Talk" bulletin No. 28 covers recent progress in the production of error-free magnetic computer tape. The 4-page illustrated bulletin discusses the physical causes of signal dropouts in modern digital computers designed to use magnetic tape as a long period storage medium. In addition, it covers the reasons why errors arise from such defects, steps taken to eliminate errors, and a summary of progress made during 1953.

Magnetic Amplifier Systems. Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J. A 4-page folder describes a line of magnetic amplifier systems that are varied and versatile in design and performance. It lists a few of the many uses for magnetic amplifiers and outlines other applications for units of similar design. The company's engineering service is discussed.

Electronic Voltmeter. The Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. Wider range and higher stability of the new 4-mc voltmeter are described in Vol. 5 No. 9 of the *Journal*. Included are illustrations, chief features and technical specifications of the model 400D vtvm.

Precision Interval Timers. Potter Instrument Co., Inc., 115 Cutter Mill Road, Great Neck, N. Y. Data sheet No. 400 describes techniques and equipment for measuring time intervals from a fraction of a μsec to 1 sec (or longer if desired) with accuracies as high as $\pm\frac{1}{8}$ μsec by electronically counting the exact number of pulses produced by a highly-stable crystal-controlled h-f oscillator during unknown interval. Illustrations, specifications and optional features are given for 5 types of counter chronographs. Information on photoelectric screens is included.

Compression Connectors. Burndy Engineering Co., Inc., Norwalk, Conn. To facilitate selection and identification of Hydent connectors, convenient, multicolored wall charts ($23\frac{1}{2}$ in. $\times$ 35 in.) are available listing the company's insulated and uninsulated compression terminal and link sizes up to 2/0. Each connector is listed with the conductors accommodated, tooling required for installation, and, for terminals, the screw sizes accommodated. There are three charts in the series.

Loudspeakers. Jensen Mfg. Co., 6601 South Laramie Ave., Chicago 38, Ill., has issued a new catalog, No. 1040, and two new data sheets, No. 164 and 165. The catalog covers the company's line of general purpose and commercial sound loudspeakers, as well as accessory cabinets, volume controls and transformers. Data sheet No. 164 introduces the Weather Master drive-in theater speaker line and No. 165 lists the latest of the company's high-fidelity equipment.

Epoxy Resins. Bakelite Co., a Division of Union Carbide and Carbon Corp., 260 Madison Ave., New York 16, N. Y. Three new technical bulletins on type C-8 epoxy resins have been issued. The resins described, with the proper hardeners, can be used in tooling, casting, laminating, potting, encapsulating, embedding and adhesive applications. Specific data

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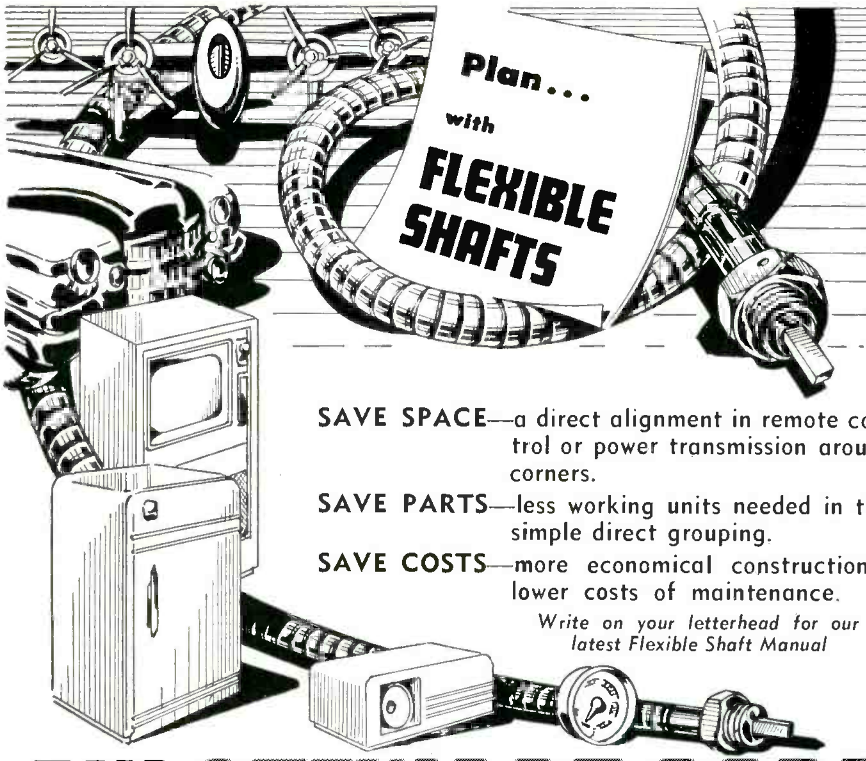
are given on the physical properties of individual resins and hardeners, together with the physical, chemical and electrical properties of recommended resin-hardener combinations. Included in each bulletin is a list of experienced compounders who are equipped to render technical assistance and to supply specially formulated compounds for particular end uses.

Air Data Computer. Servomechanisms Inc., 500 Franklin Ave., Garden City, Long Island, N. Y., has compiled an 8-page technical brochure on its master air data computer. The publication points out that the computer provides a single coordinated source of information, eliminating much duplication. Schematic diagrams show how the plug-in type computer permits calculation of complex function with a minimum of equipment.

X-Band Catalog. Transline Associates, A Division of EDDCO, 57 State St., Newark, N. J. Catalog X-3 is a 4-page folder dealing with a line of X-band waveguide components and test equipment. Included are illustrations, application and design information on variable flap attenuators, waveguide terminations, fixed waveguide attenuators, slide-screw tuners and waveguide T-junctions. Ordering information, sales conditions and warranty data are given.

Germanium Diodes. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. The 4-page bulletin, GD-1A, lists ratings and specifications on the company's germanium diodes. Included is a complete replacement guide of IRC germanium diodes for replacing RETMA type diodes, and ratings and characteristics for new Red Dot germanium diodes for 100 C applications.

Wire-Stripping Solutions. Fidelity Chemical Products Corp., 470 Frelinghuysen Ave., Newark, N. J. Various types of X-Var wire-stripping solutions are discussed in a 2-color, detailed sheet. Strippers for formex, formvar, enamel, nylon and nylclad wire are described. The types of X-Var stripping solutions are described as to applications, corrosion resistance, con-



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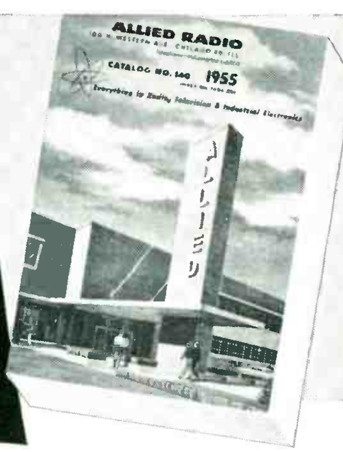

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sistency, safety precautions and illustrated instructions for each. The stripping solutions mentioned are used by electronic firms and government agencies to remove organic finishes from wire.

Audio Products. The Astatic Corp., Conneaut, Ohio, now has available a new, complete products catalog. Included among other stock items of the company's manufacture are phonograph pickups and needles, recording heads, microphone stands, tv receiver uhf converters and boosters. The new catalog stresses brevity of general descriptions and completeness of specifications, performance and replacement data. It is in simple form for easy reference.

Wires, Cables and Components. Birnbach Radio Co. Inc., 145 Hudson St., New York 13, N. Y., has released a 44-page catalog of electronic wires, cables and components. It lists practically every type of wire and cable now in use for microphone, intercom, broadcast and other electronic uses, with detailed technical information on each type. The section on plugs, jacks and connectors contains schematic diagrams and full descriptions for every item. The back cover is devoted to complete charts of commonly used engineering data.

High-Voltage Regulator Tube. CBS-Hytron, a Division of Columbia Broadcasting System, Inc., Danvers, Mass. Bulletin E-226A covers the 6BD4A h-v regulator tube designed for anode and convergence supplies of color tv receivers. The tube illustrated and described in the bulletin has a large bulb that provides long leakage paths and prevents corona effects. Included are mechanical and electrical data, maximum ratings and characteristics charts.

Picture Tube Chart. Reon Tube Corp., 58-15 57th Drive, Maspeth, L. I., N. Y., has published a new tv picture tube replacement guide chart. It includes a list of all type tv picture tubes, their descriptions, Reon replacements and direct substitutions. It also lists characteristics and changes for the substitutes. Printed in 2

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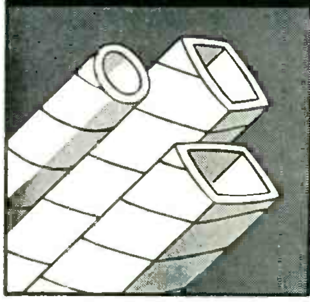

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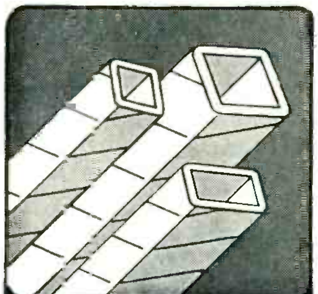

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colors, the 4-page chart was planned to have all pertinent data available at a glance. The chart also shows a cross section of a picture-tube gun illustrating its complete structure. Another page consists of a Reon tube base chart, which is also fully illustrated.

Repeat Cycle Timers. The A. W. Haydon Co., 230 N. Elm St., Waterbury, Conn. Bulletin RC200 contains complete information on a new line of miniature hermetically-sealed repeat cycle timers. It describes cycling time, timing accuracy detail characteristics and determination of timing tolerances. Illustrations and design features are included.

Automation. T.A.B. Engineers, Inc., Milwaukee and Ogden Aves., Chicago 22, Ill. A pamphlet entitled "Cut Costs with Automation" is an evaluation chart that will help top executives rate the automation possibilities and potentials of their own plants. It gives a complete analysis of products, production, costs and future markets. The brochure reviews the meaning of automation, its history and its future.

Magnetic Laminations. Magnetics Inc., Butler, Pa. Catalog ML-101 illustrates and describes a line of magnetic laminations that are performance guaranteed. An index and individual specification sheets list both the window area and the cross-section area for a square cross-section of laminations. Tolerances for the various types are also listed. Ordering information is included.

Iron Powder. Plastic Metals Div., The National Radiator Co., Johnstown, Pa. Iron powder data sheets No. PMS-12-A-R2 and B-R2 give the composition and characteristics of electronic iron core materials as submitted to the Metal Powder Association. Electronic engineers will find helpful information in the data sheets such as particle size, apparent density, frequency range, relative permeability and Q value, and itemized electronic uses for various iron powders.

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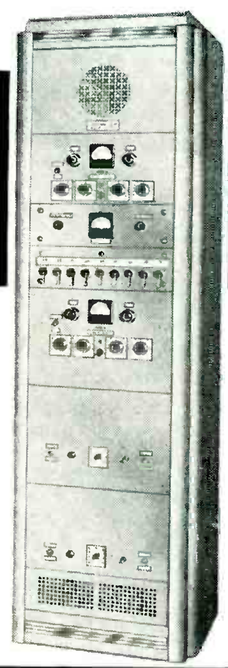

Our P-6924 Rack as used by Gai-Tronics, Inc., Reading, Pa.

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Made by Electronic Specialists!

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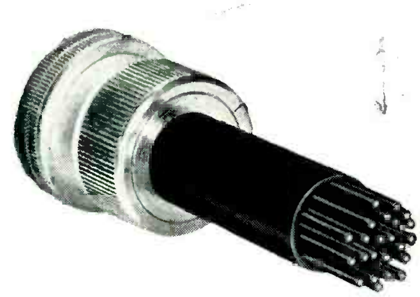
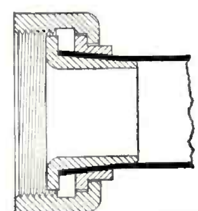
A NEW IDEA IN *Flexible Plastic* TUBING CLAMPS





for use with AN TYPE CONNECTORS

This unique tubing clamp provides an inexpensive method to protect open wiring used in connection with a standard AN TYPE CONNECTOR.

It is an *easy* and *quick* way to attach flexible plastic tubing to a connector—*without the use of hand tools*. When used in conjunction with a gasketed adapter, a waterproof joint is provided between connector and tubing.

Material—aluminum. Sizes to accommodate tubing from ¼-in. I.D. to 2-in. I.D. AN plug sizes 12S to 48.

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726 STANTON STREET
TOLEDO 4, OHIO

PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

Electronic manufacturers announce plant expansions . . . Industry associations elect officers . . . Engineers and executives take on new jobs . . .

OTHER DEPARTMENTS
featured in this issue:

Lockheed Plans $10 Million Missile Research Lab

LOCKHEED AIRCRAFT has appropriated a fund of $10 million to finance establishment of a new scientific laboratory for advanced research by its missile systems division in Van Nuys, Calif.

Tentative organization of departments in the missile systems division is as follows: Theoretical Physics and Chemistry, Electronics and Telemetering, Computers and Controls and Radar and Systems.

The lab's aim will be to explore new scientific fields for new weapons. The end objective of their research will be reliable, producible missile systems.

Research in the nuclear field will also receive heavy emphasis in the new laboratories.

Products of Lockheed's scientific research will be determined only after exploration of many "promising recent developments which must now remain secret," according to E. R. Quesada, vice-president of the company.

Heading the research laboratory will be E. H. Krause, nuclear physicist, who resigned as associate director of research at the Naval Research Laboratory in Washington to join Lockheed.

Dr. Krause directed the nuclear weapons research program conducted jointly by the Los Alamos Scientific Laboratory in New Mexico and the Naval Research Laboratory in Washington, D. C. He was in charge of scientific experimentation, including complex instrumentation, on the atomic test program conducted at Eniwetok during

E. H. Krause

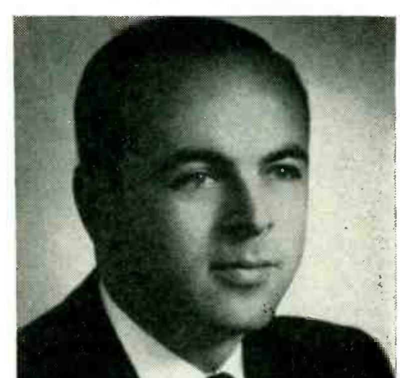
Operations Sandstone, Greenhouse and Ivy.

Krause will be joined in the research laboratory by Montgomery H. Johnson, named associate director. Dr. Johnson has worked on atomic and nuclear physics, quantum theory, electro-dynamics, absorbent materials, atmospheric physics and ionosphere research. Formerly at the University of California Livermore Laboratory, he has served on the Radiation Laboratory staff of the University of California since 1952, working on nuclear weapons research. He also served on the MIT Radiation Laboratory staff during the war and later at Naval Research Lab.

Another scientist joining Krause is Eric Durand, who came to Van Nuys from Chicago Midway Laboratories, where he was associate director. Dr. Durand is a specialist in solid state physics, radiation, infra-red navigational systems, test range instruments, rockets, bombing aids and ordnance devices.

The staff will include Edward J. Zadina, who resigned as technical adviser and operations analyst with the U. S. Air Force Special Weapons Center, and Henry R. Senf, who before joining Lockheed was acting director of development of CAA's Air Navigation Development Board.

The Missile Systems Division was established late in 1953. It now has 700 employees. Personnel is expected to increase to 1,000 by year-end.



Parts Manufacturers Elect Rossman

THEODORE ROSSMAN of Pentron Corp. in Chicago was elected chairman of the Association of Electronic Parts & Equipment Manufacturers.

Wilfred L. Larson of Switchcraft, in Chicago, was named vice-chairman, and Helen Staniland

RCA

TECHNICAL NEWS FOR DESIGNERS

FROM THE RCA TUBE DIVISION

TRANSMITTER TYPES—SPECIALLY "TAILORED" FOR MOBILE DESIGNS

For the 450-470 Mc Mobile Band
RCA-6524

RCA-6524 is a new twin-beam power tube well-suited for fixed and mobile UHF design—as a balanced push-pull rf power amplifier or frequency tripler. The tube can deliver 20 watts (approx.) in class C cw and fm services—at 462 Mc! Max. plate dissipation is 25 watts (ICAS). A common cathode for the two units reduces cathode inductance to a negligible value.

Max. length, 3-9/16"
Max. diameter, 1-13/16"

For the 152-174 Mc Mobile Band
RCA-5763

No bigger than your thumb, RCA-5763 fills your need for a compact "miniature" beam power tube capable of taking 13.6 watts input at 175 Mc—in mobile, portable, or fixed services. Useful as a frequency multiplier, oscillator or rf power amplifier. Max. plate voltage as multiplier 300v. Heater voltage, 6.3v. (For 12.6v. heater circuits specify RCA-6417, identical in all but heater characteristics to the 5763.)

Max. length, 2-5/8"
Max. diameter, 7/8"

For the 152-174 Mc Mobile Band
RCA-2E26

RCA-2E26 is a beam power tube well-suited as an rf or af amplifier, frequency multiplier, or oscillator. Max. plate voltage for class C service is 600v. As a class C plate-modulated amplifier, the tube takes 27 watts (ICAS). As a class AB_2 amplifier/modulator, two RCA-2E26's will deliver 54 watts (ICAS) of audio power at a dc plate voltage of only 500v. Heater voltage, 6.3v.

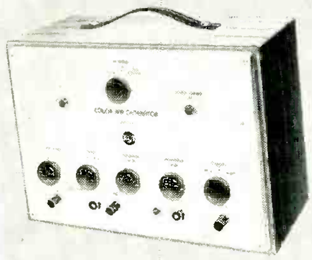
Max. length, 3-21/32"
Max. diameter, 1-5/16"

For the 152-174 Mc Mobile Band
RCA-6146

RCA-6146 is a versatile beam power tube capable of handling 60 watts (ICAS) at 175 Mc at a plate voltage of 400v. Will handle 90 watts input (ICAS) at frequencies up to 60 Mc at plate voltage of 750v. Heater voltage, 6.3v. (For 26.5v. heater circuits, specify RCA-6159, identical in all but heater characteristics to the 6146.)

Max. length, 3-13/16"
Max. diameter, 1-23/32"

For Color-TV—New RCA Color-Bar Generator



RCA WR-61A Color-Bar Generator is designed for testing color-TV receivers and monitors. FOUR crystals—more than any other make—provide the high accuracy necessary for color TV. Generates signals for producing 10 bars of different colors simultaneously (without manual switching) including bars corresponding to R-Y, B-Y, G-Y, I, and Q signals for adjusting phase and matrix circuits in all makes of color receivers... Luminance signals at bar edges for checking color "fit" or registration. Adjustable sub-carrier amplitude for checking color sync action.

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New Fourth Edition of the Radiotron Designer's Handbook puts technical facts right at your fingertips. Only $7 per copy. Write Commercial Engineering for further information.

For COMPLETE TECHNICAL DATA, write RCA Commercial Engineering, Section J-19-R, Harrison, N. J.

ELECTRON TUBES • SEMICONDUCTOR DEVICES • BATTERIES • TEST EQUIPMENT • ELECTRONIC COMPONENTS

RADIO CORPORATION of AMERICA

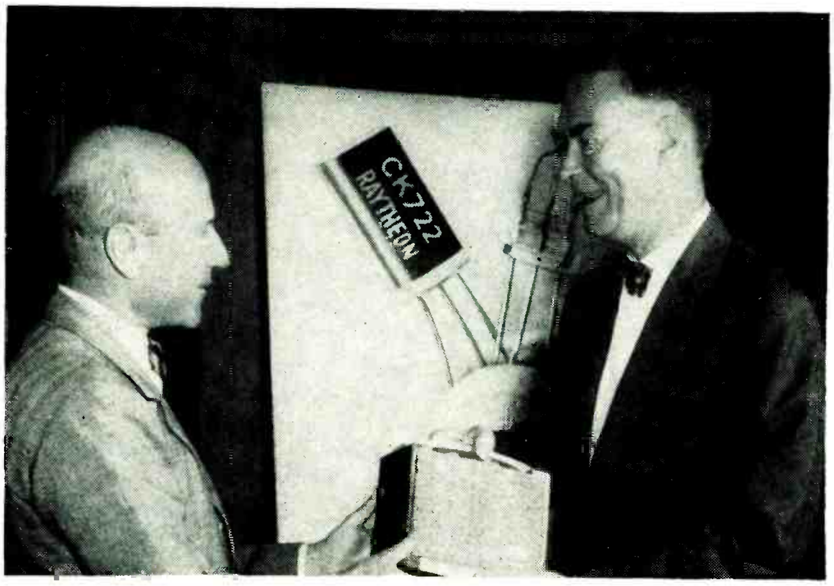
TUBE DIVISION HARRISON, N. J.

Quam of Quam-Nichols Co. in Chicago was reelected treasurer for her eighteenth term. Kenneth C. Prince of the law firm of Prince & Schoenberg was renamed executive secretary.

EP&EM is a trade group consisting of 118 electronic firms in the midwest.

Rossman, who had been vice-chairman of the group, succeeds Karl W. Jensen of Jensen Industries as chairman. Both Rossman and Jensen represent the organization on the board of the Radio Parts of Electronic Equipment Shows which sponsors the annual Electronic Parts Show.

Raytheon Produces Transistor Portable



MASSACHUSETTS GOVERNOR Christian A. Herter, right, received from Charles F. Adams, Jr., president of Raytheon, an all-transistor portable radio using seven transistors. It is an experimental handmade model containing no tubes. It is able to operate from four standard flashlight batteries for several times as long as a standard portable operates from its A and B batteries. Raytheon recently made its millionth transistor. It is estimated that commercial transistor portables may be on the market next year.

Ketay Joins In Forming Nuclear Firm

KETAY MANUFACTURING CORP. and American Metal Co. with Lehman Brothers, investment bankers, participated in forming a new company, Nuclear Science and Engineering Corp. Gordon Dean, former chairman of the Atomic Energy Commission, is board chairman of the new firm. The company intends to provide a variety of technical services to firms engaged in nuclear power development and to industries interested in the application of radioactivity to industrial products and processes. It will supplement firms engaged in nuclear reactor design and engineering, and those which manufacture radiation detection gear.

American Metal and Ketay Manufacturing have subscribed to a substantial portion of the capital stock of Nuclear Sc.

Headquarters of the new company have been established in Pittsburgh. It is headed by Ronald A. Brightsen, president. He was previously associated with the atomic power division of Westinghouse, as were the company's vice-president and technical director, Ralph L. Ely, and the company's secretary-treasurer, Richard S. Frankel.

IT&T Forms New Divisions, Names Officials

A new domestic research and manufacturing division, the Farnsworth Electronics Company, has been formed by IT&T.

Farnsworth Electronics will take over and expand the research and production activities in the field of industrial and defense electronics, formerly carried on by IT&T's Capehart-Farnsworth division. The creation of the new division will establish within the IT&T system another source of supply in the fields of advanced electronics and the application of atomic energy to industry.

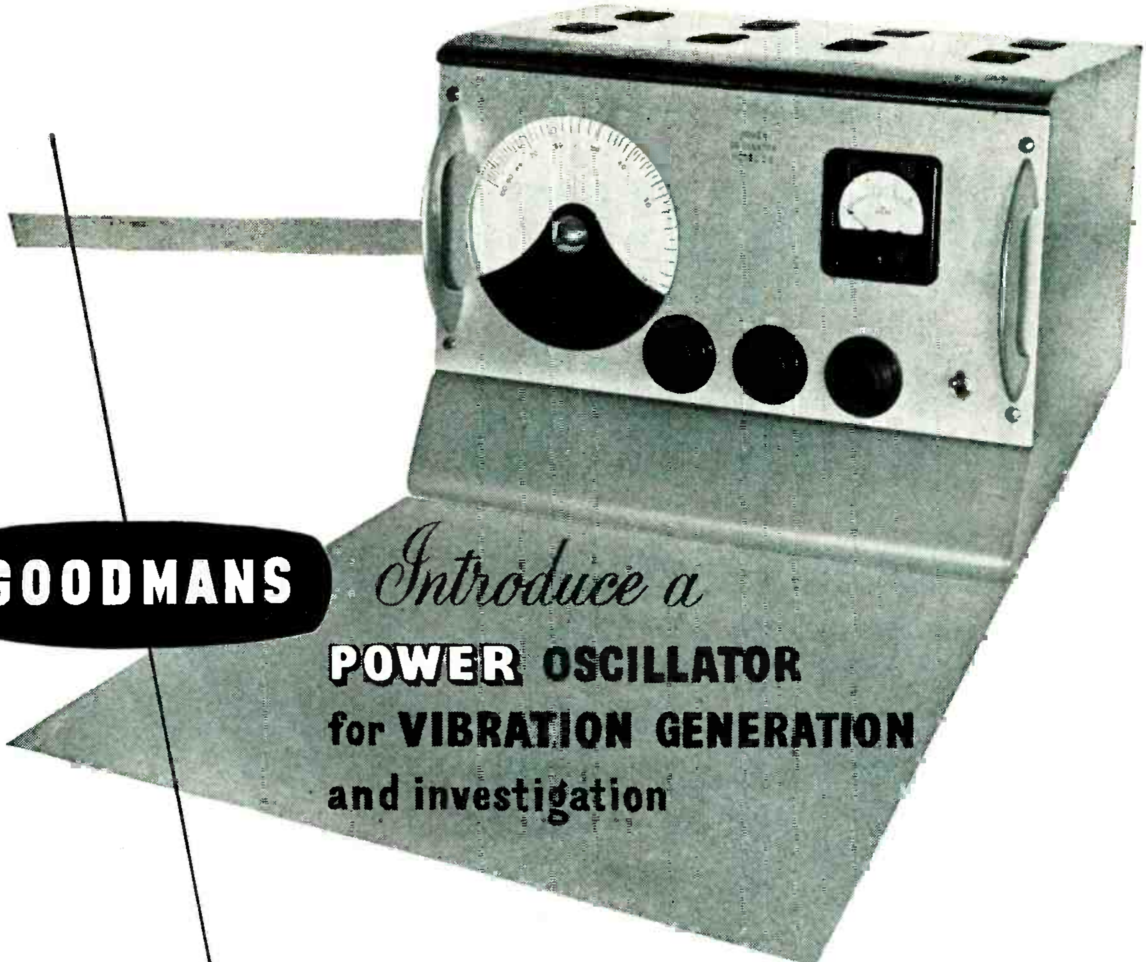
Former Capehart-Farnsworth officials staff the new electronic company. Harvard L. Hull, who was general manager of research and development, becomes president. Dr. Hull, who joined Capehart-Farnsworth last year, has been active in atomic research from 1943 and served as director of remote control engineering at Argonne National Laboratory. Philo T. Farnsworth will act in the capacity of vice-president and technical director for the new company and W. F. Hoeppner, who was assistant to the president of Capehart, has been appointed vice-president.

Capehart-Farnsworth Company will concentrate on the design, manufacturing and distribution of its television and radio receivers, high-fidelity phonographs and phonograph combinations and allied lines. A new president has been appointed, Lawrence G. Haggerty, who joined the company in 1950 and has been vice-president in charge of the technical products division since 1953.

Two new vice-presidents have also been named for the company—general sales manager E. W. Gaughan and comptroller Paul H. Hartman.

Fred D. Wilson, who headed Capehart-Farnsworth Company for five years, has been elected IT&T vice-president in charge of industrial relations.

IT&T's Federal Telephone and Radio Co. has also formed a new division, an instrument division for the manufacture and distribution



GOODMANS *Introduce a* POWER OSCILLATOR for VIBRATION GENERATION and investigation

—provides a stabilized 10-10,000 c/s supply

A vibration generator depends for its accuracy largely upon the suitability of its driving equipment. Goodmans have now produced a self-contained drive unit consisting of oscillator, amplifier and power pack. Although primarily intended for use with Goodmans Model V.47 shaker, it will also find wide application in the laboratory and in industrial processes where a high quality source of audio frequency is required. A brief specification of this latest Goodmans product is given below, and full circuitry details are available on request to "Vibration Dept. W".

FOR USE WITH THE GOODMANS SHAKER

MODEL V.47
or where small scale vibration testing is involved.

Brief Specification

Frequency range—10-10,000 c/s. in 3 ranges.
Power output—5 watts into 3 ohms,
Output Level Stability—±0.05 db 10-10,000 c/s.
Distortion—less than 0.2%.
Hum level—72 db down on 5 watts
Power supply—100/115 v, 200/225 v, 225/250 v, 50-60 c/s. 75 watts.
Weight—45 lb.
Dimensions—16½ in. x 13 in. x 11 in.

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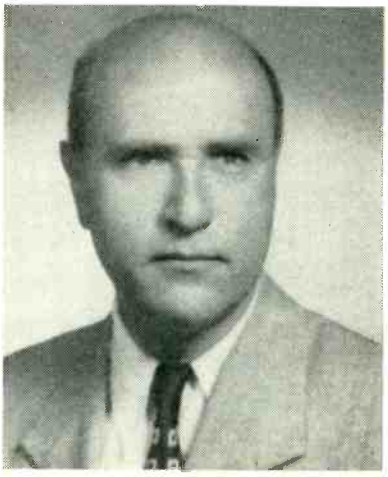
in the U. S. of precision instruments for testing and measuring.

The new division will make available to American industry the electronic precision measuring and testing equipment developed by IT&T's domestic and foreign associates, and other instrument makers abroad.



Rudolf Feldt

The director of the new Federal division is Rudolph Feldt. He was formerly in charge of the cathode ray instrument division of the Allen B. DuMont Laboratories, which he joined in 1942. Before that he was employed by IT&T associates in France and Germany.

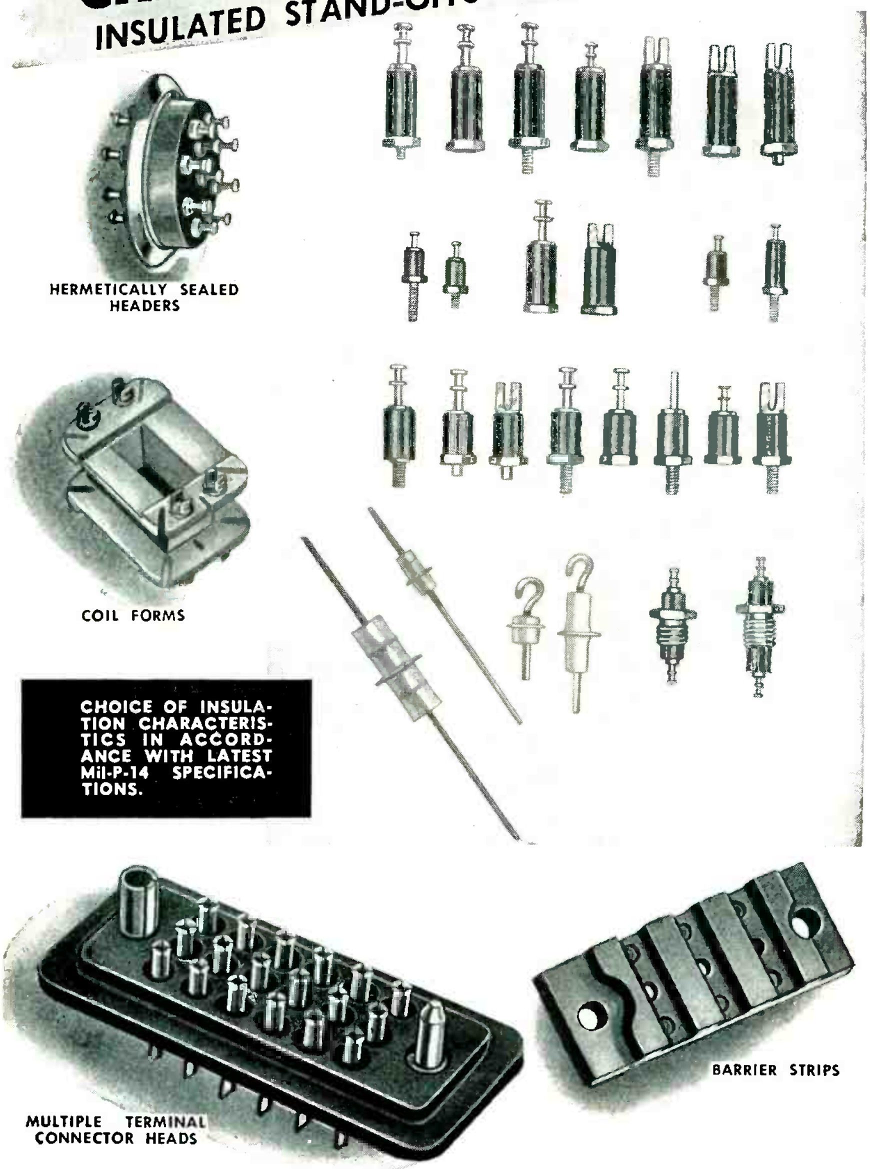
Federal Telecommunications Laboratories appointed I. W. Gleason as sales manager for systems and commercial research and development. He has been with the company for 14 years.

GE Plans Stanford Tube Lab, Appoints Engineers

A NEW ELECTRON tube development laboratory will be established by GE in a building to be built on Stanford University land in Palo Alto, Calif.

Work at the laboratory will be concentrated on developing and exploring the application of microwave electron tubes which, according to W. R. G. Baker, GE vice-president, promise to revolutionize the broadcast, communications and radar industries over the next ten years. Lab operations have already started in temporary space near Stanford.

The laboratory to be completed in



October initially will be a 10,000 sq ft structure equipped with facilities necessary for applied research and development on microwave tubes.

In the determination and interpretation of the fundamental principles of the operation of new microwave tubes, personnel of the new G-E laboratory will work closely with the Stanford Electronics Research Laboratory, directed by Dean F. E. Terman of the School of Engineering, and the Stanford Microwave Laboratory, directed by Edward L. Ginzton.

H. R. Oldfield, Jr.

H. R. Oldfield, Jr., has been appointed manager of the new G-E laboratory.

He is a former manager of the G-E Advanced Electronics Center at Cornell University, Ithaca, N. Y. and, until his new appointment, was manager of plans and product applications in the laboratories department.

Approximately half of the new laboratory staff, now being recruited, will be scientists and engineers. Skilled technicians, including glass blowers, model makers and draftsmen, also will be employed.

In GE's cathode raytube subdepartment Leonard C. Maier was appointed manager of engineering and Harry R. Hemmings was named to the newly created position of manager of manufacturing.

Dr. Maier has been with GE in

L. C. Maier, Jr.

Syracuse since 1950, most of the time in engineering positions in the electronics laboratory. Previously, he was a research associate at MIT's electronics lab.

In his new position he will be in charge of all cathode ray tube product engineering for GE monochrome tv picture tubes, color tv picture tubes, and special purpose cathode ray tubes.

H. R. Hemmings

Hemmings, who joined GE in 1937, has been manager of the sub-department's Buffalo picture tube plant for the past three years.

He will be succeeded as Buffalo plant manager by Willard L. Male, manager of employee relations for the sub-department.

The new position of manager of manufacturing was created to integrate the Buffalo and Syracuse tv picture tube manufacturing operations, in preparation for GE's eventual production of color TV picture tubes.

Victor H. Fraenckel, former liaison scientist in physics at the GE

Want more information? Use post card on last page.

research laboratory, has been appointed consultant on scientific relations.

He will be responsible for informing and counseling the management of the research laboratory regarding scientific work underway outside the company. He will evaluate and forecast the probable future trends in external scientific activities of significance to the firm.

Prior to joining GE in 1937, he was engaged in electronics research for Farnsworth Television in Philadelphia and as a physicist for HyGrade-Sylvania in Emporium, Pa. During World War II he was appointed an expert consultant to the Secretary of War and served in Europe on special missions concerned with electronic countermeasures and scientific intelligence.

Firestone Tire Builds Guided Missile Plant

A NEW $2 million plant is being built in Los Angeles for the Firestone Tire & Rubber Co. to be used for the production of the Corporal, the Army's guided missile. The plant will provide 350,000 sq ft of manufacturing space. It is located next to the firm's present tire plant.

Meinken Buys Electronic Tube Firm

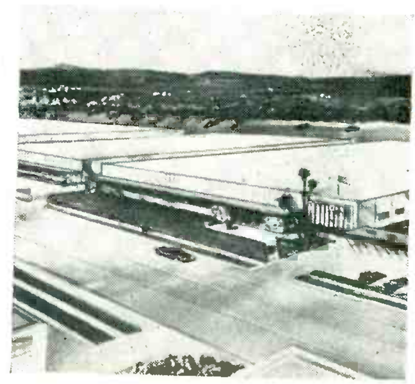
KENNETH C. MEINKEN, former president of National Union Radio Corp., has purchased the Electronic Tube Corp. of Philadelphia. Meinken has acquired control of the company and was elected by the board of directors to the presidency of the corporation.

Meinken had been connected with National Union since 1941. Prior

to joining National Union, he had been connected with Philco, performing special administrative and management duties.

Plans for the expansion of Electronic Tube are being formulated. Organized in 1937, the company manufactures oscilloscopes, cathode ray tubes, d-c amplifiers and electronic strain analyzers.

Further expansion into the electronic equipment field and the establishment of a special development group to engineer and produce cathode ray tubes for color television is planned by the firm.



Ramo-Wooldridge Builds New Plant

RAMO-WOOLDRIDGE Corp. of Los Angeles has started construction on a 150,000 sq ft plant addition which represents a $1,750,000 investment. When the project, expected to be completed by November, is finished Ramo-Wooldridge will move in with a staff expanded from 150 to 1,000.

Since its incorporation in September, 1953, the company has accumulated a backlog of $4 million. Work is in electronic computers and guided missile control systems research for commercial and military projects.

Recent additions to the staff are W. W. Cooper, professor of economics and industrial administration, and Abraham Charnes, associate professor of mathematics and industrial administration, both of Carnegie Institute of Technology Graduate School of Industrial Administration. Cooper and Charnes will work through the summer on new methods of mathematical analysis of industrial management

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This Library contains 1083 articles culled from recent issues of ELECTRONICS Magazine—the cream of the information essential to those working with or concerned with the design of electronics equipment. **For instance, you'll find 233 diagrams of industrial circuits,** measurement methods for television picture tubes, factors in permanent magnet design, and specific help for reading industrial circuits and redesigning them for your own uses.

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Included are not only the measuring and operating techniques used by radio designers and technicians, but also a wealth of engineering aids for parts and equipment design of television, radar, and other vacuum tube apparatus.

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Handle

With Mounting Plate

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TYPE H-1268 fits 3/8-32 thd. Also types for 1/2-20 and 15/32-32 thd. with larger shafts.

Here's Why:

Each SEALNUT has three parts—a black silicone sleeve, a nickel plated brass nut, and a silicone O-ring. The sleeve seals the switch handle and the nut bears against the control panel, sealed by the O-ring. SEALNUTS are the only switch seals that provide rigid, metal-to-metal contact for positive, secure mounting.

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TOGGLE SWITCH

TYPE H-1267 fits 15/32 thd. is equal to Boot AN 3223-1. Also types for 1/2-20, 1/4-32 and 1/4-40 thds.

NOW SEAL OUT MOISTURE, DIRT and FUMES

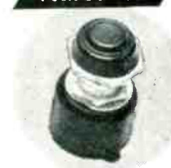
at Switches and Control Shafts

SEALNUTS have operated without leaking at external hydraulic pressures of 200 lbs./in., stay flexible at —65°C, meet requirements of MIL-B-5423. Over a million have been used to protect military electronic equipment.

* U. S. Patent 2162023

TYPE H-2475 fits 15/32-32 thd. Other types for various pushbutton diameter and lengths.

PUSH BUTTON



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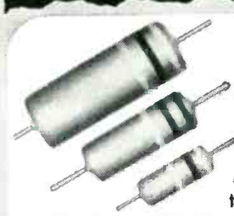

CAPLESS* TYPE "A"

5% Tolerance

Maintains close tolerance under critical conditions. The most economical resistor of its type available. Comparable in size and price to fixed composition resistors. Offers greater reliability at lower cost.

Wattage Ratings: 1/2 w, 1w, and 2w.

PRECISION TYPE "D"

1% — 0.5% Tolerance

Made to meet requirements of MIL-R-10509A.

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Greater Uniformity on Large Production Runs

The STEMAG CHEMO-CARBON Process provides for the carbon film to be impregnated with selected chemical materials immediately after the depositing of the carbon under high vacuum.

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Also specify STEMAG CHEMO-CARBON RESISTORS

- Subminiature and Miniature
- High Temperature and Fungi-proof
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- High Wattage
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QUALITY COMPONENTS FOR ELECTRONICS AND NUCLEONICS problems in the computer systems division.

Former vice-president and general manager of Hughes Aircraft Co., Gen. Harold L. George, is administrative consultant and a member of the board of directors.

Mycalex Names New Research Chief

RICHARD A. HUMPHREY has been appointed chief of research and development of the Clifton plant of Mycalex Corp.

The research on synthetic mica, in which Humphrey has been active for the past eight years, has led to the manufacture of this strategic mineral on a commercial scale. The Mycalex Corporation is now in the process of establishing a synthetic mica production facility.

Clevite Buys Counter Firm, Names Weckler

CLEVITE'S Brush Electronics has purchased the assets of the Digital Instrument Co. of Coral Gables, Florida, manufacturer of electronic counters. Meryl C. Burns, former president of the Florida concern, will serve as manager of the digital instrument department of Brush Electronics.

The products formerly manufactured by Digital will be integrated into the Brush line.

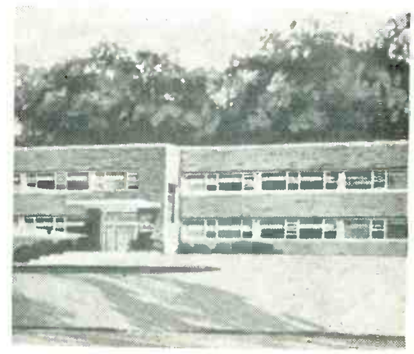
Herman L. Weckler has been elected general manager of Clevite Corp.

Weckler has been vice-president-operations of Clevite since July,

1953, when he first joined the corporation. For thirteen years he had been vice-president and general manager of Chrysler Corp., where he was also a director.

During the past year, he has had general responsibility for the operations of Clevite's manufacturing and selling units. In his new position as vice-president and general manager, he will have general responsibilities in all Clevite activities, including the central staff and its research and development units.

New Research Center For GPL Underway



CONSTRUCTION has started on a research center, covering 29,000 sq ft, for General Precision Laboratory in Pleasantville, New York. It will house staff and equipment for design work on television cameras and other commercial tv units, plus experimental work in electronics for military application. The building is on the grounds of the 80-acre one-time Mandeville estate which is now the main headquarters for GPL.

The center will be ready for occupancy about the first of the year.

Philco Promotes Top Officers

WILLIAM BALDERSTON, president of Philco for the past six years, was elected chairman and James H. Carmine, executive vice-president for the past five years, was elected president. John M. Otter was elected executive vice-president. He was previously vice-president in charge of consumer products divisions.

Balderston succeeds James T.

Want more information? Use post card on last page.

Buckley, who declined re-election as chairman after 42 years service with the company. Balderston, as board chairman, will devote himself to broad areas of finance, manufacturing, research, engineering and legal and license activities.

Carmine, in his 31 years with Philco, has specialized in sales, distribution, merchandising and advertising. Otter, who joined Philco in 1926, became a vice-president of the firm in 1948.

General Mills Appoints Soucek

ZEUS SOUCEK has been appointed as general manager of General Mills' mechanical division.

Since 1950, Soucek has served as government sales manager for DuMont Laboratories. Between 1929 and 1950, he was successively engineer in charge of research for Bendix Aviation; vice-president of W. L. Maxson; vice-president of Brewster Aeronautical Corp.; president of Philharmonic Radio and president and owner of the Arpin Construction Company.

Chance Vought Appoints Missile Chief

CHANCE VOUGHT Aircraft has appointed Samuel Oliver Perry, Jr., as chief of missile design, to head this activity in the company's California plant. He joined Chance Vought in 1941. Prior to his new appointment, he was chief of field

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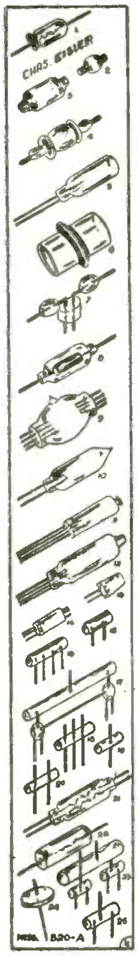

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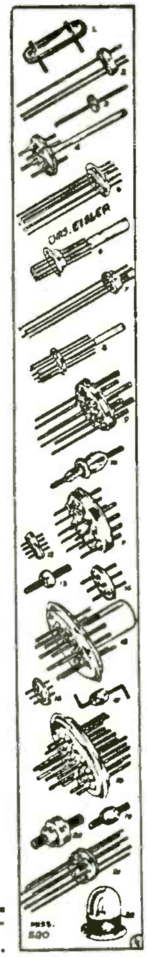

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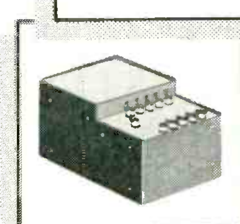

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test and flight operations conducted at two California bases for the Regulus guided missile built in the Dallas aircraft plant for the U. S. Navy.

He has been associated with the company's missile programs since 1946. He carried out a large portion of the analytical work on servo-mechanisms for the successful Regulus program.

In 1950, he was transferred from Dallas to California, where he served as assistant to the chief of missile design and later assumed responsibility for testing and flight operations at two bases.

Seidel Succeeds Elliott at RCA

ROBERT A. SEIDEL has been elected executive vice-president of Consumer Products for RCA. He succeeds J. B. Elliott who resigned to become president of Schick. Seidel, who joined RCA as a vice-president in 1949, was formerly vice-president and controller of the W. T. Grant Co.

Stanford Research Names Benedict

DONALD L. BENEDICT has been appointed director of physical sciences research at Stanford Research Institute. He was formerly assistant director of the engineering division.

He will supervise all project work and Institute-sponsored research in the fields of chemistry and chemical engineering, metallurgy, ceramics, biochemistry and physics.

With SRI since 1949, Dr. Benedict has supervised programs in

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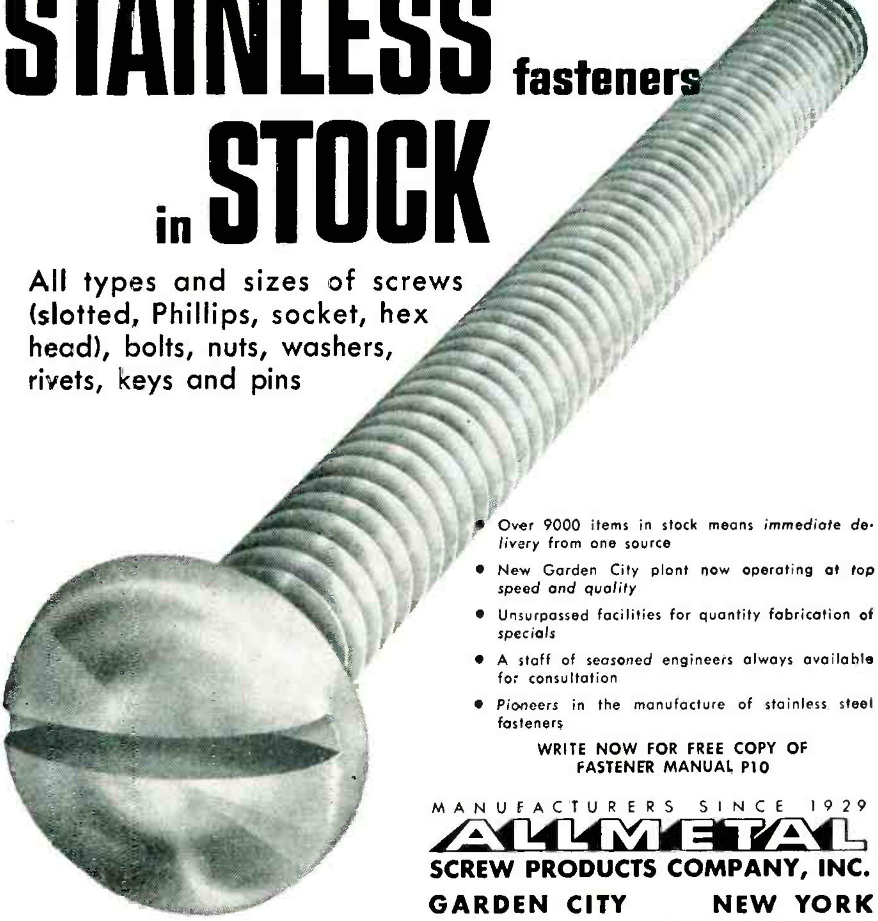

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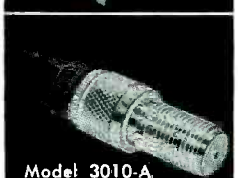
Model 4900

New Electro Proximity Pick-up System

Actuates Electronic or Electro-Mechanical Devices for counting parts, indicating position and distance, detecting presence of metallic mass, sequence timing, limiting control. Operates from 0 to over 12,000 times a minute at distances up to 3/8".

Produces Constant Electrical Output in Excess of 5 Volts when any metallic mass approaches the pick-up. Output voltage is independent of the speed or proximity of the actuating mass and remains constant while near the pick-up and drops to 0 when removed. $66.50 complete. **Special Types** for extended range and size.



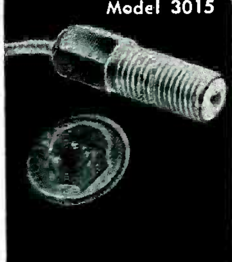
Model 3010-A

Electro Magnetic Pick-up

Indicates Without Mechanical Contact RPM rate of speed or motion. For acceleration and velocity studies, precision ignition timing, ballistic research, many others.

Produces Variable Electrical Output in proportion to any magnetic object's rate of speed. It can be actuated by displacement or vibration of magnetic material in the field of the pick-up, such as a keyway in a shaft, gear tooth, pin or slot in the moving part. $22.50 less mating connector. **Special Types** for high temperature and deep space. Available with AN type connectors.

Model 3015



New Electro Miniature Magnetic Pick-up

For Small Space and Light Weight Applications. Controls electrically operated devices, rockets, guided missiles, etc. For mechanical or electrical counting. Indicates rate of travel, angular or linear speed, vibration. Similar performance characteristics to "3010-A" with 25% voltage output. $16.50 complete.

MEASURE STATIC OR DYNAMIC DISPLACEMENT

Electro Dynamic Micrometer Measures Without Mechanical Contact vibration in heat exchangers, motors, shaft whip, radial expansion due to high RPM, rate of acceleration, valve travel. Independent of acceleration or frequency of displacement.

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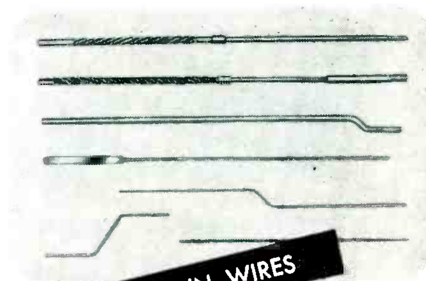

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The Engineering Company can give you immediate delivery on following bases: 50 Watt, 3303B, 412 Industrial Base, Giant 7 Pin Bayonet, 4310 Four Pin Jumbo, Tetrode, Hydrogen Thrytron Bases in both Aluminum and Copper up to 6.50 dia etc. All bases to JAN-1A/MIL-E-1B and subjected to weights and strength tests.

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electronic research and has participated in theoretical and technical work in the application of new materials to electronic components.

He has served as consultant to Raytheon Manufacturing Co., advising on microwave tubes, design of equipment for microwave cooking and dielectric heating.

In 1945 he was named a research fellow in Harvard University's department of engineering science and applied physics. Earlier he was a research physicist with Sylvania's research laboratory at Flushing, L. I.

Hans Hollman Joins Hydro-Aire

HANS ERICH HOLLMAN, a German engineer in microwaves and transistors, has joined the engineering staff of the electronics division of Hydro-Aire of Burbank, Calif. In 1928, Dr. Hollman developed a microwave link in Germany and in 1936, he published an encyclopedia on microwaves, a forerunner of the MIT Radiation Series. Since his arrival in the U. S. with a group of German scientists seven years ago, Hollman has been working at the Naval Air Missile Test Center, Point Mugu, Calif. He will head the company's research and development program in the field of semi-conductor applications.

Kay Electric Names Oncley

THE KAY ELECTRIC COMPANY of Pine Brook, New Jersey, manufacturer of test equipment, has appointed Paul Oncley as audio de-

Rawson

SINE-COSINE POTENTIOMETER

TYPE RL11C

Ingenious design uses linear winding to generate sine function and cosine function. May be used as a variable resistor or as a generator with separate excitation. Resistance, 16,000 ohms. This unit has numerous uses.

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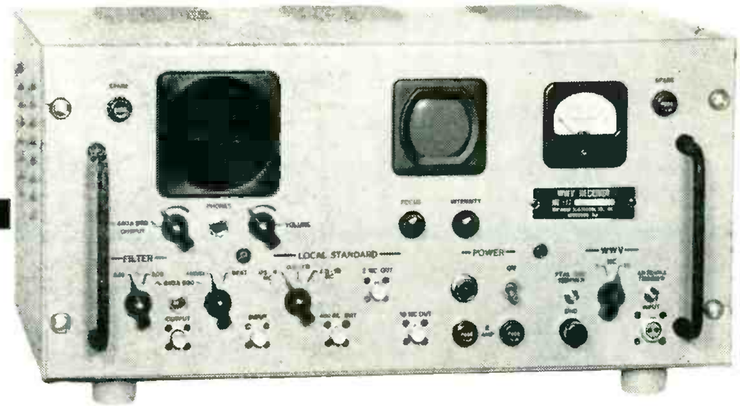

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The WWV frequency standard, as transmitted by the U. S. Bureau of Standards, is the most accurate frequency standard of any in the world.

By using the new Matawan WWV receiver, this frequency standard, with all its information (standard audio frequencies, time signals, propagation notices) is now available to your laboratory. The WWV carrier, after elimination of its modulation, by means of a narrow band pass crystal filter, monitors your local HF standard. The rotative pattern on the screen of the cathode ray tube gives sense and amount of the frequency deviation.

Either the 5MC WWV or the 15MC WWV may be received. The receiver will accommodate any local frequency in the range from 50kC to 10MC equal to a subharmonic of 10MC, 2 MC or 400 kC. A second channel receives the audio modulation and time signals of the WWV-Standard.

Four Models Available.

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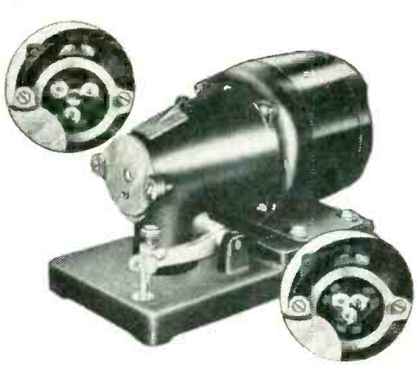

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WIRE STRIPPER

Completely removes any type of insulation, including plastic—cleanly, without damage to solid, stranded or multi-conductor cable to ½" diameter. Strips to 1½" length. Works instantly, simple to adjust. Exclusive High Speed Triple-Disc Cutting Mechanism centers cable for accuracy, gives more and better cutting edge. ¼ H.P., 110 volt single phase AC motor. Immediate delivery. Write or wire today.

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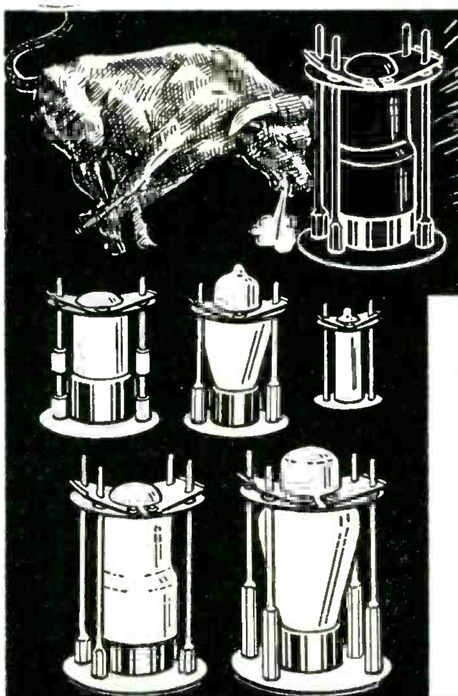

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VACUUM TUBE RETAINERS

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.

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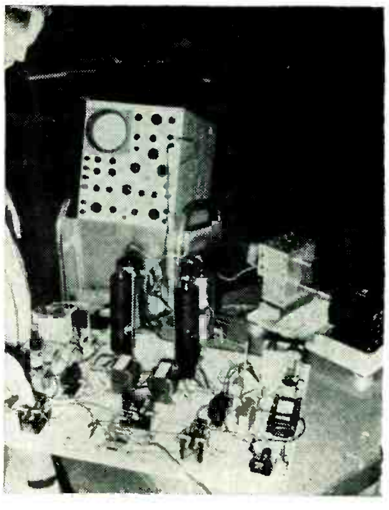
velopment engineer.

During World War II, Dr. Oncley was affiliated with the Division of Physical War Research at Duke University, where he designed special instruments for outdoor acoustic transmission tests and for micro-meteorological measurements. He joined the research staff of Bell Telephone Laboratories in 1945, working on the acoustics of speech and music under Harvey Fletcher and R. K. Potter. In 1949, he began a program of research on the acoustics of the singing voice under a grant from the Research Corporation, at Westminster Choir College and Columbia University. During the years 1951-53, he was also a research associate in electrical engineering and lecturer in the acoustics of speech and music at Columbia University. He has served as a special consultant for Rangertone, Regal Electronics and Radionics Laboratory.

At Kay Electric, Oncley will devote his time to development and expansion of the line of acoustic measuring instruments.

Carboloy Opens New Development Lab



Circuit used in developing an automatic magnet tester is analyzed in the new lab

NEW LABORATORY for measuring and analyzing magnetic materials was recently opened by Carboloy department of GE in Detroit.

It is the hub of activities for

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the department's new permanent magnet manufacturing plant in Edmore, Mich. and the development foundry in Detroit, Mich. The laboratory will work in cooperation with the company's research laboratories in Schenectady to further the development of new magnetic materials and techniques.

Installations in the lab include magnetizing and demagnetizing equipment, stabilized power supplies, basic machine tools to allow construction of magnetic circuit components, automatic equipment for recording hysteresis loops, and facilities for developing high speed test equipment for production line use.

Mathes Named Chief Engineer Of Rosen

RICHARD E. MATHES has been named director of engineering of Raymond Rosen Engineering Products, electronics manufacturer in Philadelphia.

Mathes was formerly a research and development engineer with RCA for approximately 18 years; section head of electronic countermeasures of the design branch of the electronic division, Bureau of Ships; plant manager and chief engineer of Finch Tele-Communications Corp. and later was chief engineer and assistant general manager of Gray Research and Development Co.

Brew Appointed Chief Engineer

RODERICK A. BREW has been appointed chief engineer of Richard D. Brew and Co. of Concord, N. H.

For the past three years he has been associated with Western Union in their engineering department.

Karp Metal Affiliates With H and B Machine

FORMAL AFFILIATION with the west coast division of the H and B American Machine Co. at Culver City, California, was made by the Karp Metal Products of Brooklyn, New York.

The 20,000 sq ft Culver City

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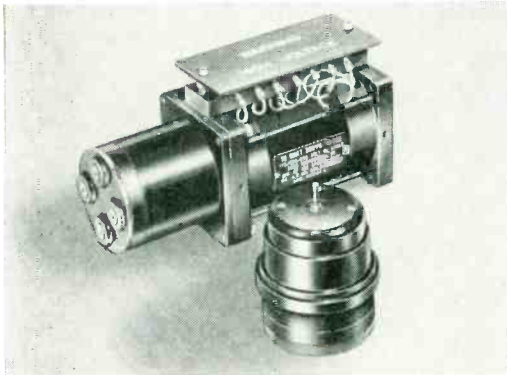

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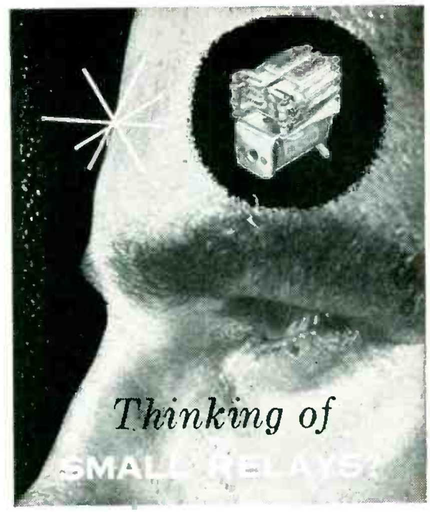

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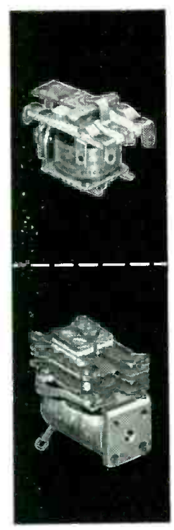
Cramped quarters don't cramp the style of ADVANCE midgets and miniatures. You can use them on loads up to 5 amperes continuously . . . and at three times their rating intermittently—with complete safety. They'll resist shock and vibration . . . stand up under temperature extremes. You'll find them readily adaptable to any mounting need . . . any type of duty. Here are a few examples:



"TINY MITE"
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This ultra-small d-c relay occupies less than ½ cu. in. mounting space! It's stable under vibration and shock . . . plated to prevent corrosion. Operate time is 5 milliseconds. Contact rating: .5 amp. or 1 amp.

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TQ SERIES

Only .94 cu. inches in size, yet this relay carries 5-amp. loads in any combination up to 4 PDT. Mechanically secured throughout, it's extremely efficient. No gassing or bubbling. Withstands 10G vibration. Temperature range: —55° to +125° C.

Hermetic enclosures on these types are impervious to varying climatic conditions . . . are sealed and carefully checked against leakage.

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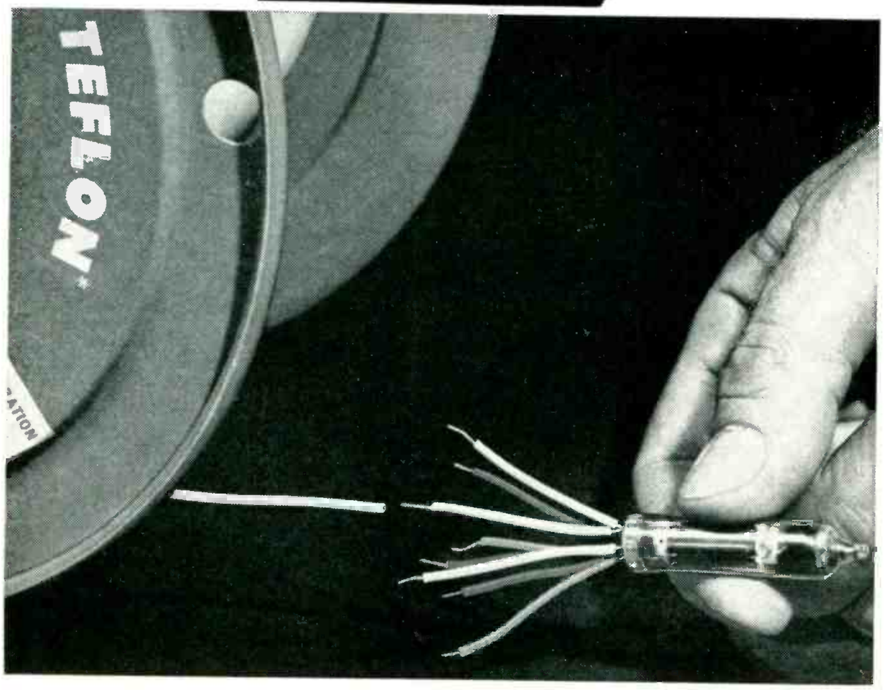
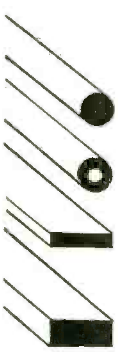
Sales Representatives in Principal Cities of U.S. and Canada



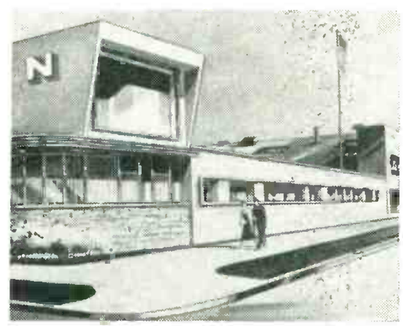


plant, which is already in operation, will be used in manufacturing sheet metal products for west coast customers.

Reason for the affiliation, according to Dan Karp, vice-president in charge of sales, engineering and production, is the tremendous growth of the electronic industry on the west coast.

Although the Karp Company manufactures no standard product of its own, it sells approximately $5,000,000 worth of equipment annually to its more than 400 customers throughout the world.

The company was founded in 1925 and by 1942 was operating four separate plants. In 1948 operations were consolidated into the present 88,000 sq ft Brooklyn plant that has 400 employees.



New Auricon Camera Plant Completed

THE NEW PLANT of Berndt-Bach, manufacturer and distributor of Auricon 16-mm sound-on-film cameras and equipment, has been completed in Hollywood, Calif.

The facilities were planned for the design, development and production of motion picture cameras and kinescope recording equipment for the film and television industries. Special facilities have been provided for research and development of natural-color film equipment for television, film studio and educational use.

Nachtigall Leaves Mark Simpson

SALO NACHTIGALL, production manager and executive engineer with Mark Simpson Manufacturing for 11 years, has left the company to

devote full time to his own firm, The Fanon Electric Co. Fanon has been a contract manufacturer of electronic equipment, wiring harnesses, cable assemblies and electromechanical assemblies. Plans are to manufacture a complete line of audio amplifiers and inter-coms. A line of electric phonographs is being prepared for delivery.

Gamewell Names Engineering Supervisor

THE GAMEWELL COMPANY of Newton Upper Falls, Mass. has appointed Edward S. Ruth to the position of supervisor of industrial signaling engineering.

Ruth comes to Gamewell from Edwards Co. of Norwalk, Conn. where he was for many years director of research engineering and development.

General Transformer Names Walovich

GENERAL TRANSFORMER CO. of Homewood, Ill., has appointed John Walovich as chief engineer succeeding Conrad E. DeHorn, who is no longer active with the company.

Walovich has been assistant chief engineer since 1951.

Hauman Instruments Elects Friedman

HAUMAN INSTRUMENTS has elected Bernard L. Friedman as president and general manager, and appointed him chief engineer of the

newly formed photronics division.

The parent organization is engaged in the design and manufacture of electronic instrumentation equipment, while the photronics division designs and produces electronic-flash equipment for the photographic field as well as photoelectric control systems.

Friedman was most recently associated with Sanborn Co. of Cambridge, Mass. as assistant to the director of engineering.

Louis Rosenblum of Photon, in Cambridge, Mass., has been elected a director and consultant to the photronics division. Rosenblum has been associated with Polaroid Corp. as assistant to the vice-president in charge of engineering.

Mason Named Ray-O-Vac Director of Research

H. J. MASON has been named director of research and development for Ray-O-Vac Co.

Mason has been associated with the company since 1939 and in 1952 was named assistant director of research.

Stromberg Appoints Captain Bergeson

ANDREW H. BERGESON, who recently retired from active duty in the U. S. Navy with the rank of Captain, has been retained by Stromberg-Carlson as a consulting engineer.

He was head of the aviation electronics branch of the Navy's Bureau of Ships from 1941 to 1944.

He was director of the electronics division of Navy's Bureau when there's a soldering job to be done...

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On industrial assembly lines ... in home workshops ... in electronic labs ... for production, repair, maintenance ... the world's most versatile family of pencil soldering irons is on the job, doing a **better job**! No wonder they're called "Ungar's Little Angels"!

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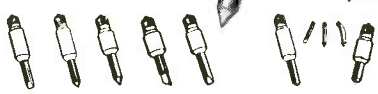

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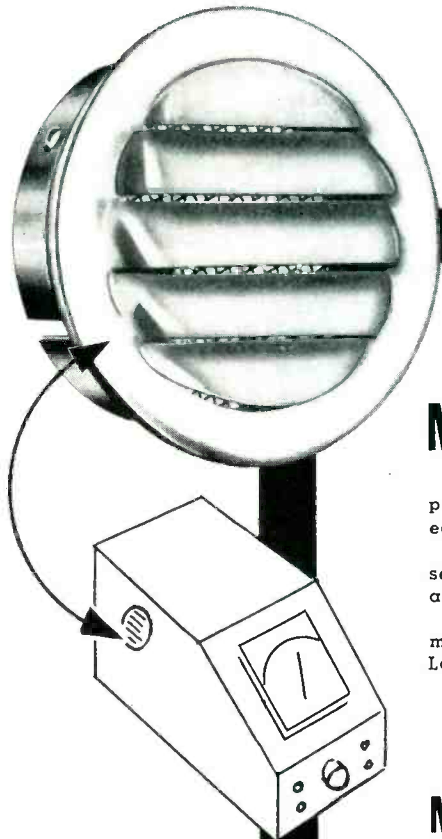

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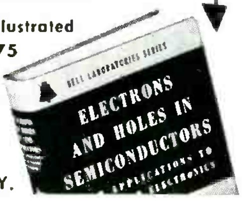

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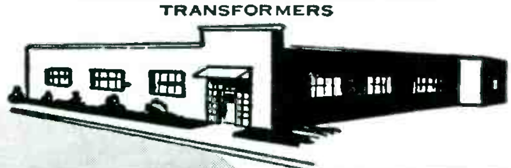

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of Aeronautics from 1946-1949.

From 1951 to 1954 he represented the Navy in the operation of Project Lincoln.

Little Appoints Computing Head

LESLIE G. PECK has joined the staff of Arthur D. Little of Cambridge, Mass., where he will be in charge of the computing laboratory.

Among Dr. Peck's previous appointments were a professorship at John Hopkins, where he taught mathematics, and a position at Los Alamos Scientific Laboratory, where he was responsible for much of the success of their computing program. Immediately before joining ADL he was a research associate at New York University. He conducted research in hydrodynamics and numerical analysis making use of the UNIVAC.

Tempel Expands Plant

A NEW administration building has just been added by Tempel Manufacturing of Chicago, manufacturers of magnetic steel laminations. Tempel now has 14 buildings comprising 43,000 sq ft on an 8½ acre tract.

Fairchild Recording Names Suiter

FAIRCHILD RECORDING EQUIPMENT COMPANY has appointed Lyman E. G. Suiter as assistant to the vice-president. He will assist in general manufacturing problems.

Suiter was previously with the radio division of Westinghouse

where for the last 14 years he has served in a variety of manufacturing supervisory positions on both military and commercial equipment. Most recently, he directed the firm's home radio production line activities.

Guideline Associates Changes Its Name

GUIDELINE ASSOCIATES has changed its name to Transline Associates to avoid confusion with the products of another manufacturer. Only the name of the company has changed and no delays in shipping schedules will result, according to the firm.

Mossman Completes New York Move

DONALD P. MOSSMAN, manufacturers of multiple-circuit lever, turn and pushbutton switches, has completed the transfer of all manufacturing facilities from Joliet, Ill. to the company's new Brewster, New York plant. All sales and administrative functions are also now located at Brewster.

Beltone Names McNabb Director Of Research

LOUIS A. MCNABB was appointed director of research and chief engineer of the Beltone Hearing Aid Co. of Chicago.

Formerly director of the electronic division of Bell and Howell, McNabb participated in the de-

14 REASONS WHY VARIABLE TRIMMER JFD PISTON CAPACITORS ARE PREFERRED


actual size (one inch)

1. Vernier Micrometer Adjustment
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11. Q Measurements Beyond 10,000
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13. Dust-proof Construction
14. Meet Strictest Military Demands

AIR EXPRESS DELIVERY ON STANDARD MODELS

MODEL	CAP. MMF	TEMP. COEFF. PPM PER °C	DIEL.	ROTOR ELECTRODE	TEMP. RANGE
VC 5	.5 to 5	approx. zero	Quartz	Invar	−55°C to +200°C
VC 11	1 to 10	approx. zero	Quartz	Invar	−55°C to +200°C
VC 12	10 to 20	approx. zero	Quartz	Invar	−55°C to +200°C
VC 1G	.5 to 8	+50 ± 100	Glass	Invar	−55°C to +125°C
VC 3G	.7 to 8	+600 ± 100	Glass	Brass	−55°C to +125°C
VC 4G	1 to 18	+600 ± 100	Glass	Brass	−55°C to +125°C
VC 11G	.7 to 12	+100 ± 50	Glass	Invar	−55°C to +125°C
VC 11GRB	.7 to 10	+750 ± 100	Glass	Brass	−55°C to +125°C
VC 11GRC	.7 to 10	+275 ± 100	Glass	Invar Brass Screw	−55°C to +125°C
VC 13G	1 to 10	+100 ± 50	Glass	Special Alloy	−55°C to +125°C

Other models available for ungrounded operation, larger ranges, fixed standards, etc.

Consult with JFD Engineers for piston capacitors designed to meet your specifications. Write today to be placed on the JFD Capacitor Bulletin mailing list.

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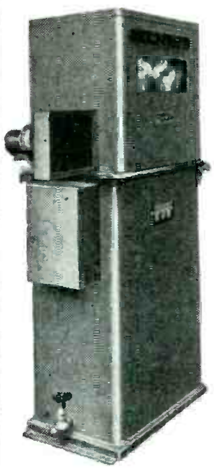
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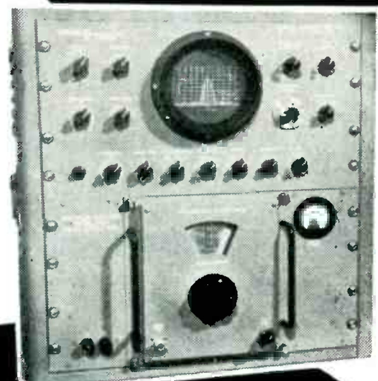

now 50 mc to 4000 mc

WITH TWO TUNING HEADS

Check these outstanding features:

- Low noise input, less than 0.5 microvolts across 50 ohms, for high usable sensitivity
- 10 MC maximum sweepwidth, continuously reducible to 0 MC
- Continuously variable differential markers, ±50 kc to ±5 mc
- Continuously variable resolution (I.F. bandwidth) 9 kc to 100 kc
- 1 cps to 60 cps sweep rate, continuously variable with single control.
- DC coupled video amplifier for analysis of CW signals.
- Three selectable amplitude scales, 40 db log, 20 db linear and square law.
- Low frequency swept oscillator provides high inherent stability.
- Excellent construction and design make the equipment unparalleled for minimum down time.
- Optional bezels and CRTs for visual examination or camera use.
- Low cost.

Tuning Heads

RF-2 50 mc - 250 mc
RF-3 220 mc - 4000 mc in five ranges

Inquiries invited on Panoramic Spectrum Analyzers for special problems. Write today for descriptive literature.

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Makers of
- Panadaptor
- Panalyzor
- Panoramic Sonic Analyzer
- Panoramic Ultrasonic Analyzer

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velopment of that company's miniature electronic equipment for 15 years.

He was chief engineer of the Victor Animatograph Corporation of Davenport, Ia., from 1948 to 1950.

Later, as a consultant in product design, McNabb worked on hearing aids, miniature recorders, speech reproduction and transistors.

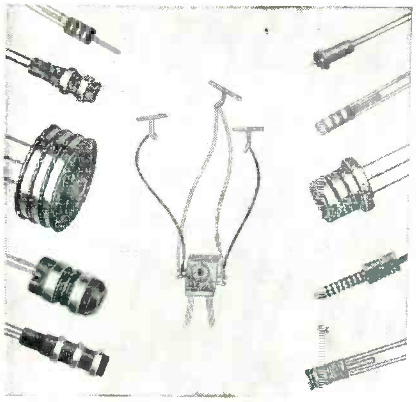
India Sets Plans For Electronic Plant

A MILITARY electronic factory is being set up near Bangalore, India, to make radio and radar equipment for the Indian armed forces. Set up as the result of an agreement last year between the Indian Government and France's Compagnie Generale de Telegraphie, the new plant will be called Bharat Electronics. A French three-man technical team has had consultations with India's Secretary of Defense and its factory board. As a result, nine junior Indian officers are being sent to France for further training.

Also attached to the plant will be a French-supervised training school, expected to open its doors by the end of the year. The whole operation is under Brigadier B. D. Kapur from the weapons and equipment section at General Headquarters, New Delhi.

Hosterman Named By Sylvania Electronics

CHARLES W. HOSTERMAN has been appointed to the newly created post of assistant general manager of



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MINIATURE PLASTIC FILM CAPACITORS

The new EFCON® plastic Film Capacitor, Type MH, is produced with tolerances of ±5%, ±2% and ±1% *in standard production!* High stability without derating. DuPont's "Mylar"* polyester film with *low* dielectric absorption. Leads soldered directly to foil.

Hermetically sealed in metal cases.

Also available: Type MC-"Mylar" polyester film capacitor in wax impregnated cardboard tubes; Type S—Molded silvered mica capacitor.

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MAINTAIN ACCURACY

high temperature ACCELEROMETER

Now, Pacific Scientific presents a unique new *high temperature* accelerometer, designed by Humphrey to give accurate, clear signals at temperatures from −65° to +550° F. —far in excess of former operating ranges! The rugged stainless steel and ceramic construction provides long life and allows precision tolerances for maintaining repeatability.

For the higher temperatures encountered in missile work, as well as for use in all types of aircraft where heat dissipation is a problem, this new unit provides the ideal answer!

SPECIFICATION DATA:

- **Environmental**—Temperature: −65° to +550° F. Shock: 60 G's in any direction without damage to the instrument.
- **Accuracy**—Within ½% to 2% depending upon G range and potentiometer resistance. (Including linearity, resolution and environmental conditions.)
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ARLINGTON, TEXAS, 111 East Main Street

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the electronics division of Sylvania.

Manager of the radio tube division's plant at Shawnee, Okla., since 1950, Hosterman jointed the Sylvania organization in 1943 and served in supervisory personnel capacities in various plant locations until 1947, when he was appointed manufacturing superintendent at the radio tube plant in Huntington, W. Va. He left Huntington to become manager at Shawnee.

Volkert Names Schell Plant Manager Assistant

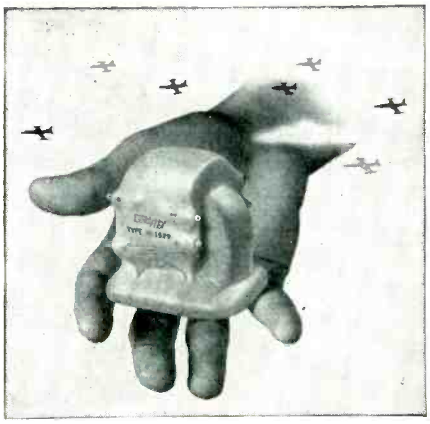
CHARLES E. SCHELL has been appointed assistant to the plant manager of John Volkert Metal Stampings of Queens Village, New York.

Schell had been associated with Sylvania for 25 years. He served as plant manager of Sylvania's parts division.

AMF To Acquire Potter & Brumfield

AMERICAN MACHINE & FOUNDRY expects to acquire Potter & Brumfield Manufacturing as a wholly-owned subsidiary for 92,000 shares of AMF common stock in exchange for all of Potter & Brumfield's stock.

Makers of electrical relays, fractional horsepower motors and electro-mechanical assemblies, Potter & Brumfield has three plants with a total of 41,000 sq feet in Princeton, Ind., employing approximately 600 people. An addition of 20,000



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Open Type Transformer

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FORM FLEX

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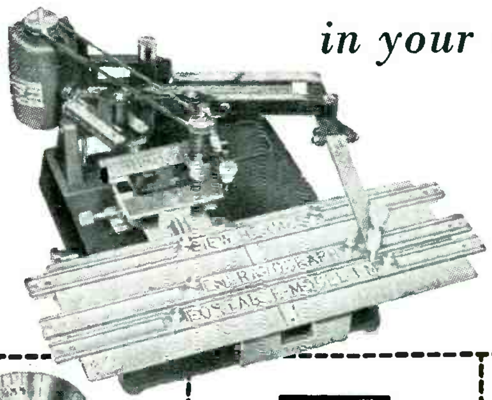
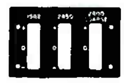


Lowest set-up time for unskilled labor

CALIBRATIONS



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10,000 IN USE Accepted by all leading manufacturers as the speediest, most versatile portable engraver. Only the NEW HERMES has these patented features:

- Adjustable for 15 ratios.
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- Automatic depth regulator.
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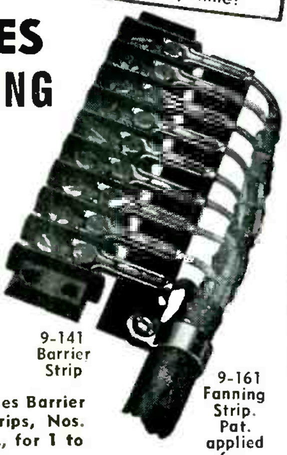
HERE'S BIG HELP IN TERMINAL WIRING!

The correct wire to correct terminal every time!

The New

JONES FANNING STRIP



Connections are made through Fanning Strip, on bench or anywhere apart from barrier strip, and quickly slipped into assembly.

9-141 Barrier Strip

9-161 Fanning Strip. Pat. applied for.

Use with Jones Barrier Terminal Strips, Nos. 141 and 142, for 1 to 20 terminals.

Simplifies soldering. Insures correct connections. Saves time. Ideal for harness or cable assembly. Brass terminals, cadmium plated. Bakelite mounting. Send for complete data.

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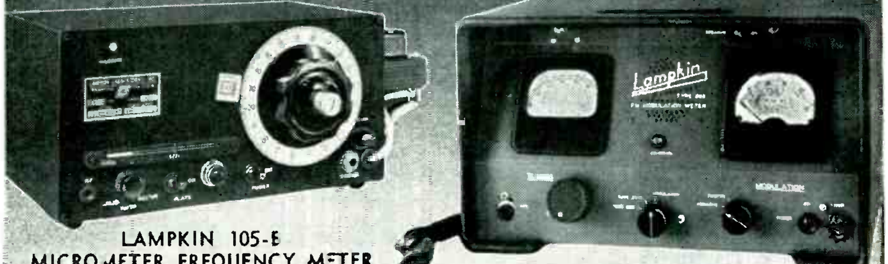
Measure FREQUENCY AND FM DEVIATION *To 500 MC!*

For development . . . production . . . and communication testing!



LAMPKIN 105-B MICROMETER FREQUENCY METER

Heterodyne-type, uses one crystal to measure all transmitters from 0.1 to 175 mc., and crystal-controlled transmitters to 500 mc. Accuracy better than 0.005%. Readings in absolute frequency, or percentage of error from desired frequency. Useful as precision, low-level, CW signal generator, 20 mc. up. Price $220.00.

LAMPKIN 205-A FM MODULATION METER

Direct indication of peak deviation on voice modulation, 0-25 kc. positive or negative. Tunable 25 to 500 mc. in one band. Doubles as relative field-strength meter. Built-in speaker. Jack for oscilloscope. Price $240.00.

MEET FCC SPECS—for mobile-radio maintenance. SMALL SIZE—less than 13" wide, less than 14 lbs., apiece.

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sq ft is under construction there.

No change in management is contemplated. President is Richard M. Brumfield, a founder of the company. Ralph T. Brengle is vice-president.

Salkover Metal Moves To New Plant

SALKOVER METAL PROCESSING of Illinois has moved to its new plant in Franklin Park, Ill.

The copper brazing and bright annealing organization formerly occupied two buildings. Both of the old plants have been discontinued and all operations are now concentrated in the Franklin Park building which has practically twice the floor area of the other two plants combined.

Resdel Engineering Names DeDiemar

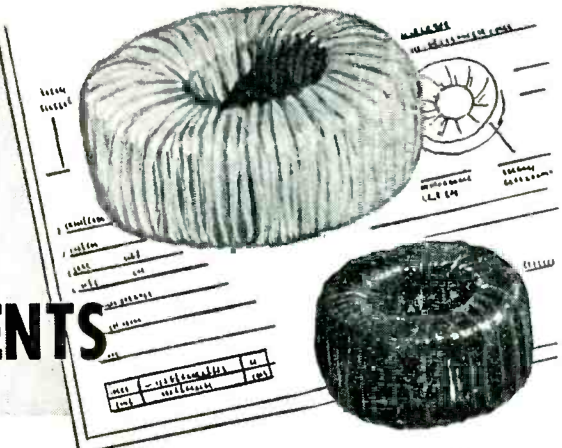
J. L. DEDIEMAR, former Convair design specialist, has been appointed chief engineer of Resdel Engineering.

DeDiemar joined Convair's engineering department at the firm's Vultee field division, Downey, Calif., in 1946. In 1947 he was transferred to the company's San Diego division. He has been an electronics project engineer there for the past year. For several years he was a staff assistant in the electronics section.

Before joining Convair, DeDiemar was an electronic engineer with Gilfillan Bros. in Los Angeles.

DeDiemar will have charge of engineering for Resdel's projects which include electronic research

UNIVERSAL meets exacting DESIGN REQUIREMENTS *in* TOROIDAL COILS



Our specially designed machines now wind Toroidal Coils quicker and with more accuracy than other standard methods. Universal Toroidal Coils in any size wire to your specifications—are economical in materials and possess the smallest external leakage field of all other shapes.

Universal Toroids wound to Mil-T-27 specs.

Wire sizes #42 (.00249 mils) to #10 (.1019 mils).

Excellent Delivery in small or large quantity.

Engineering Service Available.

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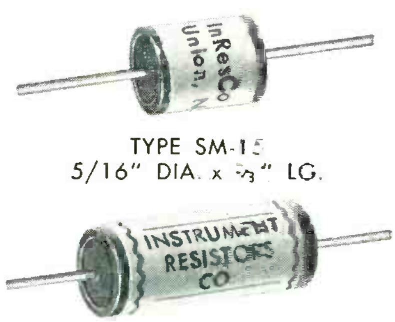
IN-RES-CO TYPES SM-15 & SM-30 WIRE WOUND RESISTORS

SUB-MINIATURE weather-tested midgets

Type SM-15 and SM-30 Resistors offer three vital advantages — sub-miniature size, weather resistant construction and high resistance. The elimination of center hole mounting and the inclusion of axial leads increases winding area and results in 25% greater resistance value than resistors of standard design. Special coating is moisture and fungus proof and designed to meet JAN-R-93 specifications. Sealed in Bakelite construction affords additional climatic protection. As ratings are conservative, types SM-15 and SM-30 can be specified with confidence for service under rigorous conditions.



TYPE SM-15
5/16" DIA. x ⅔" LG.

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5/16" DIA. x ¾" LG.

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Williams Ferric Oxides analyze better than 99% Fe_2O_3. They contain a minimum of impurities. They are available in a broad range of particle sizes and shapes. Among them, we're certain you'll find one that's "just right" for your requirements. The proper application of Ferric Oxides to the manufacture of Ferrites is our specialty.

Tell us your requirements . . . we'll gladly send samples for test. Chances are good that our Ferric Oxide "Know How" can save you considerable time and money. Address Dept. 25, C. K. Williams & Co., Easton, Pa.

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and development work for the armed forces and commercial firms. The company's current products include electronic test equipment, radar units, and dielectric and induction heating devices.

Wilton Tool Starts New Plant

WILTON TOOL MFG. CO. broke ground for a new 65,000 sq ft general office and factory building in Schiller Park, Illinois. The expansion will cost approximately half a million dollars. The plant will be located on a five acre tract.

Wilton plans to move to the new plant in January of 1955. No major interruption of production or delivery schedules is anticipated.

I-T-E Circuit Breaker Appoints Corwin

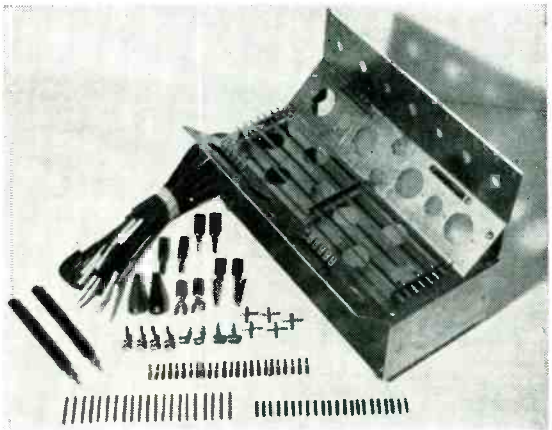
JEROME CORWIN has been named to head the new design and development section on electromechanical devices, servo mechanisms and computers in the special products division of I-T-E Circuit Breaker Company. It was indicated that the addition of this new section was undertaken to further complement future activities of the division in the radar field. Corwin was previously chief of the mechanical engineering section of the U. S. Army Signal Corps Laboratories at Fort Monmouth, N. J. His background covers work on mechanical structures and electromechanical instrumentation in both the electronic and physical science fields. He has also directed a program for

UNI-CHASSIS BREADBOARD

Pays for Itself the First Time Used

CUTS BREADBOARD TIME 50%

The Uni-Chassis Method for breadboarding experimental or semi-permanent electronic circuits results in large time savings throughout the electronics laboratory. The aluminum Uni-Chassis is 7½ x 8¼ x 11 inches, drilled to accommodate 16 tube sockets of various sizes and provided with extra mountings for switches, potentiometers, and heavier components—almost any practical electronic circuit can be assembled without further drilling or special mountings. Four grooved and plated brass bus bars are mounted on insulated strips and run the full length of the Chassis. They are ideal for supplying common potentials by way of short leads to any part of the circuit.



UNI-LEAD SET

Twenty-two flexible test leads and an assortment of fittings—test prods, alligator clips, banana plugs, etc.—comprise the Uni-Lead Set. Each lead is fitted with beryllium copper terminals of special design which make tight spring contacts with all fittings and with chassis terminals.

PRICE: Together or separately; $7.50 Uni-Chassis only; $13.50 Uni-Lead Set; $19.50 Complete

UNI-PRODUCTS, div. of Uni-Science, Inc.
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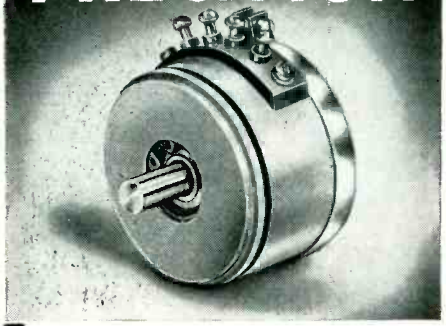
UNI PRODUCTS

PRECISION *Potentiometers*



Rattray precision potentiometers have a wide scope and cover many types and sizes, in the field of wire-wound units of high accuracy, long life and stability. Rattray's designs are compact, having mechanical and electrical capabilities of the highest quality. The two basic lines include: single and multiple turn linear and non-linear models. Rattray has the facilities for quantity production orders; fast deliveries made on sample and special requirement quantities.

Models	106	162	200	300	181-3	181-10
Dimensions:						
Diameter, in.	1.060	1.620	1.985	2.985	1.820	1.820
Length, single unit, in.	0.656	0.838	0.838	0.838	1.200	2.080
Add per section, in.	0.500	0.615	0.615	0.615	0.880	1.560
Resistance Range, ohms:						
Linear, max.	50,000	140,000	178,000	283,000	100,000	350,000
Non-linear			Depends on function involved.			
Electrical Contact Angle	350°	350°	350°	350°	1080°	3600°
Functional Tolerances:						
Linear	±0.35%	±0.15%	±0.10%	±0.075%	±0.1%	±0.075%
Non-linear	to ±0.5%	±0.5%	±0.4%	±0.3%	±0.5%	±0.3%
Torque Per Section, oz. in.	0.5	0.5	0.5	0.5	1.0	1.0
Wattage Rating at 40°C	1	2.5	4.0	5.0	3	5
Operating Temperature Range			− 55°C to + 75°C standard.			
Resolution, Max.	1/1500	1/2500	1/3300	1/5300	1/6000	1/20,000

Function tolerances indicated are typical and vary with resolution.
In all cases, extra taps can be provided as required.
Ball bearings available if required, and will increase length slightly.

Manufacturers Representatives: Many choice territories open.

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116-08 Myrtle Avenue Richmond Hill, 18, N. Y.

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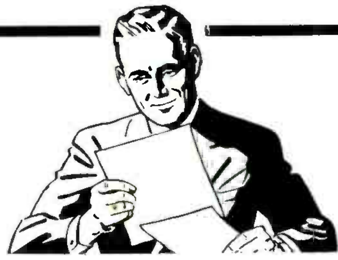
MIL-I-7444 SPECIFICATION VINYL TUBING

from Resin Industries



A Resinite *Certified Laboratory Test Report*, sent with your shipment of specification vinyl tubing, is your positive assurance that your shipment has been tested by us and conforms exactly with its applicable specification.

Certified Laboratory Test Reports, in addition to the usual certificates of compliance, are supplied by Resin Industries, at no extra cost to you, whenever you order Resinite EP-69 (MIL-I-7444) as well as certain other Resinite Specification tubings.

Here is an added service to you, designed to speed your processing of each shipment. It is one more reason why it pays to order specification vinyl tubing from Resin Industries, Inc.

Write today for samples and performance data.

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SPECIALISTS IN VINYL SLEEVING AND TUBING FOR THE AIRCRAFT, ELECTRONICS AND PHARMACEUTICAL FIELDS

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the development of a series of supporting structures, drives, controls and data recording systems.

Byron Jackson Acquires Rollin

BYRON JACKSON CO. of Los Angeles has purchased Rollin Co. of Pasadena, Calif., manufacturers of high-precision test equipment for electronic devices. Plans are under way for a new plant to house the added engineering and manufacturing facilities. Byron Jackson has been in pump manufacturing since 1872. Only in the past three years has the company branched into electronics.

Brew Moves To New Plant

RICHARD D. BREW CO., designers, developers and manufacturers of delay lines, moves into its new plant of 12,000 sq ft, adjacent to the Concord Airport in Concord, N. H.

Facilities include an electronic laboratory for design and testing of delay lines and associated components, a development engineering department, a machine shop for specialized tooling and a production department.

Loasby Promoted By Raytheon

FRANK LOASBY has been named director of sales engineering and service of Raytheon's television and radio operations.

Prior to joining Raytheon in 1952 as manager of the sales engineer-

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1. Glasseal hermetically sealed sub-miniature paper tubulars. Manufactured to the highest commercial standards and engineered to the exacting performance requirements of Military Specification MIL-C-25-A.
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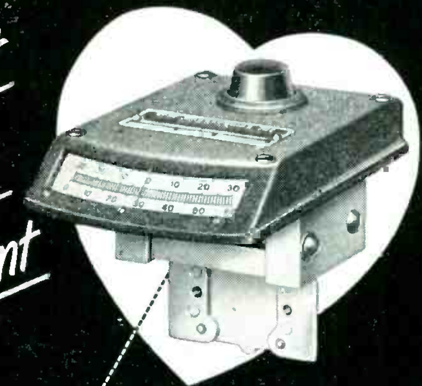

FOR MEASURING LIGHT reflectance and color, the Photovolt Corporation of New York uses a Model 600 G-M Galvanometer for its popular Reflection Meter (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

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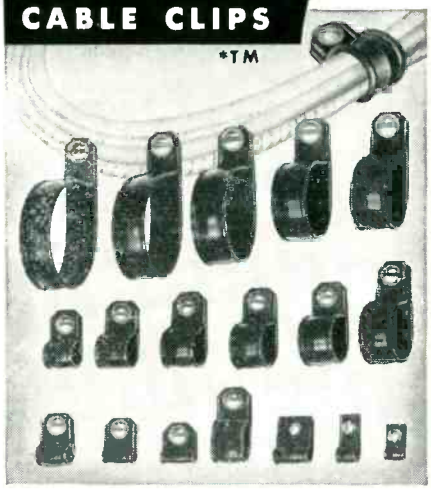

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Two special application kits of Carboloy® Thermistors (negative temperature coefficient resistors) are now available for design and application work. Each kit contains a selection of the most widely used styles and sizes.

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Kit #1, $20.00 FOR ENGINEERING APPRAISAL
Contains 18 Thermistors: two of each, in three styles and three sizes.

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Contains 104 Thermistors: twenty-six sizes and four styles. Also contains steel, lead and fibre washers, and tubing for building assemblies.

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ing laboratory, Loasby was owner of Sumac Industrial Research of Los Angeles, a firm devoted to industrial electronics control application research. He has also held positions with Libby of Culver City, California and with Electronic Chemical Engineering Company of Los Angeles.

Loasby succeeds C. W. Hoshour, who has resigned.

Neomatic Names Clifton Davis

CLIFTON H. DAVIS has been appointed assistant chief engineer of Neomatic, sub-miniature relay manufacturer in Los Angeles, California. He will serve directly under T. Ross Welch, president and chief engineer.

Hobson Named President Of Honor Society

J. E. HOBSON, director of Stanford Research Institute, has formally succeeded to the national presidency of Eta Kappa Nu Association, electrical engineering honor society with some 22,000 members throughout the world.

Retiring president is Eric T. B. Gross of the Illinois Institute of Technology.

Hobson was director of the department of electrical engineering at the University of Pittsburgh and professor of electrical engineering at Illinois Institute of Technology. He was director of Armour Research Foundation, Chicago, for four years before assuming leadership of Stanford Research Institute in March, 1948.

Dr. Hobson will preside at Eta

Kappa Nu's assembled convention at the time of its Golden Anniversary observance at the University of Illinois, Urbana, on October 15 and 16.

Ward Products Forms Antenna Lab

WARD PRODUCTS of Cleveland has established a new antenna research laboratory in Ashtabula, Ohio, for the design and testing of all types of television and automotive antennas. W. H. Rickards is director of engineering at Ward.

The new testing laboratory will supplement the facilities of Gabriel Electronics in Needham, Mass., for antenna research and development. Walter Domoracki, formerly with Philco, is the engineer in charge of the laboratory.

Florida Distributors Form Association

A state-wide group of electronic distributors has been formed in Florida to be known as the Florida Electronic Distributors Association. Officers for election when bylaws are adopted are: Harvey Herman, chairman; Sidney Lucker, treasurer and Theodore J. Sharaf, secretary.

Alectro Moves, Names Levy

ALECTRO moved into a new 6,000 sq ft plant in Los Angeles. The company, founded last year as National Development Co., is primarily a service organization de-round • • oval flat • • grooved ribbon •

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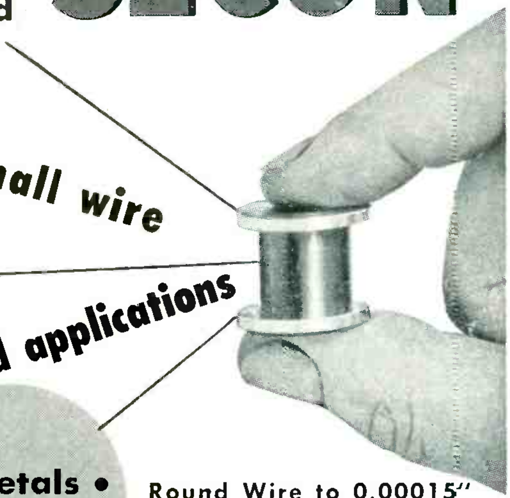

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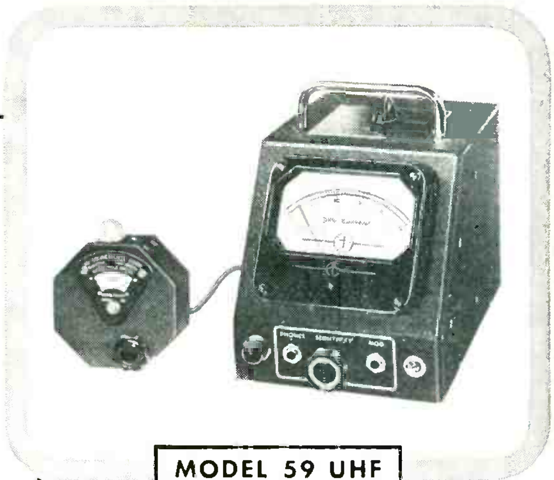

MODEL 59 UHF

SPECIFICATIONS

FREQUENCY RANGE: 430-940 Mc in a single band
FREQUENCY ACCURACY: ±2% (Individually calibrated)
OUTPUT: CW or 120-cycle modulation
POWER SUPPLY: 117 volts, 60 cycles, 30 watts
DIMENSIONS: Oscillator Unit 4⅝" x 2½"
Power Unit 5⅛" wide x 6⅛" high x 7½" deep

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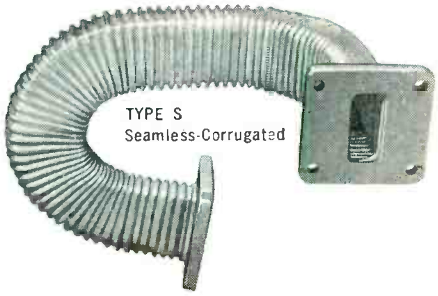

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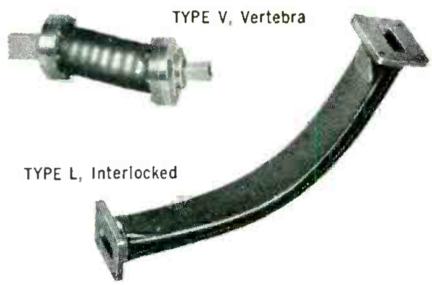

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signing and producing electronic components.

Sol E. Levy, formerly in charge of development engineering, has been appointed vice-president and general manager. His experience includes development engineering at Western Geophysical Co. of Los Angeles and National Union Radio in Newark, New Jersey.

Robert E. Baddorf, former assistant professor of electrical engineering at University of Southern California and design engineer at Sola Electric of Chicago, is president. Lloyd Thornblad, former design engineer at Robert M. Hadley Co. in Los Angeles, and lecturer in engineering at U.S.C., is secretary-treasurer.

National Company Expands Staff

UNDER THE DIRECTION of Raul H. Frye, vice-president of engineering, the National Company expects within the next year to double its present research and engineering staff. Reasons for the expansion move, according to Frye, are to complete engineering and development on several new government defense contracts recently awarded to the firm and to accomplish the first step in the company's plan for broad expansion of its commercial line of electronics products.

McNamee Heads Dressen-Barnes Research

B. F. McNAMEE has been appointed chief of research and development

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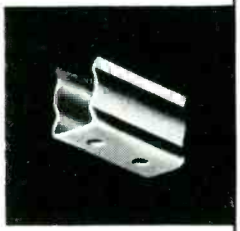

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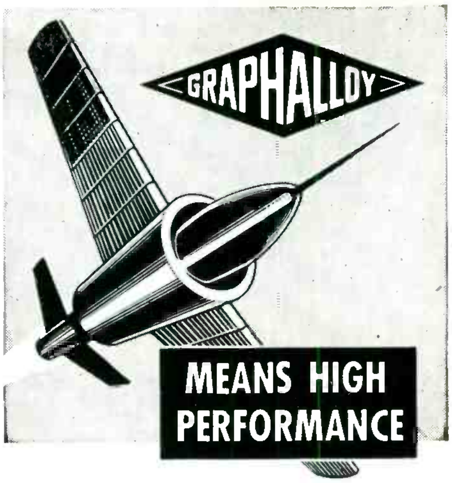

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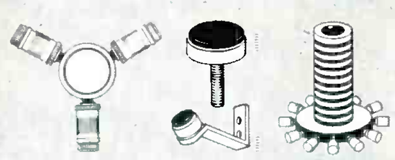

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of motor controls and power supplies for Dressen-Barnes Corp. of Pasadena, California. McNamee has designed such geophysical instruments as seismometers and recorders. He has also designed and built many types of automatic motor speed controls, from fractional horsepower ratings up to larger industrial sizes, as well as automatic voltage controls for electric generators.

Giannini Appoints Chief Designer

J. F. STEIGERWALD has been appointed chief designer of the corporate engineering division of G. M. Giannini & Co. He was formerly chief production engineer with Jack & Heintz of Cleveland, manufacturing manager of Aerojet Engineering Corp. of Azusa, California, and vice-president and production manager of the Bill Jack Scientific Instrument Co.

Steigerwald will be responsible for tooling, processing, and production design of instruments developed by the Giannini division.

Stanford Research Appoints Baker

RICHARD H. BAKER, former electronic computing and control systems consultant, has joined the staff of Stanford Research Institute as a systems engineer. He will work in the recently expanded electronic data processing unit, a section of SRI's division of industrial economics research.

In recent years Baker has carried on independent research and acted as consultant on computing and control system design and application for equipment manufacturers and the Department of Defense.

He previously organized an electronics research laboratory while acting as chief engineer of Digital Controls of La Jolla, Calif.

Earlier he initiated a program of digital electronic systems research and development with the Bill Jack Scientific Instrument Co. of Solana Beach, Calif.

Before that, he was with the special weapons research division of Northrop Aircraft Co., Haw-

thorne, Calif., where he designed computer systems and installed and tested the BINAC—one of the first high-speed digital computers.

Convair Works On Missile Test Facility

CONSTRUCTION has started for a new $250,000 test facility on Point Loma, Calif., for one of the U. S. Air Force's guided missile programs.

Ground has already been broken on the five-acre government site on Fort Rosecrans. One of the major structures will be a steel tower covered with aluminum sheeting on three sides. Other structures will include two sheds and a horizontal testing fixture for vibration and air-pressure tests. The facility is not designed for firing missiles, but for testing components and systems.

Convair engineers are in charge of the project. They are H. A. Smith, chief plant engineer, and Charles U. Giusti, construction engineer.

Polarad Forms Computer Division

POLARAD ELECTRONICS has formed a computer division under the direction and supervision of Leroy Packer. The organization will be located at the firm's Brooklyn plant and will be concerned with the development and application of electronic computer techniques, services and equipment for industrial and government applications.

From 1948 to 1950, Packer was a research engineer on the staff of

Leroy Packer

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the Franklin Institute research laboratories, where he did work on airplane simulators and developed a new device for the electronic testing of abrasive wheels.

From 1950 to 1952 Packer was section leader of the input devices section of the research division of Burroughs Corp. He did research on high speed input devices for large scale digital computers and transistor circuit development.

In 1952, he joined the staff of the Columbia University electronics research laboratory where he was group leader of the digital techniques group. Here, he directed research work on navigational and guidance systems, and developed digital devices for use in the tracking of military aircraft.

Du Mont Tube Division Promotes Scott

ROBERT G. SCOTT has been named assistant sales manager of the cathode-ray tube division of A. B. Du Mont Labs.

As well as assisting in the management of the tube sales department, Scott will continue to contact television receiver manufacturers in the dual capacity of technical consultant and home office sales representative.

Scott joined Du Mont in 1948, as a senior engineer working on the design and development of important picture-tube innovations such as large screens, short necks, and wide-angle deflection. He later transferred to product engineering, where he followed these developments through their initial mass-production stages.

For the past two years, Scott has been manager of sales engineering of the c-r tube division.

Buckingham To Receive Wetherill Medal

A JOHN PRICE WETHERILL MEDAL will be awarded to William D. Buckingham of Western Union Telegraph Company by The Franklin Institute of Pennsylvania. The Medal is awarded for discovery or invention in the physical sciences. With the award is a citation which

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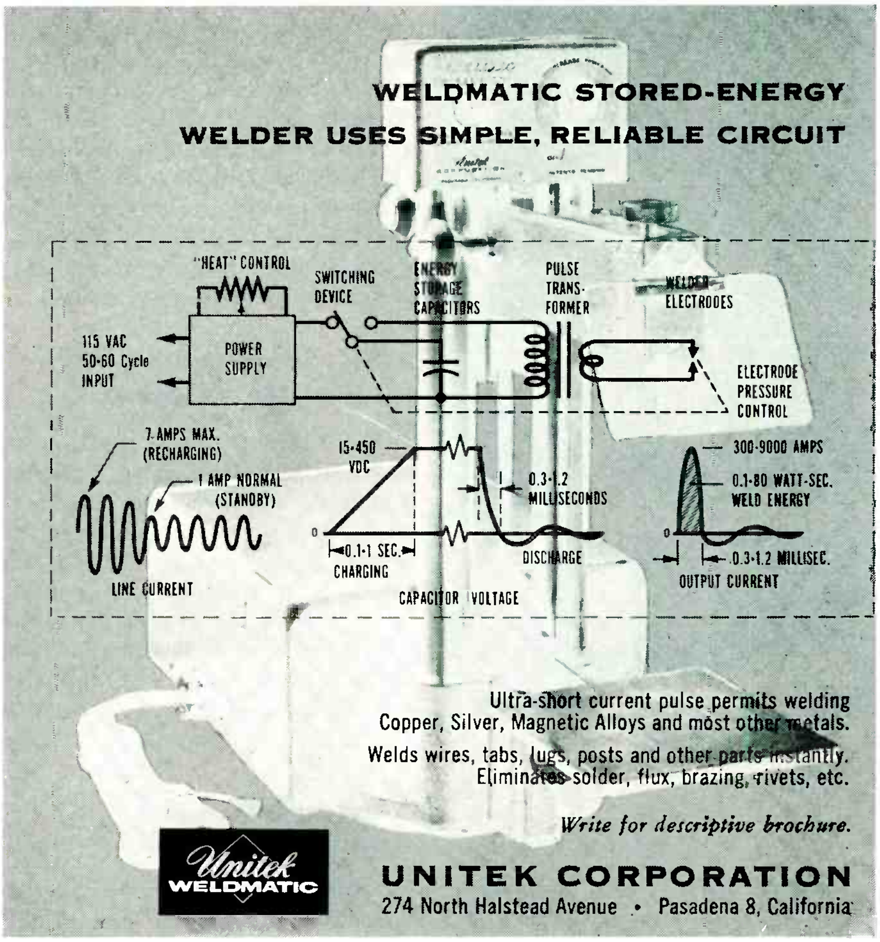

reads "In consideration of his invention of the Zirconium Concentrated-Arc Lamp, a device capable of producing a high intensity, sharply defined, extremely small beam of light and with modulation characteristics heretofore unobtainable in practical devices."

Buckingham joined Western Union in 1925. In 1927 he was transferred to the Electronics Research Division Laboratory at Water Mill, Long Island, where he has been active in applying electronic techniques and equipment to land line and cable devices. He has to his credit 19 United States patents in addition to the patents on concentrated-arc lamps.

George Norman Joins Sprague Electric

GEORGE H. L. NORMAN has joined Sprague Electric as coordinator of the company's activities in the field of electronic computer components. He was general sales manager of the new products division of Corning Glass.

Previously, Norman spent a total of 17 years with Aerovox Corp. He was at one time chief engineer and factory manager of Aerovox Canada, and was later chief engineer of the mica division of the firm's main plant at New Bedford, Mass. During World War II, he spent five years with the Canadian Air Force and was deputy director of airborne radar development.

AIEE Broadcasting Committee Named

J. B. EPPERSON of Scripps-Howard Radio in Cleveland, Ohio, has been appointed chairman of the television and aural broadcasting committee of the AIEE. He succeeds C. E. Dean of Hazeltine Laboratories. C. M. Braum of the Joint Committee on Educational Television is the new vice-chairman and R. K. Hellmann of Hazeltine Laboratories is secretary.

Technicraft Labs Appoints Eddy

FRANCIS T. EDDY, formerly assistant superintendent of the Water-

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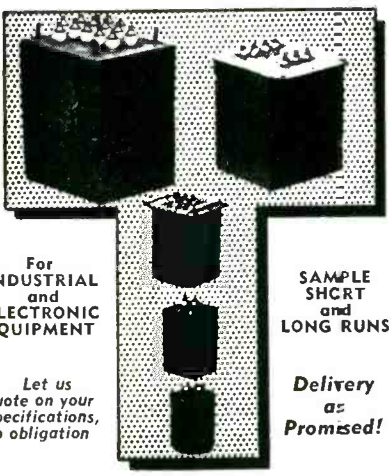

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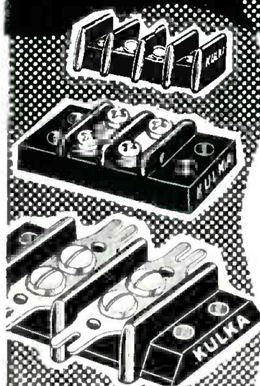

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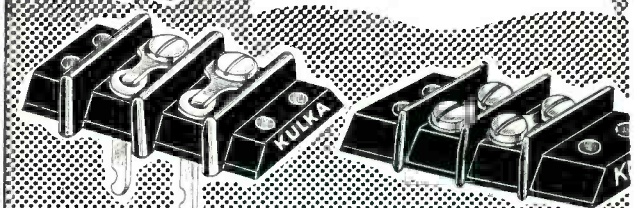

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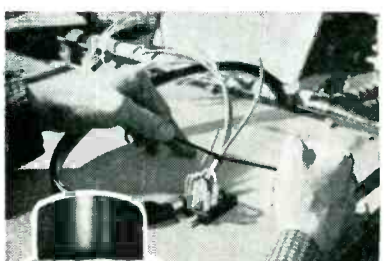

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Foreign Agent: Turner, Halsey Co. Inc., 40 Worth St., N.Y.

bury Mfg. Co. of Chase Brass and Copper, has been named assistant manager of Technicraft Laboratories, reporting directly to Alfred M. Winchell, president and general manager.

Eddy will be in charge of sales and manufacturing operations including production, purchasing and factory engineering.

Telecomputing Plans New California Plant

TELECOMPUTING CORP., of Burbank, California, computing equipment and service firm, will start construction on a 50,000 sq ft, $430,000 plant in San Fernando Valley, Calif. The plant, expected to be complete by the year's end, will employ 500 workers for manufacture of Telecomputing's Point 'o Sale Recorder, an automatic sales recording device that sorts sales information for inventory control.

Sessions Clock Forms Industrial Division

AN INDUSTRIAL products division of The Sessions Clock Company has been established. It consolidates all former sales activities for clock radio timers, clock movements and industrial timing motors. Establishment of the division is designed to increase selling and service efficiency to industrial customers. As a result of this move, there are now two main product divisions at Sessions of equal importance—the clock division and the industrial products division.

Vernon A. Lee has been named manager of the division.

Scintilla Celebrates Plant Expansion

BENDIX AVIATION formally opened its new electronics building at the Scintilla division in Sidney, N. Y.

Production operations in the new 30,000 sq ft building will be devoted to the manufacture of coils, capacitors, filters, spark gaps and jet ignition units.

Want more information? Use post card on last page.

NEW BOOKS

Introduction to Microwaves and Their Scientific Applications

BY H. H. KLINGER, S. HIRZEL, *Stuttgart, Germany*, 1953, 118 *pages*, 9.60 *German marks.*

ACCORDING to the preface, this little book was written for students and physicists familiar with electronic fundamentals but not so well versed in the technique of high frequencies. The main subject of the book is the use of microwaves as a tool in physics, chemistry, astronomy and biology; a highly condensed but thoroughly readable review of principles and practices employed in microwave work (wave guides, cavity resonators, generators, detectors, methods of measurement) occupies the initial forty pages.

In the main part—the applications of microwaves in science—a remarkable amount of useful information can be found. In microwave spectroscopy, for instance, rotational spectra are discussed in great detail; inversion spectra, Stark and Zeman effects, etc. are explained and many examples are described. Other chapters discuss magnetic-resonance effects, dispersion and relaxation phenomena in polar liquids and high-frequency metallic conduction at low temperatures. There is also much interesting material in the chapter on biological effects of microwaves.

A few pages on radio astronomy and astrophysics, severely limited by lack of space, report measurements of solar and lunar radiation. A chapter on typical microwave experiments may appear, at first glance, to be merely a collection of well-known laboratory devices, but even here many readers will learn things they had overlooked, as for instance the distinction between two radically different types of metal array lenses. A final chapter on particle accelerators using microwaves is too short even for such a highly condensed book.

The bibliography, which lists 85 titles, gives an incomplete but truly international collection of references up to about 1952.

One might expect that such a wealth of material would make a

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hundred-twenty-page book rather rough reading; surprisingly, this is not at all true. Readers with a fair knowledge of German will find this a pleasant and sensible introduction to some highly interesting fields of research in physics. One is inclined to reverse the author's recommendation and suggest this little book to the attention of students and engineers who know a lot about microwaves but would like to learn more about physics.—ROBERT ADLER, *Research Department, Zenith Radio Corporation*

Electronics

BY THOMAS BENJAMIN BROWN, *George Washington University, John Wiley & Sons, Inc., New York, N. Y.*, 545 *pages*, 1954, $7.50.

Electronics

BY GEORGE F. CORCORAN AND HENRY W. PRICE, *University of Maryland, John Wiley & Sons, Inc., New York, N. Y.*, 460 *pages*, 1954, $7.00.

Electronics

BY A. T. STARR, *Pitman Publishing Co., New York, N. Y.*, 1954, 395 *pages*, $7.50.

Active Networks

BY VINCENT C. RIDEOUT, *University of Wisconsin, Prentice-Hall, Inc., New York, N. Y.*, 485 *pages*, 1954, $10.65.

FOUR new books on electronics to serve the oncoming generation of engineers, each with somewhat different viewpoints, each useful as texts, each pointing up the vast expanse that continues in this amazing field.

Professor Brown's Book

After 35 years of teaching courses in tubes and their applications the author of this text ought to know what he wants, what he has found to be the most satisfactory arrangement and the best order in which to take up the many and varied subjects, even if that order is not too logical. Professor Brown has not been completely satisfied with what he has had to use during this teaching period, and his present text is the result of searching but not finding his ideal.

This is really a combined text and laboratory manual. The third paragraph in the book is a demonstration of diode current, not secured

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by the old method of plotting, laboriously, the current point by point as a function of anode potential but by the modern method of using an oscilloscope to see visually the entire characteristic. Throughout the text will be found demonstrations and laboratory experiments. One of the features of the opening chapter is a derivation of Child's law.

Following chapters on conventional subjects, the final part of the book deals with electronic instruments, oscilloscopes, voltmeters, bridges etc., and finally several appendices giving tube data, advice on planning and equipping a laboratory, derivation of the Schottky effect and closing with crystal rectifiers and transistors.

The Corcoran-Price Book

This, too, is a first-course book, somewhat more mathematical than Professor Brown's text, expending more space on the fundamentals of field concepts, mobile charge behavior, thermionic emission, diode behavior and is perhaps more orthodox in its arrangement.

Progress is steady from diodes to more complex tube structures and behavior, to linear and nonlinear amplifiers, feedback circuits, gas-filled tubes and applications, with some 65 pages on germanium diodes and transistors. The final chapter deals with oscillators.

Many problems and many examples of circuits with realistic constants aid in giving the student a feel for practical electronics.

Active Networks

For the reader who has studied the physics of vacuum tubes and related devices (or who is not especially interested in this aspect of electronics) this book of Professor Rideout covers the fundamentals of all networks capable of amplification, that is, tube circuits, transistors, magnetic amplifiers, and, to a much lesser extent, servos.

After a first chapter on fundamental concepts—networks, lines, communication systems—the book really begins with amplifiers of the several types. It is interesting that magnetic amplifiers and transistors are introduced with no fanfare

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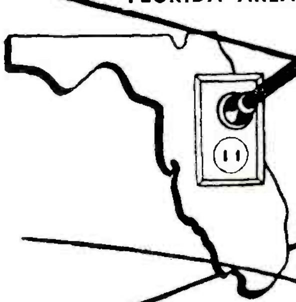

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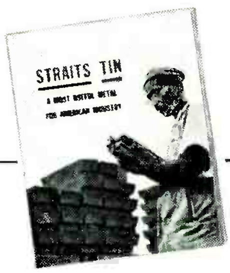

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whatever. Then follow low-pass amplifiers, transient response of amplifiers, and after several chapters dealing with the several well-known divisions of amplifiers, such matters as oscillators, modulation systems, wave-shaping circuits including trigger circuits and finally a chapter on noise and information theory.

In appendices will be found a brief exposition of Fourier analysis, Laplace transformation and charts of characteristic tube and transistor curves and data.

All of these books provide the instructor with distinctly teachable texts, with "Active Networks" somewhat out of the conventional pattern and with the other three "Electronics" more conventional but distinctly up to date.

Starr's Electronics

This is a typically British text with emphasis on the analytical treatment of circuits and tube functions rather than on engineering applications. It should be very useful as an undergraduate text or for an engineer who wishes terse mathematical discussions of basic material.

It has more on the fundamental aspects of electronics—wave theory, electron ballistics, semiconductors, gaseous discharges, energy levels—than the other texts noted herein and the entire treatment is mathematical rather than descriptive. The mathematics involves ordinary calculus, some usage of Heaviside notation, Laplace transforms, Fourier analysis but with sufficient explanation so that the tyro can use it. Appendices give mathematical formulas, steady-state a-c theory, Maxwell's equations and other useful material.

Chapter headings are Physical Fundamentals, Valves, Rectification, Circuit Theory, Amplifiers, Oscillators and Detectors, Electronic Applications (32 pages), plus the seven appendices.

The American reader will run across terms not employed here such as trigatron, the nomotron circuit, long-tailed pair, megslip, velodyne and others but they are quickly identified with their American equivalents.—K.H.

(Continued on p. 446)

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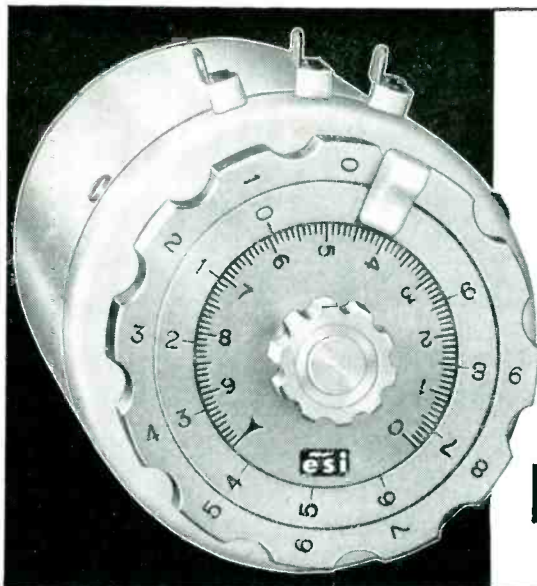

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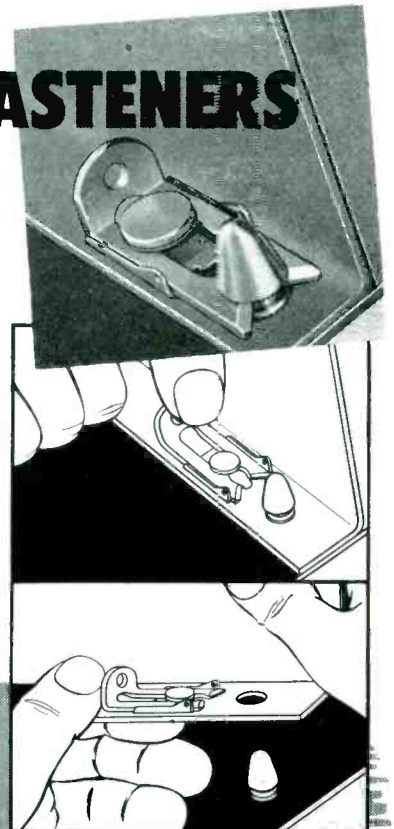

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Theory and Design of Electron Beams

By J. R. Pierce. *Second Edition, D. Van Nostrand Company, Inc., Toronto, New York, London,* 1954, 222 *pages*, $4.50.

Pierce's book has, no doubt, become a standard reference for tube engineers whose job it is to design electron tubes employing high-current electron beams. It contains in one volume all the necessary basic theoretical material, obviating any need to search the scattered literature. It is this convenience and the knowledge that an authority has collected the material which justify the existence of this book. An engineer suddenly confronted with the task of designing beam generating and guiding structures will, therefore, find it very useful.

Electron Optics

Chapter I, "Properties of Electric and Magnetic Fields", deals with the fields which are found in such devices as cathode-ray tubes, triodes and some microwave tubes employing means of focusing electron streams. In other words, it deals with the theory of quasistatic fields.

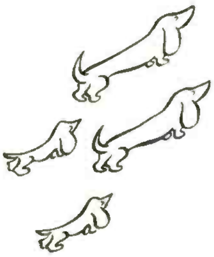
Chapter II, "Forces and Equations of Motion", discusses the Lorentz equation for non-relativistic motion and contains a paragraph on scaling.

In Chapter III, "Simple Motions", the general equations of motion are applied to the special cases of motion in uniform electric and/or magnetic fields and in the electric field produced by hyperbolic electrodes.

In Chapter IV, "Some General Relations", a few more simple cases of electron motion are discussed, and some general laws such as the conservation of angular momentum, Busch's theorem and Liouville's theorem are treated. The concept of "index of refraction" for purely electric fields is also introduced.

Chapter V, "Some Typical Special Problems", deals principally with a discussion of analogue devices useful in the solution of problems of electron motion.

Chapter VI, "The Paraxial Ray Equation", is a chapter on elementary electron optics or the motion of electrons in rotationally symmet-



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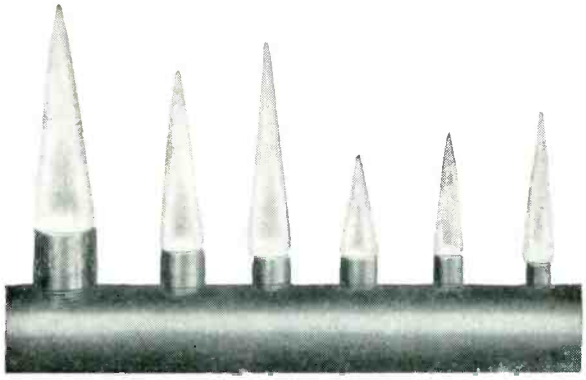

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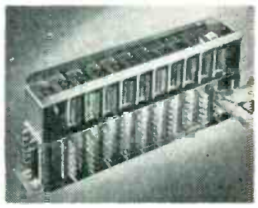

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PERMAG CORP., 210 TAAFFE PL., BROOKLYN 5, N. Y. – Phone: MAin 2-0114 rical and two-dimensional fields where space-charge effects are neglected.

Chapter VII, "Magnetic and Electric Lenses: Analytical and Numerical Solutions", contains some more elementary electron optics of several commonly used electron lenses.

Guns and Focusing Systems

The material of Chapters I to VII, constituting about one-half of the book, is contained in most books on electron optics. Chapters VIII to XI are the important chapters of the book, and a student of electrical engineering or an engineer concerned with design of guns and focusing systems should be able to understand these chapters even in the absence of Chapters I to VII.

Chapter VIII, "The Effect of Thermal Velocities", deals with the effects of the Maxwellian velocity distribution in an electron stream emitted from a cathode. This chapter is almost a reprint of Pierce's original paper on this subject. The material seems to have withstood any attempts to derive the results in a more straightforward manner.

Chapter IX, "Space Charge in Electron Beams", discusses the spreading of a drifting electron beam due to space-charge-repulsion effects and means to prevent such spreading by the use of a uniform longitudinal magnetic focusing field (Brillouin flow and confined flow). Questions of stability of the flow and the effects of the presense of ions are briefly discussed. The second edition of Pierce's book contains a new paragraph on "Harris flow".

Chapter X, "Electron Guns", discusses the important theory of the so-called Pierce gun and gives design information for such a gun.

New Material

The last chapter, "Periodic Focusing Fields", the addition of which was no doubt the chief reason for printing the second edition, is quite short. One cannot help feeling that a delay in publication might have made it possible to enlarge this last chapter. It deals with theory of beam focusing by means of a series of electron lenses arranged periodically along the electron beam. If these periodic fields are generated by means of permanent magnets, a sizable weight reduction of the focusing means and auxilliary equipment seems possible. Important investigations in this connection are being carried out but are still in the early stages so that new information being gathered must be reserved for a third edition.

In summary, this reviewer would like to state that Pierce accomplished his aim "to collect together with reasonable orderliness the minimum amount of theoretical material necessary for a good understanding of electron flow and electron focusing in devices other than electron microscopes and image tubes".

Unfortunately, the design engineer, equipped with the knowledge contained in Pierce's book, soon finds out that this knowledge is only necessary but not sufficient. Such an engineer will feel that the book would have been more useful if it had contained instead of Chapters I to VII descriptive experimental material with examples of actual structures and discussions of factors causing discrepancies between simple theory and experimental results. The author is well qualified and could have done better than to state "No attempt is made to deal with problems of experimental technique; concerning these I offer nothing but sympathy".—R. G. E. HUTTER, *Sylvania Electric Products, Inc.*

Introduction to Electric Fields

BY WALTER E. ROGERS. *McGraw-Hill Book Co., Inc., New York*, 1954, 333 *pages*, $7.50.

DESIGNED to provide a text for a one-semester or one-quarter course for junior and senior electrical engineering students taking either communications or power option, this book indeed constitutes an adequate introduction to the subject of electromagnetic field theory. As such, it presumes no prior training in vector analysis and only a nodding acquaintance with differential equations.

The books starts off with a 26-

page treatment of elementary operations with vectors. The concepts of gradient, divergence and curl, however, are introduced later in connection with discussion of electric potential, Gauss' law and Ampere's law, respectively. Methods for solving the necessary differential equations are described in some detail as the equations are encountered.

Approach

In the main, the book furnishes an approach to Maxwell's equations through a study of electrostatic and electromagnetic fields. Vector methods are employed throughout. The book is long on providing practical experience in working with field problems.

A valuable contribution is the graphical presentation of field configurations. These presentations are obtained using both the fluid-mapping methods developed by A. D. Moore of the University of Michigan and a membrane-analog method developed by the author. This latter method makes use of a taut rubber sheet suitably deformed and illuminated. An appendix describing both methods in some detail is provided for use by instructors who desire to plan laboratory work to accompany a course taught from this text.

The text's approach to Maxwell's equations is by way of studying Coulomb's law, the concept of potential, the field of an electric current, Gauss' law, the equations of Poisson and Laplace, the magnetostatic field and time-varying electric and magnetic fields. Also included is material on solution of field problems by the method of images and on the properties of dielectrics and insulation. The final chapter discusses the vector potential.

The text is adequately indexed and particularly strong on problem material both inserted in running text to explain the concepts introduced and for assignment to the student.—J.C.

Coil Winding

BY WILLIAM QUERFURTH, *Geo. Stevens Mfg., Co., Chicago, Ill.*, 128 *pages*, 1954, $6.50.

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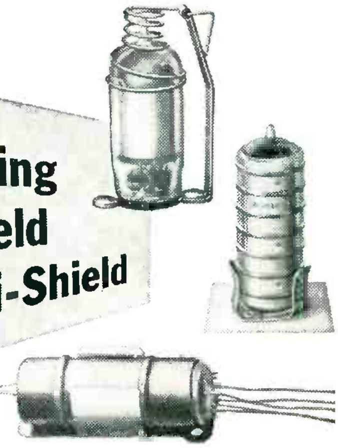

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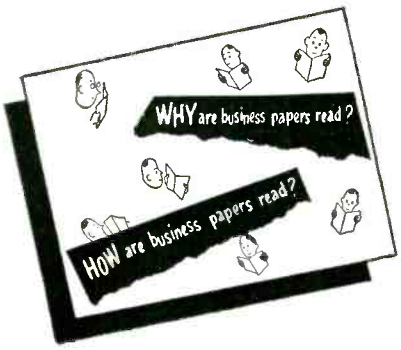

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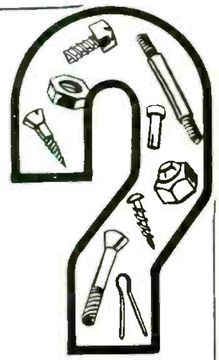

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Controllers for Electric Motors

BY HENRY D. JAMES AND LEWIS E. MARKLE. *Second Edition, McGraw-Hill Book Co., Inc., N. Y.,* 1953, 426 *pages,* $7.00.

THIS book is primarly intended for maintenance personnel engaged in work with industrial motor-control systems. Main emphasis is placed on electrical control systems; electronics comes into the picture only in the form of conventional magnetic amplifier controls.

The book gives a good technical description of the factors involved in motor controlling and describes the electrical engineer's way of achieving control by the means at his disposal. It should be of value to electronics engineers in showing him the limitations of nonelectronic systems and in teaching him basic concepts for applying electronic controls.—J.D.F.

The Cyclotron

BY W. B. MANN. *John Wiley and Sons, Inc., (Methuen's Monographs on Physical Subjects), New York, 4th edition,* 1954, 118 *pages,* $2.00.

THIS is a new edition of a book first published in 1940, when Professor Ernest O. Lawrence wrote (in the Preface), "Let us cherish the hope that the day is not far distant when such a great cyclotron will be built!" The dream which was the object of this sentiment was a cyclotron capable of accelerating helium ions to 100 or possibly 200 million volts. That dream has been eminently fulfilled, notably at Professor Lawrence's own laboratory in Berkeley, California, where a 184-in. synchrocyclotron has accelerated alpha particles to 400 Mev.

The author, formerly associated

with Imperial College at the University of London, is at present a member of the staff of the U.S. National Bureau of Standards. In publishing a 4th edition of this now classic monograph, Methuen is filling a real gap in the literature of high-energy machines. There is, in fact, no other book-length treatment of this subject in English.

Dr. Mann's text is not highly mathematical, and can be easily followed by anyone who has ever sat in on an undergraduate course in atomic physics. If the discussion of cyclotron applications is neglected, college freshman mathematics becomes sufficient for an understanding of this largely qualitative text, which was actually aimed at readers working outside the realm of high-energy physics.

The fact that the book was originally written during a period when the designers of high-energy machines first began making great strides adds another facet to the interest with which this volume should be received—as an important contribution to the history of modern physics.

That is not to say that the book is of historical interest only: an epilogue, added in 1953, manages to bring the reader up to date. Moreover, as an exposition of the basic principles underlying the design and operation of cyclotrons, the book is not likely to be soon obsolete.—CHARLES SÜSSKIND, *Stanford University, Stanford, Calif.*

Electron Optics

THROUGH ERROR, the review of O. Klemperer's book, published in September 1953 ELECTRONICS, contained the statement that the book had no index. The reasons for this error are as follows: the publishers sent ELECTRONICS a proof copy of the book; this was duly furnished to E. G. Ramberg, the reviewer, who noted that there was no index and properly commented on this fact. The book as published, however, does contain an index and this fact was not checked by the editors before Mr. Ramberg's review was published. This mis-statement is regretted.

THE EDITORS

BACKTALK

Ionic or Iontic?

DEAR SIRS:

IN MOST cases, non-Greek scientists have adopted Greek words to express scientific conceptions with such success that they have drawn the admiration of the Greek scientists themselves. . . .

However, the basic term *ion* is the neuter of the present participle of the Greek verb *ienai*, to go. This term *ion* is quite correct as regards English pronunciation, spelling and meaning. But its derivatives and compounds, as they are used by non-Greek authors are not only incorrect but they are also confusing. . . .

Introducers of the derivatives or compounds have added to the original word *ion* the respective suffix, or additional word, to form new words having new meanings; the terms ionic, ionization, to ionize and ionosphere have been formed.

But the correct spelling of the first of them ought to be *iontic* to retain its proper meaning and not *ionic* because the adpective ionic comes from the Greek adjective *ionikos* having the meaning: "Of or pertaining to Ionia or the Ionians", an ancient Greek land and race, respectively. . . .

Ionic is also a synonym of *ionian* which, in addition to having the above meaning, refers to the Ionian Islands of to-day . . . no relation whatever to the electrically charged atoms, molecules or radicals. . . .

When we wish to produce a composite word relating to *ion* we have to use the root of the word, which is *iont-* (or ionto- for euphony) adding to it the suffix or the second constituent word . . . it has been done for *iontophoresis*. Can it not be done for a few more terms?

There is also the new radioactive isotope ionium, which should be spelled and pronounced: *iontium*, unless the introducer had in mind to honor the memory of the mythological Io, the ancient Greek priestess whose name is borne by the Ionian Sea.

So it follows that we should use the correct spelling and pronuncia-

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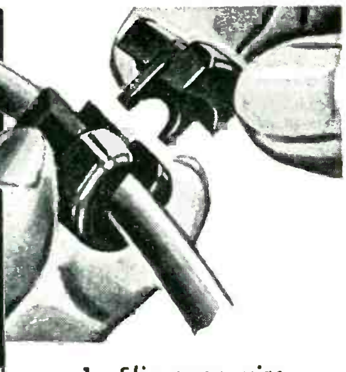
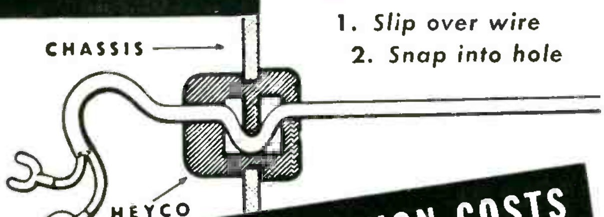
anchor power cords to the housing & eliminate strain on terminals





1. *Slip over wire*
2. *Snap into hole*

CUT PRODUCTION COSTS IMPROVE PRODUCT QUALITY

● Heycos absorb all cord pull, push and torque and insulate wire from housing. Product life is increased and product appearance is improved. Samples available on receipt of wire sizes.

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ASK FOR BULLETIN 33

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- Rise Time: 0.02 microseconds.
- Output Impedances:
  75 ohms (2.5 volts max.)
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- Self-contained regulated supply.

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Stability refers to the ability of a resistor to retain its ohmic value during its entire useful life, and under varying conditions. Tolerance, on the other hand, is simply a statement of the ohmic limits within which the resistor was selected.

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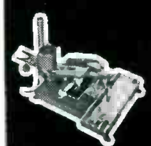

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tion with the terms iontic beam, iontic current, iontic focusing, iontic mobility, iontic modulation, iontic product, iontic strength, iontic theory, iontic valve, iontic medication, iontically heated, ionti-zation current, iontization gauge, iontization manometer, iontization temperature, iontization spectro-meter, iontization chamber, iontiza-tion potential, de-iontization poten-tial, iontization voltage, iontized layer, iontized gas, iontospheric ray, iontospheric wave, ionto-spheric path, iontospheric dis-turbance, iontospheric storm and iontospheric cyclic variations.

I believe the real electrical or electronic era is not at its end but at its beginning, and that electrical, radio and electronic terms have not yet attained their final form. They are continually evolving . . . to become more and more clear and precise. Therefore, in the case under consideration we should be bound to accept the correct terms. . . .

DIONYSIUS J. BATAIMIS
Member of the Technical Services
Hellenic National Broadcasting Institute
Athens, Greece

Editor's Note: Mr. Bataimis certainly presents a strong case. We wonder who so correctly introduced the word iontophoresis for the medical introduction of ions into tissues of the body?

Feedback

DEAR SIRS:

I WAS interested in Joseph Diamond's article, p 148, Nov. 1953 ELECTRONICS, and I would offer these comments on some of the points your contributor makes.

In his very first column he says, "a tetrode stage . . . raises a stability problem that has not been discussed before".

Now in point of fact P. J. Baxendall discussed this very problem (of applying over 30 db N.F. to 6L6's to get less than 0.1 percent distortion) in *Wireless World* of January 1948. This article was subsequently reprinted with others as a booklet, "High Quality Amplifiers."

It is true that Baxendall uses a separate feedback winding which may be covered by Mayo's patent cited, but the distortion is 0.1 percent for 10 watts, which is all Diamond can get for 0.1 percent. Moreover, Baxendall's design does give square waves at 30 cps.

Referring to Diamond's Fig. 2, . . . for 18 watts the distortion is about 0.55 percent which puts the apparatus in the public address category and not hi-fi if one uses all loud speakers in series to give 100 ohms.

On p 149 (middle column) he says the anode follower gives excellent balance at 1 mc. This is open to question. Due to circuit strays an uncompensated anode follower begins to drop off somewhere about 10-20 kc. To make an anode follower go up to 1 mc it is necessary to use shunting condensers as described by Sowerby in *Wireless World*, p 447, Sept. 1948.

I would not say it is necessary or desirable to incorporate a 1-mc flat anode follower in the triple feedback circuit but it seems Diamond was claiming too much for the plain anode follower.

Williamson made his amplifier to be flat up to about 200 kc to deal adequately with recording characteristics. As is well known flatness up to upper audio limits requires low phase shift at carrier frequencies (100-200 kc). . .

Without in any way deprecating Diamond's article I would suggest that it is probable that the scheme has been in use since 1945 by the English company H. J. Lenk & Co., which marketed (since that date) the "Triple Loop" 0.1-percent distortion amplifier.

Where, I think, the triple loop feedback scheme may score is that it possibly permits of moderate fidelity without special large and expensive output transformers.

On the whole the triple loop feedback scheme does not seem to be so vastly superior to the positive-negative feedback scheme expounded by John Miller (p 106 March, 1950, ELECTRONICS). There are several more feedback components including electrolytic 8-μf condensers and for commercial "cut-rate" production the positive negative feedback scheme scores on component costs.

Nevertheless Diamond's article was very interesting.

F. B. WHITE
London, England

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Radio, Audio, Industrial Electronic Appliances

SEARCHLIGHT SECTION

(CLASSIFIED ADVERTISING)

Continued on pages 460-494

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(Continued on the following page)

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RA-3954, Electronics
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FOR THE FIELD OF ELECTRONICS

This CONTACTS Section

supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.

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(Continued from preceding page)

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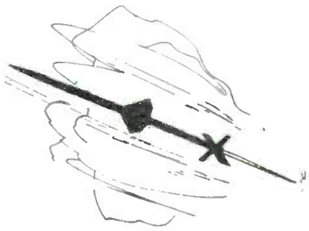

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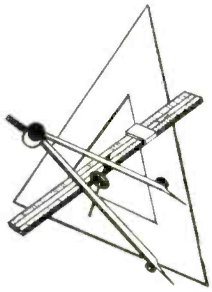

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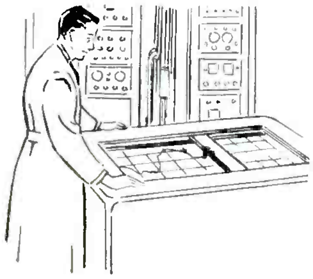

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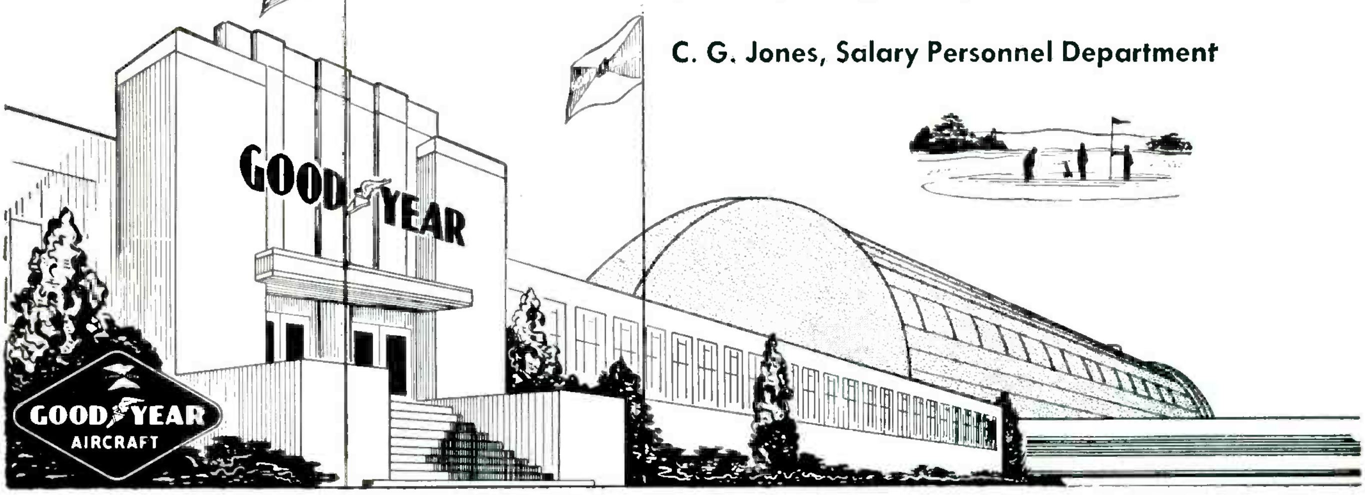

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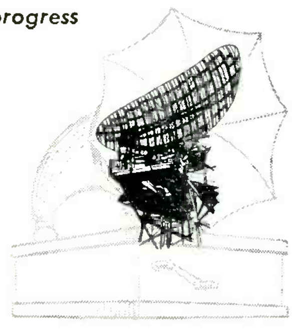

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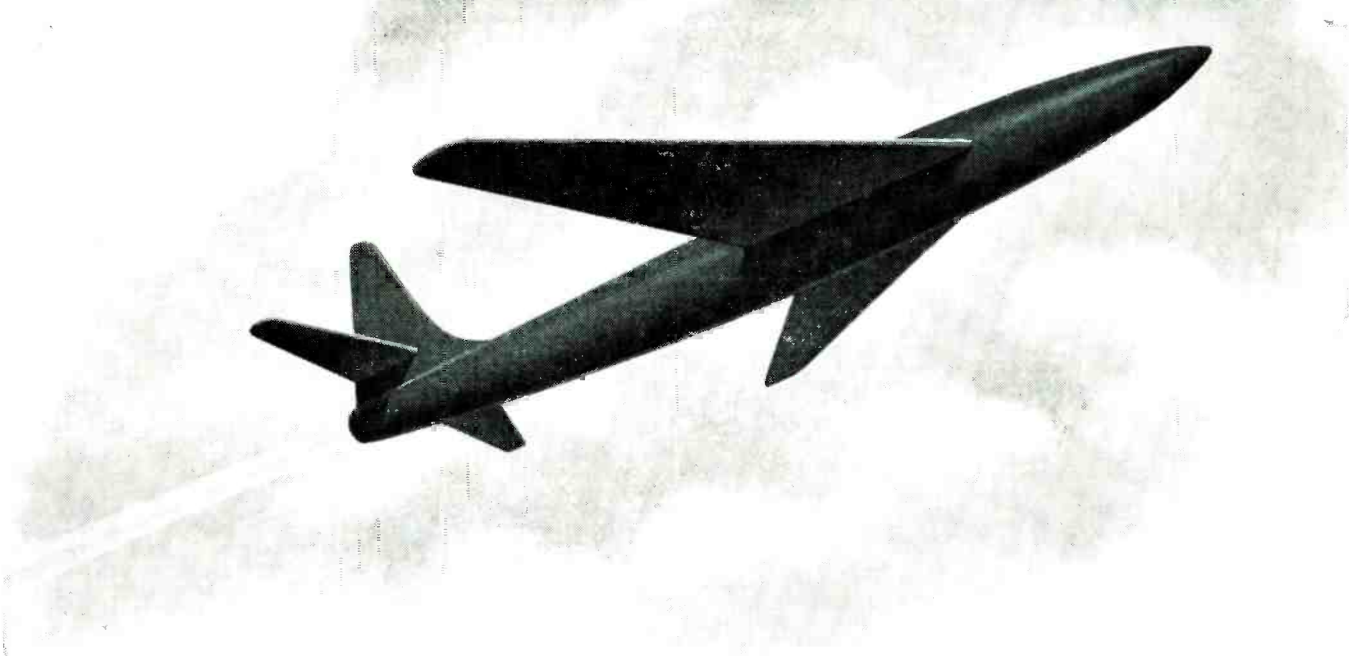

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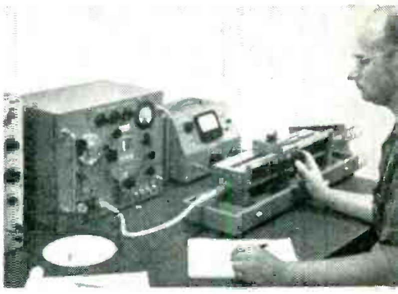

Electronics Research Engineer F. R. Zboril measures input impedance of a scale model helical antenna array used for ground tracking of missiles. Most of Lockheed's other antenna work involves advanced research studies on flush mounted antennas.

E. O. Richter, Electronics Research department manager (seated), W. R. Martin, antenna laboratory group engineer (standing), and J. L. Rodgers, electronics research engineer, discuss design of corrugated surface antenna.

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RW-3988, Electronics
330 W. 42 St., New York 36, N. Y.

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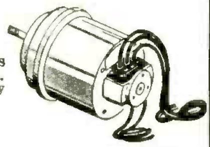
"Put yourself in his place."

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.

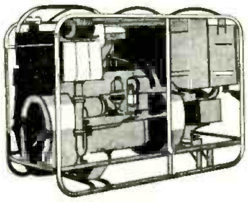
Quantities Available.

REPEATERS ....$20.00 ea.
TRANSMITTERS ....$20.00 ea.

SYNCHROS

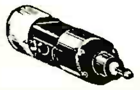
General Electric MOD. 2J15M1; 115-57.5 Volts 400 Cycle ....$22.50 ea.
AUTOSYN MTR. KOLLSMAN Type #403; 32 VAC; 60 cycle; single phase $9.95
AUTOSYN MTR. BENDIX Type #851; 32 VAC; 60 cycle; single phase $9.95
MICROSYN UNIT, Type 1C-006-A $15.00
1F Special Repeater (115V-400 Cy.) ....$15.00 ea.
2J1F 3 Generator (115-400 cyc.) ....$10.00 ea.
5CT Control Transformer: 90-50 Volt; 60 Cy...$45.00
5F Motor (115/90 Volt—60 cyc.) $45.00
5SDG Differential Generator (90-94 volts — 400 cyc.) ....$30.00 ea.
TRANSMITTER, BENDIX C-78248: 115 Volt, 60 Cycle ....$25.00 ea.
Differential—C-78249: 115 V., 60 Cy $5.00
REPEATER, BENDIX C-78410: 115 Volt, 60 Cycle ....$37.50 ea.
REPEATER, AC synchronous 115 V., 60 cycle, C-78863 ....$15.00 ea.
REPEATER, DIEHL MFG. No. FJE 22-2: 115 Volt; 400 Cy., Secondary 90 V $27.50
5G GENERATOR (115/90) 60 cycles $45.00
7G Synchro Generator (115/90 volts; 60 cycle.$75.00
6G Synchro Generator (115/90 volt; 60 cycle).$60.00
6DG Synchro Differential Generator (90/90 volt; 60 cycle) $50.00
2J5F1 Selsyn Control Transformer: 105-55 Volts; 60 Cycle $22.50
2JD5HA1 Selsyn Generator: 115-105 Volts; 60 cycle $50.00
2J1F1 GENERATOR: 115 — 57.5 Volt; 400 cycle ....$12.50 ea.
2J1H1 DIFFERENTIAL GENERATOR: 57.5—57.5 Volt; 400 cycle ....$12.50 ea.
2J1G1 CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle ....$7.50 ea.
2J5H1 SELSYN GENERATOR: Mfg. G. E. 115-105 Volts, 60 Cycle $27.50

POWER UNIT PU-35/U



400 cycle, single phase, 115 volt, 60 cycle, single phase, 115 volt. Delivers 2500 watts each, both freqs. can be used simultaneously for total 5000 watts. 400 cycle generator is permanent mag. type. Power plant is Hercules 4-cyl., water-cooled, short block engine. Complete control panel incl. Running time, cycle, voltmeter, temperature and oil pressure gauges. 1700-1725 RPM. Wt. approx. 500 lbs ....$350.00 ea.

ALNICO FIELD MOTORS



(Approx. size overall . . . 3¾" x 1¼" diameter)
DELCO TYPE #5069600: 27.5 volts DC: 250 RPM $15.00
DELCO #5069230: 27.5 VDC; 145 rpm $15.00
PM Motors Delco Type #5069371: 27.5 volts; DC Alnico Field; 10,000 R.P.M.; dimensions 1" x 1" x 2" long; shaft extension ½" diameter 0.125" $8.00

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

Immediate Delivery

ALL EQUIPMENT FULLY GUARANTEED

All prices net FOB Pasadena, Calif.

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase, 115 VA; 75 PF. Input: 28.5 VDC; 12 amp $59.50

PIONEER 12117

OUTPUT: 26 volts; 400 cycles; 6 volt amperes, 1-Phase. INPUT: 24 VDC; 1 amp ....$25.00 ea.

ALTERNATOR, CARTER

Mfg. Carter Motor Co.; OUTPUT: 7 VAC; 9.7 amp.; 650 cycles, and 295 VDC, 200 amps. INPUT: 26.5 VDC; 10.5 amps; 6500 rpm ....$49.50 ea.

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle; 1500 VA. INPUT: 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts, 27.5
BRAND NEW ....$39.95 ea.

PE 109 LELAND ELECTRIC

Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 RPM. Input: 13.5 VDC; 29 amp $65.00

MG 153 HOLTZER-CABOT

Input: 24 V, DC. 52 amps. Output: 115 volts — 400 cycles, 3-phase, 750 VA. and 26 Volt — 400 cycle, 250 VA. Voltage and frequency regulated ....$95.00 ea.

PIONEER 12130-3-B

Output: 125.5 VAC; 1.5 amps. 400 cycle single phase, 141 VA. Input: 20-30 VDC, 18-12 amps. Voltage and frequency regulated $75.00

12116-2-A PIONEER

Output: 115 VAC; 400 cyc.; single phase; 45 amp. Input: 24 VDC 5 amp $65.00

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF. and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. Input: 27.5 VDC, 60 amps, cont. duty, 6000 RPM. Voltage and Frequency regulated $95.00

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. Input: 27.5 DC; 12.5 amp; Cont. Duty ....$90.00 ea.

PIONEER 10042-1-A

DC INPUT 14 Volts; OUTPUT: 115 Volts; 400 Cycle 1-Phase; 50 Watt $75.00

94-32270-A LELAND ELECTRIC

Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle. .40 PF. Input: 27.5 Volts DC 18 amps cont. duty, voltage and freq. regulated $95.00

PIONEER 12147-1

OUTPUT: 115 VAC 400 cycle; Single phase. INPUT: 24-30 VDC; 8 amps $79.50

MG 149F HOLTZER CABOT

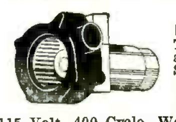
OUTPUT: 26 VAC @ 250 VA; 115V @ 500VA; Single Phase; 400 cycle. INPUT: 24 VDC @ 36 amps $49.50

EICOR CLASS "A" NO. 1-3012/08-7

OUTPUT: 125 VAC; 400 cycle; single phase; 100 VA. INPUT: 24-30 VDC; 11 amps; Duty int. Voltage and Frequency Regulated $99.50

BLOWER

Eastern Air Devices, Type J31B: 115 volt; 400-1200 Cycle; single phase; variable frequency; continuous duty, L. & R. #2 blower; approx. 22 cu. ft./min. $15.00

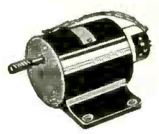


BLOWER: Mfg. John Oster; Type C2A-1B; 27 VDC; 63 amps; 1/100 H.P.; 7000 RPM; Series Wound ......$9.95 ea.

BLOWER ASSEMBLY

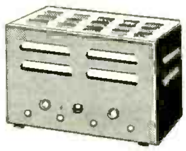
115 Volt, 400 Cycle, Westinghouse Type FL 17CFM, complete with capacitor. New ....$9.95 ea.

PIONEER TORQUE UNITS



Type 12602-1-A. Includes CK-5 Servo 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.

MAGNETIC AMPLIFIER UNIT



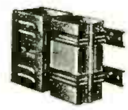
Mfr. Pioneer Instrument . . . Type 12071-1-A; 110 Volts, 400 cycles; 26 Volts, 400 cycles; 4-Tubes (12AH7-GT); take-off for four autosyns. $29.95 ea.

TELEGON OSCILLATOR

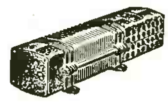
INPUT: 115 Volts, 60 cycle. OUTPUT: 26.5 Volts, 400 cycle, 3-watts @ 250 ohm load. Ideal for laboratory use . . . approx. 10" x 7" x 8", wt. 16 lbs. ....$29.95 ea.

CONSTANT VOLTAGE TRANSFORMERS

Manufactured by SOLA
REGULATION ± 1%

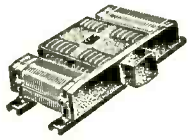


1000 VOLT AMP.



Primary voltage 210-270, 60 cycle, 3-phase. Secondary voltage 240 volts, 2.4 amp. ......$75.00 ea.

2000 VOLT AMP.



Primary voltage 95-190; 125-250. Secondary Voltage 115 volt, 17.4 amps, single phase. Tapped to provide operation on 50 or 60 cycles. $95.00 ea.

5000 VOLT AMP.

Primary voltage 190-250 volts, 60 cycle, single phase. Secondary voltage 230, 11.3 amps; 115 volts, 23.5 amps. PF. 93% ....$149.00 ea.

HIGH CYCLE GENERATOR
DUAL VOLTAGE

115 volts AC; KW 1.5; PF 1.0. Single Phase. Cycles 800; DC; Volts 28.5; watts 500; r.p.m. 2666; mfgd. by D. W. Onan & Sons; frame No. 19533B $99.50

SINE-COSINE GENERATORS

(Resolvers)

Diehl Type FJE-43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two output sequel to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle ....$30.00 ea.
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor ....$25.00 ea.

VOLTAGE GENERATORS (RATE)

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-35-D $17.50
ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-44-D $17.50
A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase, .015 Amps. Type PM-1, 1200 R.P.M. $15.00

C & H SALES CO

2176 East Colorado Street • Pasadena 8, California • RYan 1-7393

RADAR ANTENNAS

SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor. New $279.50
SO-3 (3CM) Surface Search type with reflector and drive motor, but less plumbing. New in original cases $99.50
SO-13 (10CM) Complete assembly with 24" dish, dipole, drive motor and gearing. New $89.50

RADAR SETS

MODEL SQ. Portable radar set, 10CM. Operates on 90-130 volt. 60 cy., 1 Ph. "A", "B", and "PPI" presentation. Complete with tech manual and full set of operating spare parts. Used but in good condition $495.00
MODEL ASG-1 Radar unit consisting of transmitter and converter assembly CPR-43ABC, Antenna Assembly CRP-ACZ. Mouting Base CPR-10ABE, etc. New in original case $198.50

SCR-545A RADAR

Removed from trailer. Includes: Azimuth and Elevation Control Units; 214A and 154A Indicators; Input and Output Servo Amplifiers; Three BC-1035A Scopes; Power Panel and RA-65A Power Supply; Range Cont. Unit; Range Converter; Search Rec. and Cont. Unit; Search Trans; Track Rec. and Control Unit; Track Trans; Range Unit; Auto. Controller; no Antenna included. In good condition. A terrific value at.... $975.00
Only one set available.

Radar Repeater Adapters
NAVY TYPE CBM-50AFO

A repeater unit for video signals and trigger pulses designed to work in conjunction with standard Navy radar equipments wherein provision is made for operation of remote P.P.I. sets. This adapter provides four video and trigger pulse lines for operating one or more remote P.P.I. control installations. 115 Volts, 60 cycles A.C. Dimensions are 31½ x 21 x 15 in. .... New $97.50
Write for descriptive circular

G. E. SERVO AMPLIFIERS

Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed in 1st column. New less tubes $29.50

TUBE SPECIALS

1N21B	$1.49	3BP1	$2.95
1B24	3.95	3CP1	1.95
2J62	12.50	7BP7	2.75
2J531	1.75	861	9.50
3B22	1.65	C6J	4.00

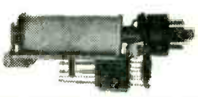
NEW SCR-522A EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

REPAIR PARTS FOR BC-348

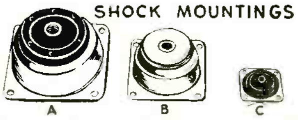
(Models H. K. L. R.)
Also BC 224 Models F. K., Coils for ant., r.f., det., osc., I.F., c.w. osc. xtal filters, 4 gang cond. front panels, dial assemblies, vol. conts. etc. Write for complete list and free diagram.

PLUG IN RELAYS



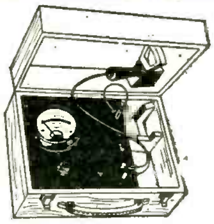
Clare octal base 75 ohm coil. 115 V. 60 Cy. Makes two breaks one. New.... $1.95
Western Electric D163781 Octal Base 2400 Ohm coil 10 MA operating. Makes one. Normally open. New $4.95

SHOCK MOUNTINGS

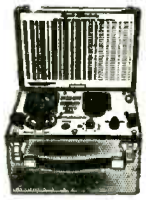


A B C

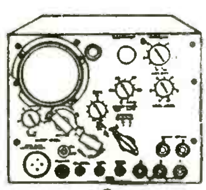
Type A—3 x 3 x 1-¾ in. .... .30
Type B—2-⅜ x 2-⅜ x 1-⅛ in. ..... .20
Type C—1-¼ x 1-¼ x ⅜ in. .... .10



A



B



C

Fig. A **FLUXMETER.** Measures field strength of magnets from 500 to 4000 gauss. Indicates polarity. Probe gap 1¼". British handicraft in fine hardwood case with hinged cover. Operating instructions on underside of cover. Size 12-¾ x 9 x 6 in. A lab instrument. Also ideal for classroom magnetics instruction. A real buy at only $24.50

Fig. B **FREQUENCY METER** 375 to 725 Mcs. Model TS-127/U. Compact. Self-contained, precision (± 1 Mc). Sturdily constructed Hi-"Q" resonator has average "Q" of 3000. Uses 957, 1S6 and 3S4 tubes. Requires standard 1½V "A" and 45V "B" battery, not supplied. Brand new with instruction book, probe and spare kit of tubes $47.50

Fig. C **PANORAMIC ADAPTER AN/APA-10.** A combined Panoramic Adapter and Scope. Has 3 inputs for feeding in receiver I.F.'s of 455KC. 5.2Mc or 30Mc. Designed also to be used as regular scope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc. Complete with 21 tubes including 3" CR tube and instruction manual. For operation on 115V 60 Cy. Price $145.00

SPECIAL OFFER! 80 page Tech. Manual for Panoramic Adapter AN/APA-10. Full of circuitry, descriptive data, theory, etc. Postpaid in U. S. A. Only $1.00

TEST OSCILLATOR TS-47/APR. 40-2000+ Mc. Fundamental coverage 40-500 Mc in two ranges. Harmonics above 2000 Mc. Provides a calibrated (dial accuracy ± 0.7 per cent) H.F. source for testing receiving equipment. Output 3MW or more up to 400 Mc. less on harmonics. C.W., mod. pulse or sine wave output. Operates on 115/230 60 Cy. or batteries. Part of APR countermeasures equipment. New with handbook of Maintenance Instructions $169.50

FREQUENCY STANDARD TELRAD 18A. Provides 1000, 100, and 10 Kc. check points from 100 to 45,000 Kc. Employs dual 100/1000 Kc Bliley Crystal. Calibrates with WWV. Operates 110/220. 60 Cy. New with instructions $23.95

TS-16/APN TEST SET. For calibrating various radio altimeters. Measures modulator sweep frequency and band width of transmitter. Excellent condition. Price $29.50

AN/APR-1 RECEIVER. For use with tuning units TN-1, and N-2, and N-3. Range 38-1000 megacycles.
Price with tubes less tuning units $149.50

158-210 Mc RECEIVER BC-1068A. Has 2 tuned RF stages, tuned converter and oscillator, 5 IF stages, diode detector, tuning eye, and 2 stages of audio. Tuning coils may be altered for lowering or increasing coverage. Operates from 115 V, 60 Cy. Gov't. cost estimated at $700.00. Our special price including 14 tubes. Only $29.50
Shipping Weight Approx. 100 lbs.

300-1200 Mc TRANSMITTER T85/APT5. Nominal output 10 to 30 watts. Tunable cavity provides range from 300-1200 Mc. Filament transformer operates from 115 V. 60 Cy. Uses 8 tubes: 1—931A, 2—6AC7, 2—6AG7, 1—6L6G, 2—829B, 1—3C22 (oscillator). Price with tubes $139.50

HIGH POT TRANSFORMER

Westinghouse. Pri: 115, 60 cy. Sec: 15.-000V C.T., @ 030A, C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price...$29.50

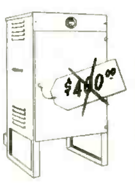
MODULATION TRANSF.

For RCA, Type 250-K Broadcast Transmitter (M1-7242) P to P Primary Imp. 15,000 ohms. Secondary Load 5,030 ohms. Size 11¼x9½x13". Wt. 143 lbs. New $49.50

60 CYCLE TRANSFORMERS

G. E. Step-Down. 6KVA. Pri: 230/460. Sec: 115/125, 60 cy. Size: 20" x 11" x 9½". Weight 225 lbs. Navy grey finish, integral junction box and mounting brackets $69.50
Plate Trans. Raytheon. U-5815. Pri: 440/220, 60 cy. 3 phase. Sec: each phase 1310V @ 0.67A test 6000V $59.50
Plate Trans. Pri: 115V., 60 cy., 1 Ph. Sec: 1470V. C.T. @ 1.2A tested at 5500V. RMS. Raytheon. Size 12¼ x 10 x 10 in. Shipping wt: 150 lbs. New. Price $27.50

G.E. BATTERY CHARGER
Charges 54 Cell Battery at from 1 to 10 ampere rate

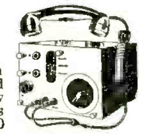


Input 115V., 60 cy. 1 Phase.
The model 6RC89F16 Copper Oxide battery charger consists of a transformer, a secondary reactor, a copper oxide rectifying element, a ventilating fan, control circuits and auxiliary equipment necessary for proper operations. Transformer tapped for various supply voltage. Eight secondary taps for adjusting changing rate. Built into metal cabinet. Metered.
Complete with spare fan and fuses. New in original packing cases. Shipping weight approx. 305 lbs.
Price $149.50

SOUND POWERED CHEST SETS

U. S. Instrument Co. No. A-260 Combination headset and chest microphone. Brand new, including 20 ft. of rubber covered cable and plug ....$17.50 each
HEADSET ADAPTER. MC-385C Matches hi to lo imp., for HS-33 or 38 phones. New in original cartons .... $ .65
TRANSMITTER CAPSULE for TS-13 handset. New in original cartons..$1.75

FIELD TELEPHONES



RM29A Complete with carrying cases and TS-13 handsets. New in original cartons $17.50

9 CONDUCTOR CABLE

Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels .... Price $.12 ft.
Sample 100 ft Coil $15.00

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.

INVERTERS

Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 1.2Kw and 26 V DC at 4 amps. New $295.00
Onan MG-0-75. Navy type PU/11 Input 115/230, 60 cy., 1 Ph., Output: 115, 480 cy., 1 Ph., 5.3 amps. and 26 VDC @ 3.8 Amps. New $225.00
Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output, 80V, 800 cy., 1 Ph., 485W. New $16.50
PE218H. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. New $32.50
G.E. 5AS131JJ11A. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New $89.50
Elcor. 32VDC to 110AC, 60 cy., 1 Ph. at 2.4 Amps. New $29.50
Type PU-7/AP 2500 VA Input 160 Amps. @ 28 V. Output 115 V, 400 Cy. 1 Ph, (1.00 PF) 2500 W. Continuous. Both voltage and freq. regulated. New. Price $98.50

DYNAMOTORS

Navy type CAJO-211444. Input: 105 to 130VDC. Output: either 26VDC at 20 amps. or 13VDC at 40 amps. Radio filtered and complete with line switch. New $89.50
Type PE94CM. For SCR-522. Brand new in overseas cases. Has wide band input and output filters $14.95

AMPLIDYNES

5AM21JJ7. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5A 4600 RPM. New $34.50
5AM31NJ9A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 7500 RPM. New $23.50
5AM31NJ18A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 8300 RPM. New $12.50

SMALL DC MOTORS

G.E. 5BA50LJ2A. Armature 60VDC at 8.3 Amps. Field 27.5VDC at 2.3A RPM 4000. H.P. 0.5. New $27.50
G.E. 5BA50LJ22 Armature 60 VDC at 8.3 Amps. Field 27.5 at 2.9 Amps. RPM 4000. H.P. 0.5 Gear Box No. T8254261-G1, has two 160 RPM and one 120 RPM take-off. Gov't. Cost $207.00.
Our price $29.50
Oster E-7-5. 27.5DC. 1/20 HP, 3600 RPM Shunt Wound. New $9.50
Dumore Co. type ELBG. 24 VDC, 40-1 gear ratio. For type B-4 Intervalometer. New $2.75

400 CY. BLOWERS

Westinghouse Type FL. 115V, 400 cy., 6,700 RPM. Airflow 17C.F.M. New $3.95

SYNCHROS

Ford Inst. Co. Synchro Differential Generator. Mod. 3 Type 5SDG. 90/90V. 400 cy., Ord. Dr. 173020. New $4.50
Armor, Synchro Differential Generator. Type 6DG. New $29.50
Hobart Mfg. Co. Synchro Dif. Generator Type XIX 115V, 60 Cy. New $4.95
5F, 5G, 5CT Also In Stock

D.C. SELSYN MOTOR

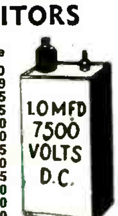
Step by step type for use with potentiometer in D.C. Selsyn Control Systems. **Bendix**—Type CAL 14810 (MK1 Mod 0). 70 Volts DC input $4.95

MOTOR GENERATORS

2 KVA O'Keefe and Merritt. 115DC to 120AC, 50 cy., 1 Ph., Export Crated. New $125.00
MOTOR GENERATOR, TYPE CGU-2 Unit of U. S. Navy TCK-7 Transmitter Motor; 2 H.P. 230V, D.C., 10 amps. Generator: 1800V. D.C., 0.4 A, 500V. D.C., 0.35A, 115V. D.C., 1.5A, 12 V. D.C., 2A. 3480 R.P.M. Self excited. Brand new including spare armature. $95.00
ALLIS-CHALMERS 230DC to 115AC. 60 cy., 1 Ph., 1.25 KVA $149.50

HIGH VOLTAGE OIL CAPACITORS

Mfd.	Volts	Price
.001	50 KV	$22.50
.01	5 KV	1.29
.02	8 KV	2.65
.02	20 KV	9.75
.025	50 KV	26.50
.05-.05	50 KV	34.50
.1	3 KV	.95
.1-.1	4.5 KV	3.50
.135	7.5 KV	6.95
.2	50 KV	39.50
.25	15 KV	15.50
.25	20 KV	17.50
.25	50 KV	44.50
1.	7.5 KV	6.95
1.	15 KV	39.75
2.	5.5 KV	9.50
2.	6 KV	12.50

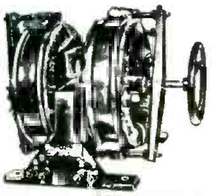


SPECIAL
$6.95

PHONE: DEERFIELD 7-0044
ELECTRONICRAFT INC. 27 MILBURN ST. BRONXVILLE 8, N. Y.
Cable Address: Electroft, N.Y.

HERSHEL RADIO CO. BIGGEST BUYS!

TRANSTAT 100 AMP



ONLY $149.

Pri. 115 VAC 60 cy 11.5 KVA Sec. 0-115 VAC 60 cy 100 Amp Max. MFD. Amertron.

BUTTERFLY CONDENSERS

YOUR CHOICE $4.95

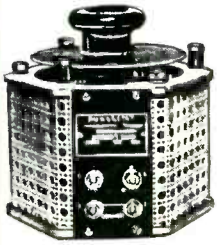
TYPE A
106 to 330 MC Can Use 955 Type Tube

TYPE B
135 to 485 MC Silver Plated.

TYPE C
300 to 1000 MC Can Use 368AS Tube Silver Plated

TYPE D
300 to 1000 MC Has Clip For Xtal Detector

POWERSTAT

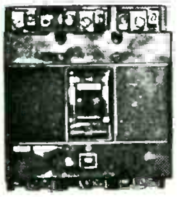


15 AMP

$29.95

Pri. 115 5V 60 cy Sec. 0-135 V-2KVA 15 Amp. Brand New.

CIRCUIT BREAKER

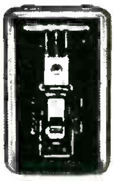


100 AMP

$19.95

3 Pole 250 VAC. 100 Amp 15,000 Amp interrupting capacity. "Wesco".

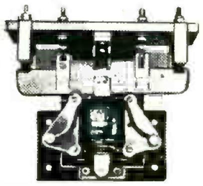
DE-ION MOTOR WATCHMAN



$9.95

3 Pole 3 Position Toggle 110 VAC 13.5 Amp — 3 PH Motors 110 VAC 1½ H.P. — Cont Rated 15 Amp CW. 2 Relay Heaters Trip at 3 Amp. Size 0 Mfg. Wesco.

CONTRACTOR RELAY



$9.95

110 VAC 60 cy 4 P.S.T. 15 Amp. Contacts 2500 V. RMS to Ground Mycalex Ins. Brand New.

PULSE TRANSFORMER

$62.50

G.E. Type K2746A Dia. 9216934 Used with Cy-153 TPL-1.

RHEOSTAT

5. Ohm

7.5 - 5.8 Amp 125V Used with Rectifier RA-39.

$3.95

RCA OUTPUT TRANS.

PP 6L6's 25 Watt Pri. 5,000 Ohm Sec. #1 500 Ohm #2 600 Ohm Sidetone 15 to 15,000 cy Flat.

$1.95

PLATE TRANS.

Only $9.95

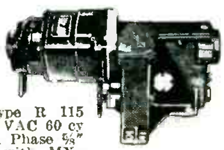
Pri. 90 VAC 60 cy 3 Amp. Sec. 6400 V. .1 Amp 6¾ x 5¾ x 6¼ H.

RELAY SPECIALS

Coil 14 VDC .47 Amp 30 Ohm Res. D.P.S.T. Contacts 1000 VDC. G.E.	$2.45
6 Contact D.P.D.T. 115 VAC 6 Amp. 530 Ohm DC Res. Each.	$3.95
Oper. Voltage 18 V. 60 cy. 4 Amp Contacts Rated 115 VAC 8 Amp. Single Winding Coil S.P.D.T. AC Res. of Coil 4 Ohm.	$3.95
24 VDC 5 Amp 240 Ohm—120 VAC 400 cy Inductive Load. Potter Brumfield.	$1.49
D.P.D.T. 110 VAC 15 Amp Will Operate 24 VDC 15 Amp Fast Action.	$2.45
D.P.D.T. Coil 3V, .27 Amp DC Res 11 Ohm.	$1.49

GEAR REDUCTION MOTOR

$49.50



¼ H.P. Type R 115 VAC or 230 VAC 60 cy 1725 RPM 1 Phase ⅝" Shaft used with MX-186/TPL-1

TRANSFORMERS

Tapped Pri. 100, 105, 110, 115, 120, 125 VAC 60 cy Sec. 2 Windings 2.6V 10 Amp. 5.15V 3 Amp. 6.4V 5 Amp; 2 Windings 10.1V 8 Amp. 434 VCT—120 MA.	$14.95
Pri. 117 VAC 60 cy Sec. 2000V, RMS 2.5 MA; 2.5 V at 1.75 Amp; 6.3V at 6 Amp Moisture Proofed.	$2.75
Pri. 100 VAC 60 cy; Sec. 400 VCT 20 MA 6.3V 1 Amp; 5V 2 Amp.	$1.29
Pri. 117.5 VAC 50-60 cy Sec. 6.3V, 0.9 Amp.	$.95
Output Pri. Impedance 20,000 Ohms Sec. Impedance 2,000 Ohms 5 MA. DC. Freq Response ±2db. 100 to 5000 cy. Used with Freq Meter BC 438.	$.95
Pri. 117.5 VAC 60 cy Sec. 220 V. at 50 MA; 5V, 6 Amp; 6.3V 2 Amp; 6.3V, 1 Amp.	$1.29
Pri. 115V 400 cy. Sec. 800V 150 MA; 200V 30 MA 5V 3 Amp; 6.3V 7.5 Amp.	$3.95

SIGNAL GENERATOR 1-122

ONLY $49.50

RF Signal 15 to 25 MC and 90 MC to 125 MC modulated at 400 cy or 625 cy 110 VAC 60 cy with carrying case.

VARIABLE TRANSFORMER

$4.95

Pri. 115 VAC. 4 Amp 50-60 cy. Sec. 30 to 135V. 25 Amp. Used with Dictaphone Reproducer MFD. U.T.C.

OIL COND.

MFD	VDC	Price
.05	3000	$1.95
.05	7500	2.29
.1	4000	1.29
.1	7500	2.49
.5	2500	1.75
2x.5	8000	1.49
1	3000	2.49
1	3600	2.95
1	5000	4.95
2	1000	.95
2	3000	4.95
4	1000	1.95
6	600	1.29
7	600	1.39
8	600	1.75
8	1000	2.49
10	600	2.49
10	1500	4.95
Dual 4	1000	
2x4	600	3.95

PAPER CAN

MFD	VDC	Price
250	10	$ .39
500	12	.49
1000	3	.69
1000	15	.95
1000	25	1.29
1200	10	.95
1600	15	1.29
24000	3	1.49
177	110 VAC	1:45

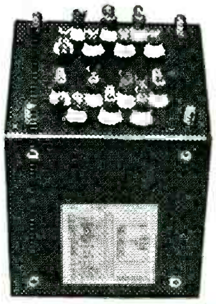
PHOTO FLASH SPECIAL

MFD	VDC	Price
525	450	$9.95

CHOKES AND REACTORS

Dual 4.5 H 120 MA; 4.54 70 MA	$1.95
Dual 1 H 400 MA; 4.2H 75 MA	$2.95
Swinging 2-7 H 550 MA	$5.95
15 H 80 MA. 385 Ohm	$1.95
1.3 H 1 VDC .020 Amp 60 cy. 600 V Ins	$ .49
5 H 225 MA 400V Ins	$1.95
Coil: Telephone Retardation—27 H 3 Amp 2 Ohm DC Res	$7.50
Coil Repeating 20, 135 and 1000 cy Signaling; Impedance Ratio 1-1	$4.95
Reactor Oil Filled 60 H 50 MA Used with SCR 682-A	$19.95

ALL PURPOSE FILAMENT TRANSFORMER



$4.95

Pri. 117 VAC 60 cy. Sec. #1 6.4V 12 Amp. #2 6.4 V 10 Amp. #3 5.0V 3 Amp. #4 5.0 V 3 Amp. #5 5.0V 3 Amp. #6 2.5V 1.75 Amp. Size 5-9/16" x 5-1/16" x 5¼" H.

POWER UNIT ARMATURE

For PE 85 A-B-C-D-E Models Armature. Brand New MFD. Leece Neville.

$17.50

FILTER UNITS

FL-15U Freq up to 57 MC—Drake.	$3.95
FL-17 Used with Dyn. PE 101.	$.95
FL-41 Used with Control Unit RM-35.	$2.95

BK22K RELAY

Used with SCR-269F Change over contains 28V Step Relay 5 Deck 6 Position SW D.P.S.T.

$3.95

CIRCUIT BREAKERS

115 Vac 3 Amp	$ .95
115 Vac 15 Amp	1.95
115 Vac 25 Amp	2.45

Mfg. Heineman Co.

HERSHEL RADIO CO.

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Detroit 8, Michigan
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TERMS: Cash with order or 25% DOWN—BALANCE C.O.D. NET 10 DAYS RATED ACCOUNTS ALL PRICES NET F.O.B. DETROIT
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FALL, 1954
TUBE SALE

Authorized Distributors for Eimac, Westinghouse (WL) CBS-Hytron (CBS), Cetron, Lewis & Kaufman and Penta Tubes.

WESTERN ELECTRIC
● NEW ● ORIGINAL-BOXED ●

2C51/396-A	$3.85	394-A	$3 00
2K45	75.00	403-A/6AK5	1.25
2K55	29.50	403-B/5591	3 45
271-A	16 00	404-A/5847	12.90
274-A	4 95	407-A	2 50
274-B	3 95	408-A	2.50
275-A	12.00	416-A	60 [illegible]
310-A	3.50	416-B	66.50
311-B	4.50	417-A/5842	write
313C, CA, CA	2.50	418-A	18.00
337-A	6.00	421-A	15 00
348-A	4.95	422-A	15.00
359-A	3.50	705-A	1.20
373-A	3 50	709-A	2 50
374-A	4.50	5780	350.00
387-A	9.00	5795	350.00

AND OTHERS

We maintain on our premises a
TEST LABORATORY
with complete facilities for
CERTIFIED ELECTRONIC TUBE TESTING

- We can test your tubes too: Jan 1-A or Mil E-1B Specs or Commercial Specs.
- We do specialized and qualitative testing on magnetrons, klystrons, ignitrons, diodes, transmitting, power tubes, etc.

EIMAC ORIGINAL SURPLUS VALUES ● BOXED

2C39A	$10.70	227A	$4.00
RX21A	6.75	250R	13.50
35TG	9.50	304TH	7.75
50-T	7.00	304TL	7.75
UH-50	6.70	4-400A	40.00
4-65A	14.80	4x500F	69.75
100TH	4.50	592/3-200A3	15.70
100TL	5.50	750TL	59.50
4x150G	35.00	1000T	116.00

- *Other EIMAC Types in Stock for Immediate Shipment.*

SPECIALS

1B24	Sylvania Jan Box	$3.80
2K28	Sylvania Boxed	27.50
C3J	Electrons, Inc.	6.75
3B24	W.E. and Raytheon Box	3.60
3B26	Raytheon Jan	2.75
3B29	Raytheon Box	9.00
3C22	G.E. Boxed	66.66
3J30	Sylvania Wood Box	55.00
R1131	Sylvania Jobb. Box	8.50

IMMEDIATE SHIPMENT from one of the MOST COMPLETE inventories of SPECIAL PURPOSE, TRANSMITTING, RADIO and TV RECEIVING TUBES. FULLY GUARANTEED, STANDARD BRANDS at the LOWEST PRICES consistent with *HIGHEST QUALITY*.

WE SPECIALIZE IN WESTERN ELECTRIC, SUBMINIATURE and NEW JAN RUGGEDIZED TYPES.

WE SPECIALIZE IN OUT-OF-PRODUCTION TYPES

01A	75c
1C6	10c
1H4	10c
1V	50c
BH	2.50
2X2	35c
41	50c
56	40c
81	75c
82	80c
6E5	40c

AND MANY OTHERS
CAN WE HELP YOU?

ALL TYPES
RADIO and TV RECEIVING TUBES
Original Jobbers' Boxed
or
In Bulk in ORIGINAL Sealed Master Manufacturers' Cartons

At Wholesale Price Levels

SUBMINIATURE TYPES

	EACH		EACH		EACH
VXR-130	$1.50	5646	$6.90	5829WA	$5.80
5633	6.90	5647	3.75	5840	6.90
5634	6.90	CK-5676	1.15	5896	6.90
5635	6.90	CK-5702	2.20	5899	6.90
5636	6.90	CK-5703	1.25	6021	5.95
5637	3.50	CK-5703WA	4.50	6D4	2.50
5638	7.90	CK-5704	2.20	6K4	2.75
5639	7.90	CK-5744	1.25		
5641	3.50	CK-5744WA	4.50		
5642	.95	CK-5784	3.25		
5643	6.00	5829	1.75		

AND MANY OTHERS IN STOCK

POPULAR, NEW RUGGEDIZED TYPES . . .
Jan and Commercial

2D21	$1.00
6J4 (RCA)	4.50
6AK5-W	1.70
5654/6AK5-W	1.85
6AS6	1.75
5656	14.75
5670	2.75
5725/6AS6W	2.45
5726/6AL5-W	1.15
5751	1.75
5763	.95
5814	1.75
5879	1.00
6073	1.75
6080	3.25
6080 WA	5.50
6082	3.35
6096	1.90

and others.

Popular Types and Crystal Diodes
DIODES

1N21	$ .35	2E24 (RCA)	$ 2.20
1N21-B	1.85	2K25	19.00
1N22	1.00	7C25	120.00
1N23	1.15	FG-17	5.00
1N23A	1.75	QK60	55.00
1N23B	1.85	QK61	65.00
1N26	6.50	QK62	75.00
1N34	.60	707-B	6.95
1N34-A	.60	725-A	5.90
1N38-A	.75	807 (Jan)	1.20
1N44	1.10	829-B	9.95
1N45	1.20	832-A	6.95
1N48	.45	866-A (RCA)	1.20
1N52	.55	869-B	30.00
1N63	1.90	872-A (G.E.)	2.75
1N69	.75	1616	.80
1N70	.80	5516	4.20
2C40	7.25	5625/KC-4	55.00
2C43	11.90	8020	2.00

"Turn Your Excess Tube Inventory Into Cash!—or Perhaps a 'Swap' Can Be Arranged to Your Benefit—For Quick Action and a Fair Deal, Write, Wire or Call."

TUBE CARTONS
Two-Colored Cartons With New Safety Partitions — Super-Gloss Red and Black Carton is the Most Distinctive Box Available Today.

SIZE	EACH
Miniature (6AU6, 6AL5, etc.)	$.01
GT (6SN7, 6W4, etc.)	.0125
Large GT (1B3, 6BQ6GT, etc.)	.015
Large G (5U4G, 6BG6G, etc.)	.02

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Terms: F O B—N Y C —25% Deposit with order— or send full remittance to save C O D charges— Well-Rated Firms D. & B. Net 10 days —CABLE BARRYLECT, N. Y. Special attention to export orders

NEW RECTIFIER TRANSFORMERS
PRI: 115 V., 60 cycles in.
SEC: 9, 12, 18, 24 and 36 Volts
Continuous Ratings

4 Amps	$8.75
12 Amps	16.75
24 Amps	35.75
30 Amps	45.00
50 Amps	59.75

FILTER CAPACITORS

Capacity	W. Voltage	Ea.
500 MFD	50 V.	.85
1000 MFD	15 V.	.35
2000 MFD	50 V.	2.25
6000 MFD	15 V.	1.50

NEW RECTIFIER CHOKES

4 Amps	.07 Hy	6 ohm	$7.95
12 Amps	.01 Hy	.1 ohm	14.95
24 Amps	.004 Hy	.025 ohm	29.95

SELENIUM RECTIFIERS
FULL-WAVE BRIDGE TYPE

Max. Amps	18/14 Volts	36/28 Volts	54/42 Volts	72/56 Volts	130/100 Volts
1	1.40	2.40	3.80	4.60	8.50
2	2.10	3.00	5.40	6.00	10.50
2½	3.00	4.20	6.00	8.00	13.00
4	3.75	7.50	11.50	14.50	25.25
6	4.50	9.00	13.00	17.50	33.00
10	6.60	12.75	20.00	25.00	42.50
12	8.20	16.25	22.50	30.00	46.00
20	13.25	25.50	38.00	49.00	79.50
24	16.25	32.50	45.00	58.00	86.50
30	20.00	38.00	57.50	72.00	.....
36	25.00	48.50	66.00	88.00	.....
50	32.00	62.50	.....	.....	.....
100	60.00	120.00	.....	.....	.....

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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

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 approx. 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. With 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 mountings. 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

MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50

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 btl. Flange for TS-45, etc. ....$2.50 ea.

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	$1.85	UG 52A/U	$3.40

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

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

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
35X.059	19	3.8	405	.095	$4.35
POSX-15	14	2.8	220	.08	8.95
DA-7A	28	27	1100	.400	15.00
DM33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
PE73 CM	28	19	1000	.350	22.50
BD 69‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.05	6.95

‡ Less Filter. † Used, Excellent. * Replacement for PE 94.

PE 94-C, Brand New 6.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115V, 800 cy, 7A, 1 phase. Used, excellent $18.75

PE-218H: Input: 25/28 vdc, 92 amp. Output: 115V. 350/500 cy 1500 Volt-ampere. NEW $37.50

PE 206: Input: 28 vdc, 36 amps. Output: 80 v 800 cy, 500 volt-amps. Dim. 13 x 5½ x 10½ New $22.50

"SEA-DOG" CONVERTER

Designed for Buships, this rugged, compact dynamotor is rated as follows:

INPUT: 115 VDC—6 AMPS
OUTPUT: 13 VDC at 40 AMPS
—OR—26 VDC at 20 AMPS

Brand New, with Switchbox and Spare Parts **$89.50**

POWER TRANSFORMERS

COMBINATION—115V/60~INPUT

CT 133 150-C-150V/65MA, 6.3V/2.5A, 6.3V/0.6A $1.79

CT 005 350-C-350V/125MA, 5VCT/3A, 5VCT/2A, 2.5V/10A, 6.3V/4A 8.10

CT-048 350-0-350V/90MA, 5V/3A, 2.5VCT/10A, 6.3V/3.5A 5.68

CT-003 350-0-350V/70MA, 5VCT/3A, 2.5VCT/9A 5.10

CT-007 400-0-400V/110MA, 5VCT/3A, 2.5VCT/15A, 2.5VCT/3.5A 5.35

CT-312 290-0-290V/90MA, 5VCT/3A, 6.3VCT/2.8A 3.25

PLATE—115V/60~INPUT

PT 034 125V/45MA $1.15

PT 159 900-0-900 VAC (750VDC) or 800-0-800 VAC (660VDC) at 225MADC 10.35

PT 167 1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC 25.50

PT 371 210-0-210V at 2.12Amp 9.45

PT 133 3140/1570V, 2.36KVA 105.00

PT 801 22,000V/234 MA., 5.35 KVA, "Lo-Cap" Donut 135.00

PT 521 7500V/.06A, Half-Wave 85.00

PT 913 2500V/12 MA H'SLD 4.95

PT 12A 280VCT/1.2A 3.95

PT-38-2 37.5/40V AT 750 MA 2.15

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.

DELAY NETWORKS

D-168184: 0.5 usec. up to 2000 PPS. 1800 ohms impedance $4.00

D-170499: Tapped delay, 0.25/.5/.75/usec. 8 KV., 50 ohms $12.50

D-165997. Delay 1.25 usec $6.50

RCA #255686-502: 1.7 usec, 1400 ohm impedance $2.00

D-162311. Delay of 0.5 usec, 72 ohms with 4 MC. Bandwidth $4.75

D-168435. Delay 0.5 usec, 555 ohms, 5mc. Bandwidth $4.50

D-172578. 416 ohms imp., 0.22 usec. Delay $4.75

D-150979: Oscillating network. Oscillates at 81.955 kc. When normal current of 10ma. is interrupted. Has built-in temperature control for stability. Assembled in shielded can 4" L x 4" Diam. $7.50

PULSE NETWORKS

15A—1-400-50; 15 KV, "A" CKT, 1 microsec, 400 PPS, 50 ohms imp $22.50

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, 21 KV 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 TRANSFORMERS

K35J45—Pulse Inversion: PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse, 4 KV; 1 usec. and .001 DUTY RATIO $6.50

54J318-1 3 wdgs. Ratio: 1:1:1, 1.10 uh./wdg, 2.5 ohms DCR $3.50

Westinghouse 4P37; Primary: 50 ohms imp. 750 v. Sec. 15 kv. 1000 ohms imp. Bifiar filament trans. built-in, deliveries 12.6 c at 2.5 amp. (pri. 115v. 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: 18KV, 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. 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 $7.50

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 EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses: 1-715, 4-89-B, 3-72's, 1-73. New ....Less Cover—$135

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

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-10 Chas. Rosen Phone: Digby 9-4124

CONDENSERS

GUARANTEED—CONDENSER—SPECIALS—GUARANTEED

16 mfd.—600 V....$1.89
Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket. Case of 84 10% Disc.

1 mfd—20 KV.....$57.50
Ind. Cartoned—Pyranol
4 mfd—1000 V......$1.19
3¼x2½x1-3/16 Ind. Boxed
4 mfd—600 V..........$.99
.5 mfd—500 V.........$.19
Top Term. Channel. Pyranol

OVER 18000 SOLD
10 mfd.—600 V.....$.98
Three term. bot. mfg. channel type. Dims. 3¾"x2½"x2". Two 5 mfd. sections rated 400 V at 72 deg "C". 1800 V test. Meets commercial specs. for 600 V operation up to 40 degs "C". Ideal for filter or power factor application. Repeat sales prove this rugged high quality condenser to be of outstanding values. Carton of 24, weight 42 lbs. Large qua. available.. **$.89**

6 mfd.—150 V.....$ .29
Three term. dual 3 mfd. oil cond. complete with brackets, measuring 4¼"x 1¾"x1". Ideal for audio crossover networks.

7 mfd—600 V.......$1.25
.115 mfd-2000 V Mica$4.65
20 amps. @ IMC. Qua. disc.
.00025 mfd—1200 V Mica $.19
.5 mfd—400 V ST Bath'b $.29
Stand. Make. Lots 100 10% disc.

Mfd.	Volts	Price	Mfd.	Volts	Price
.016	15KV	$5.75	2	1000V	.75
.0023	16KV	5.95	2	1000VTLA	1.29
.005-.005-			2	1500V	1.45
.01	10KV	4.75	2	2000V	2.80
.012	25KV	19.95	2	2500V	3.95
.02	10KV	5.25	2	3000V	4.75
.02	20KV	17.90	2	4000V	8.75
.025-.025-			2	5000V	12.50
	50KV	34.50	2	7500V	27.50
.03	7500V	4.50	2	20KV	98.50
.03	16KV	10.95	2	10KV	39.95
.035	10KV	12.95	2-2	600V	1.25
.05	5KV	2.49	3	4000V	11.95
.05	7500V	2.95	3	8KV	39.95
.08	12.5KV	12.95	3-3	150V	.35
.1	1500V	.59	3-3-3	400V	1.05
.1	2000V	.49	4	600V	1.25
.1	2500V	1.17	4	600VTLA	1.39
.1	3000V	1.39	4	600VTLAD	1.39
.1	500V	1.95	4	1000V	1.89
.1	7500V	1.75	4	1500V	2.65
.1	7500V	3.50	4	2000V	3.95
.1	10KV	9.50	4	2500V	5.95
.1	10KV	12.50	4	3000V	7.55
.1	12KV	14.95	4	4000V	13.95
.1	25KV	29.50	4	5000V	24.95
.1-.1	2000V	.98	4	7500V	52.50
.1-.1	7500V	3.50	4-4-4	600V	.98
.2	10KV	9.95	5	330VAC	1.75
.2	15KV	17.95	5	600V	1.69
3x.2	4000V	2.85	5	1000V	1.95
.25	1500V	.79	5	1500V	2.40
.25	2000V	1.19	5-5	600V	1.32
.25	2500V	1.39	6	330VAC	1.75
.25	6000V	1.49	6	600V	1.75
.25	4000V	3.25	6	1000V	2.49
.25	3000V	1.45	6	1500V	3.65
.25	15KV	15.95	7	600V	1.45
.25	20KV	19.95	7	800V	1.99
.25	25KV	44.50	7	5000V	32.95
.25	32.5KV	59.90	8	500V	1.35
.25	50KV	67.50	8	600V	2.25
.3	2000V	.99	8	600V Rd	1.79
.4	10KV	19.95	8	1000V	3.25
.5	1500V	.69	8	1500V	3.98
.5	2000V	1.85	8	2000V	7.25
.5	2500V	2.20	8-8	600V	1.89
.5	3000V	2.39	10	50VAC	.69
.5	4000V	3.15	10	600V	2.50
.5	5000V	4.15	10	660VAC	5.90
.5-.1	2000V	.89	10	1000V	3.95
.5-.5	600V	.69	10	1500V	5.95
.5-.5	1000V	.69	10	6000V	99.50
.5-.5	9KV	16.50	12	1000V	4.25
.5	25KV	54.50	10	1500V	4.95
1	400V	.39	10	2000V	6.35
1	500V	.55	15	330VAC	3.95
1	1000V	.69	15	440VAC	4.95
1	1500V	.99	15	600V	3.25
1	2000V	1.95	15	1000V	5.35
1	2500V	2.49	15	1500V	5.95
1	3000V	3.35	15	5000V	63.50
1	5000V	6.85	16	1500V	8.95
1	6000V	6.95	20	600V	5.85
1	7000V	12.60	20	330VAC	4.69
1	10KV	25.95	25	50V	1.35
1	15KV	45.50	28	1000V	7.50
1	16KV	45.50	30	330VAC	5.25
1	20KV	58.50	30	2500V	14.50
1	25KV	70.00	50	100V	2.95
1	25KV	59.50	70	220V	10.95
2	600V	.59-.79	80	4000V	49.50

BATHTUB CONDENSERS

Mfd.	Volts	Price	Mfd.	Volts	Price
.01-.01	600	.25	.3	400	.21
.02-.02	600	.25	.5	400	.27
.04-.04	600	.25	.5	400	.38
.05	600	.25	.5	600	.45
.05-.05	600	.25	.5	1000	.52
.05-.05	1000	.44	2x.5	600	.55
.08-.08	600	.25	3x.5	600	.69
.1	600	.35	1	100	.32
.1	1000	.45	1	200	.32
.1	1200	.47	1	300	.39
.1-.1	400	.12	1	400	.45
.1-.1	600	.35	1	600	.57
3x.1	600	.42	2x1	230AC	.35
.2	1000	.19	2x1	600	.75
.25	800	.12	2	400	.58
.25	400	.32	2	600	.85
.25	600	.42	4	50	.48
.25	1000	.49	4	100	.53
2x.25	600	.49			
2x.25	1000	.59			

other types available

CHANNEL CONDENSERS

Mfd.	Volts	Price	Mfd.	Volts	Price
.025	600	.19	.25	1000	.45
.05	400	.21	.4	600	.25
.05	1000	.32	.5	400*	.15
2x.05	600	.30	.5	500*	.19
.1	500	.23	.5	500	.32
.1	600	.32	.5	600	.45
.1	1000	.52	2x.5	400	.39
.1	2500	1.25	3x.5	600	.55
2x.1	400	.34	.5-.1	600	.29
2x.1	600	.38	1	400	.45
3x.1	400	.39	1	500	.55
3x.1	600	.45	1	600	.59
.25	400	.26			
.25	600	.39			

* Top Terms.

CERAMICON CONDS.

10, 27, 56 & 100 mmfd @ .... .05
1000 & 5000 mmfd @ .... .07

WANTED
Condensers of all types in any quantity, also other standard components. Top prices.

TRANS MICA CONDENSERS

Mfd.	Wvdc	Price	Mfd.	Wvdc	Price
.000015	2500	.35	.001	2500	.49
.000024	2500	.38	.001	4500	1.70
.000025	1200	.30	.001	5000	2.50
.00003	600	.24	.001	6000	2.35
.00003	1200	.28	.0015	600	.23
.00003	2500	.37	.0015	2500	.53
.00003	2000	1.30	.0015	5000	2.50
.00004	600	.23	.002	600	.27
.000047	2500	.31	.002	1200	.39
.00005	600	.23	.002	2500	.63
.00005	1200	.29	.002	5000	2.95
.00005	2500	.33	.002	6000	2.40
.00005	3000	1.29	.0024	5000	2.25
.000051	5000	1.49	.0025	600	.28
.000068	5000	1.35	.0025	1200	.43
.000068	2500	.27	.003	600	.31
.000075	5000	1.49	.003	1200	.54
.00008	1200	.29	.003	2500	.74
.00008	2500	.33	.003	3000	1.85
.00009	3000	1.35	.003	8000	5.95
.0001	600	.23	.004	600	.29
.0001	1200	.29	.004	1200	.49
.0001	2500	.36	.004	2500	.84
.0001	5000	1.75	.004	5000	2.75
.00015	600	.23	.005	600	.35
.00015	2500	.33	.005	1200	.45
.00015	5000	1.95	.005	2500	.99
.0002	600	.23	.005	3000	1.90
.0002	1200	.29	.006	600	.36
.0002	2500	.36	.006	1200	.55
.00025	600	.23	.0068	1200	.55
.00025	1200	.20	.0075	3000	1.65
.00025	2500	.40	.008	600	.35
.00025	5000	1.95	.01	600	.48
.00027	1200	.28	.01	1200	.73
.00027	2500	.36	.01	2500	1.15
.0003	600	.23	.012	1200	.70
.0004	600	.23	.015	600	.55
.0004	2500	.29	.015	1200	.78
.00047	2500	.40	.015	2500	1.25
.0005	600	.23	.02	600	.57
.0005	1200	.29	.02	600	.21
.0005	2500	.43	.02	1200	11.5
.0005	3000	1.35	.02	2000	1.50
.00062	3000	1.25	.03	600	.67
.00068	2500	.28	.03	1200	1.34
.00089	1200	.28	.4	600	4.95
.001	600	.23	.115	2000	4.65
.001	1200	.32			

Standard Brand Pots.....$.79

OHMS	Shaft	OHMS	Shaft
50	1/8 S	3000	1/8 LS
60	1/8 LS	6000	1/4
150	1/4 S	5000	1/8 LS & 3/8
300	3/8 S	10000	3/8 & 1 1/7
500	3/8 & 1/8 S	10000	5/16
1000	1/8 S	15000	1/8 S
1500	1/4 S	20000	1 1/4 & 1/8 LS
2000	1/8 LS & 3/8 S	25000	3/8 & 1/8 S
2500	1/8 S	3000	1/8 S

OHMS	Shaft	OHMS	Shaft
40000	1/8 LS	250000	1/8 LS. 9/16
50000	1/4 & 1/8 S	300000	1/8 S & 1/8 S (2 terms.)
50000	1/8 LS	5 Meg.	1/8 LS
100000	1/2"	1 Meg.	1/8 S & 1/8 LS
150000	2 1/8		
200000	1/8 LS		

Type "G" Mica CONDENSERS

Mfd.	Volts	Price	Mfd.	Volts	Price
.00005*	3KV	5.95	.0013	15KV	34.95
.00005	6KV	6.95	.002	3KV	5.25
.00005	10KV	19.95	.002*	6KV	5.95
.0001	6KV	12.50	.002	20KV	57.50
.0001	10KV	15.95	.0024	6KV	11.95
.0001	20KV	31.50	.0025	12KV	35.95
.0001	35KV	45.95	.0025	15KV	35.95
.00015	10KV	9.95	.0025	25KV	59.50
.0002	6KV	9.95	.003*	6KV	6.95
.00024	6KV	9.95	.003	6KV	8.95
.00024	8KV	11.95	.003	15KV	37.50
.0003*	20KV	32.95	.005	6KV	11.95
.00032	25KV	44.50	.00575	10KV	37.50
.00035	20KV	33.95	.03	2KV	9.95
.0005	6KV	11.50	.045	2KV	37.50
.0005	20KV	28.95	.08	1.5KV	7.95
.0006	35KV	49.95	.09	1.5KV	6.95
.0008	30KV	59.50	.115	2000V	4.95
.001	6KV	11.50			
.001	25KV	57.50			

* Faradon

MICA CONDENSERS

6, 10, 15, 27, 30, 34, 39, 50, 51, 60, 70, 75, 85, 100, 140, 150, 200, 230, 240, 250, 300, 350, 390, 400, 500, 510, 600, 650, 750, 1000, 1200, 1400, 1000, 1500, 2000, 2400, 2500, 3000, 3300, 3700, 3900, 4000, 4700, 5000, 5100, 6000, 6200, 6500, 7900, 8000 & 9100 mmfd

6 to 750 mmfd	5c	2000 to 5100 mmfd	10c
1000 to 1600 mmfd	6c	6000 to 9100 mmfd	13c

Special Mica Kit...100 @ $2.95

SILVER MICA CONDENSERS

7, 8, 10, 15, 24, 25, 27, 35, 50, 75, 100, 120, 150, 170, 200, 240, 250, 300, 330, 400, 450, 500, 750, 1000, 1100, 1200, 1300, 1450, 1500, 2000, 2200, 2500, 2700, 2900, 3000, 3300, 3600, 4300, 4700, 5100, 5600, 6200, 7500, 8200 & 9100 mmfd.

7 to 75 mmfd	8c	2200 to 5100 mmfd	22c
100 to 750 mmfd	9c	2500 to 8200 mmfd	24c
1000 to 2000 mmfd	17c	9100 mmfd.......	30c

TUBULAR OIL CONDS.

MFD.	Wvdc	Price	Mfd.	Wvdc	Price
.0025	200	.11	.02	600	.17
.0025	400	.15	.03	600*	.10
.005	600*	.12	.03	400	.14
.005	1600*	.10	.03	600	.16
.01	300	.12	.05	200	.10
.01	600	.15	.05	600	.18
.01	2000	.25	.05	1600	.23
.02	100	.09	.1	600	.22
.02	400	.14	.25	600*	.19
			.5	600	.25
			1	200	.29

* Case Graded

POWER RHEOSTATS
25 WATTS

Ohms	Shaft	Price	Ohms	Shaft	Price
.5	7/16	.99	185	1/2	.99
1.3-1.3	1/2	.95	200	1/2	.69
10	7/16	.99	225	1/8LS	.69
15	1/2	.65	225	1/4S	.69
20	1/2	.59	300	1/2	.69
25	1/2	.69	350	1/2	.69
50	1/8S	.59	375	1/2	.69
50-50	1/2	.99	500	1/4S	.69
75	1	.89	1000	7/16	1.29
100	1/2	.54	2500	1/2	1.20
125	1/2	.69	5000	7/16	1.39
150	1/2	.69	5000	1/8S	.99
175	1/2	.79			

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.1-.1	600	.34	8.0	1000	2.95
.5	600	.39	1.0	2000	1.75
.5-.5	600	.39	2.0	2000	2.49
1.0	600	.49	4.0	2000	3.95
2.0	600	.59	4.0	3000	6.25
4.0	600	.98	2.0	4000	6.25
6.0	600	1.49	.15-.15	6000	1.75
8.0	600	1.75	.1	7500	1.49
10.0	600	1.39	.4-.4	7500	3.95
8-8-8	500	1.98	.5	7500	3.95
.1	1000	.39	5	330AC	1.49
.5	1000	.49	8	660AC	2.95
1.0	1000	.59	10	660AC	4.95

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		ea.			ea.
9GP7	Tubes	$3.95	50V	25W. Pots	$.49
865	Tubes	.49	500V	25W. Pots	.49
713A	Tubes	.25	1,000V	25W. Pots	.49
20-4	Tubes	.19	5,000V	25W. Pots	.49
184P	Tubes	.25	50,000V	10W. Pots	.39
1B7	Tubes	.25	100K	10W. Pots	.39

Catalog on Request

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1000 W. PEMBROKE AVE. HAMPTON, VA.

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Tube	Price	Tube	Price	Tube	Price	Tube	Price	Tube	Price	Tube	Price
OA2	.75	3AP1	6.50	12GP7	15.00	304TL	3.00	725A	4.00	955	.25
OA3/VR-75	.75	3B22	1.50	15E	1.00	305A	3.50	726A	10.00	956	.25
OA5	3.25	3BP1	2.00	FG-17/5557	3.00	307A	1.00	726B	30.00	957	.25
OB2	.75	3B24	3.00	RK-19	1.50	310A	2.75	726C	30.00	958	.25
OB3/VR-90	.75	3B24W	6.00	RK-21	1.25	311A	5.00	728AY-GY	8.00	959	1.25
OC3/VR-105	.75	3B25	2.50	RX-21	5.75	313C	2.00	801A	.25	991/NE-16	.35
OD3/VR-150	.50	3B26	3.25	RK-23	3.00	316A	.50	802	3.00	CK-1005	.25
C1B	2.00	3B28	3.00	28D7	.75	323B	2.50	803	2.00	CK-1006	1.00
1B24	5.00	3C23	4.00	28D7W	2.00	327A	2.00	804	8.75	R-1100	5.00
1B27	8.75	3C24/24G	1.00	Twin 30	10.00	328A	3.25	805	2.50	R-1130B/1B59	10.00
1B32	1.00	3C45	6.00	FG-33/5720	15.00	329A	5.50	807	1.00	1500T	50.00
1B35	4.75	3D22	9.75	VC-50	5.00	348A	6.00	808	1.00	1613	.75
1B42	6.00	3DP1	1.50	FP-54/5740	44.00	349A	6.50	809	2.75	1614	1.00
1C21	2.00	3E29	9.00	HK-54	3.50	350A	3.00	810	9.25	1616	.50
1P36	2.50	3EP1	1.50	RK-60/1641	1.75	350B	3.50	811	2.00	1619	.25
1Z2	2.00	3GP1	1.50	RK-62	1.75	352A	15.00	811A	3.00	1624	1.00
VG-2	10.00	4-65A	15.00	RK-65/5D23	10.00	354A	15.00	812	2.50	1625	.25
2AP1	4.00	4B26	3.50	FG-67/5728	13.00	355A	15.00	813	7.75	1626	.25
2C21/1642	.50	4B27	3.50	RK-73	.75	371A/B	.50	814	3.00	1629	.25
2C22/7193	.25	4B31	25.00	75T	5.00	393A	4.50	815	1.50	1630	.50
2C26A	.50	4C22/HF-100	7.50	75TL	6.00	394A	2.00	822	15.00	1960	.50
2C33/RX-233A	1.25	4C27/CV-92	7.50	FG-81A	3.00	WL-417A	5.00	826	.50	2050	1.00
2C34/RK-34	.25	4C35	16.50	FG-95/5560	14.00	GL-434A	5.00	828	8.00	2051	.75
2C39A	12.00	4E27	12.00	100TH	4.50	446A	.75	829B	9.00	ZB-3200	50.00
2C40	5.00	4J34	25.00	RX-120	15.00	446B	2.50	830B	1.00	R-4330	10.00
2C43	10.00	4J35	75.00	F-128A	35.00	450TL	40.00	832	4.75	GL-5545	25.00
2C44	.50	4J42	35.00	HK-154	3.00	WL-460	10.00	832A	6.00	5551/652	40.00
2D21	.75	5BP1	2.00	VT-158	15.00	464A	3.00	833A	29.50	5556/PJ-8	9.75
2E22	1.50	5BP4	2.00	FG-172	18.50	WL-468	15.00	836	2.50	5610	1.25
2J21A	3.50	5CP1	3.75	FG-190/1290	3.50	SS-501	7.50	837	.75	5645	6.50
2J22	3.00	5C30/C5B	1.75	HF-200	9.50	CK-510AX	1.25	838	2.50	5656	10.25
2J26	4.75	5D21	8.00	C-202	10.00	527	12.50	843	.25	5670	2.50
2J27	7.00	5FP7	1.00	203Z	5.00	WL-530	10.00	846	75.00	5696	1.25
2J29	25.00	5FP14	5.00	204A	6.00	WL-531	4.50	849	10.00	5725	1.75
2J30	50.00	5J30	15.00	205B	.50	559	75.00	850	10.00	5801	4.75
2J32	16.00	5J32	35.00	207	40.00	575A	15.00	851	25.00	5820	(See 2P21)
2J33	16.00	5JP1	9.00	211	.50	WL-579B	12.50	860	1.50	5827X	4.75
2J34	16.00	5JP4	9.00	212E	25.00	WL-632	15.00	861	8.00	CK-5829	2.00
2J36	60.00	5R4GY	1.00	217A	2.00	WL-681/686	25.00	865	.50	5963	1.00
2J37	9.00	C6A	6.00	WL-218	20.00	701A	2.00	866A	1.00	5981/5650	50.00
2J38	8.00	C6J	5.00	221A	.50	702B	1.00	868/PJ-23	2.00	8002R	25.00
2J40	17.50	C6L/5528	5.00	235R	75.00	703A	1.50	869B	20.00	8005	4.00
2J50	35.00	6AC7W	2.50	249B	3.00	704A	.50	872A	1.00	8011	.50
2J55	50.00	6AJ5	1.25	250R	5.00	705A	.50	874	.75	8012	1.50
2J56	75.00	6AN5	2.50	250TH	14.00	706AY-GY	20.00	878	.75	8012A	2.50
2J61	20.00	6BM6	35.00	250TL	11.50	707A	3.50	884	1.00	8013	2.50
2J62	7.50	6C21	12.50	251A	35.00	707B	7.00	885	1.35	8014A	50.00
2J-B51	2.00	6G4/X-102B	2.50	252A	15.00	708A	.75	891R	100.00	8020	1.25
2K25	15.00	6J4	4.00	253A	3.50	709A	1.50	892R	150.00	8025	2.00
2K33A	40.00	6L6GAY	2.00	257A	2.00	713A	.50	902P1	6.00	8025A	5.00
2K41	75.00	6Q5G	3.25	267B	6.00	715A	1.50	918	1.75	PD8365	35.00
2K54	25.00	6SB7Y	1.00	271A	5.00	715B	3.00	920	2.50	9001	.75
2K55	15.00	6SK7Y	.75	274B	1.00	715C	10.00	922	1.00	9002	.50
2P21 (Image orthicon)	250.00	7BP7	2.00	276A	3.75	717A	.50	923	1.00	9003	.75
2X2/879	.25	9GP7	3.75	282A	4.00	719A	7.50	925	1.75	9004	.25
2X2A	1.25	9LP7	2.00	283A	3.00	721A	1.00	927	1.50	9005	1.25
3A4	.50	10Y	.25	286A	5.50	723A/B	9.50	931A	3.00	9006	.25
3A5	.50	12A6	.25	304TH	5.00	724B	.75	954	.25	9906R	1000.00

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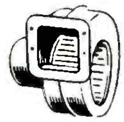

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Powered by Fasco shaded pole two pole motor. 4" inlet, 2½" x2½" outlet. No. BL230F $12.95

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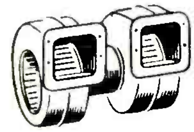

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Redmond shaded pole four pole motor. 4" inlets and 2½" by 2½" outlets. Discharge flanges shipped unmounted. No. BL400R $17.50

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OA5	3.50	2C46	10.00
OB2	1.00	2C51	3.69
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OD3/VR150	.80	2D21	.95
1B23	4.00	2D21W	2.49
1B24	6.75	2J27	7.50
1B26	1.75	2J31	17.50
1B27	16.50	2J32	17.50
1B32/532A	1.75	2J33	17.50
1B35	5.50	2J34	17.50
1B42	8.25	2J36	79.50
1B63A	28.50	2J42	105.00
1D21/SN4	3.75	2J49	59.50
1N21B	2.00	2J51	195.00
1N23B	2.00	2J56	89.50
1N26	4.95	2J61	24.50
1N34A	.79	2J62	11.00
1N35	1.95	2K22	17.50

3E29	9.50	5R4GY	1.10	274B	2.75	706CY	27.50
3FP7	1.95	5R4WGY	1.60	304TH	6.95	706DY	27.50
3GP1	1.95	5641	4.95	304TL	6.95	706FY	27.50
3J30	99.50	5851	5.50	307A/RK75	1.95	706GY	29.50
3K23	149.50	C6J	6.50	310B	8.95	707B	13.55
3K27	149.50	6AL5W	1.60	312A	2.95	708A	1.95
3K30	199.50	6BM6	45.00	316A	1.25	713A	.95
4C27/CV92	7.50	6C21	24.50	323B	8.95	715B	6.00
4C35	17.50	6F4	3.00	327A	4.50	715C	14.00

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4J28	79.50	6J6W	2.00	336A	write	719A	10.00
4J29	79.50	7C22	99.50	337A	6.00	RK72	.95
4J30	79.50	7C24	99.50	349A	8.50	720CY	99.50
4J31	79.50	7C25	135.00	350A	3.50	720EY	99.50
4J34	79.50	12GP7	17.50	368AS	4.00	721A	1.50
4J36	79.50	12HP7	13.50	383A	write	721B	12.50
4J42	79.50	15E	1.75	394A	3.50	722A	1.95

874	1.10	CK5678	1.00
878	.95	5696	1.10
884	1.00	5702	2.95
889A	129.50	5703	1.15
GL893A	295.00	5704	2.50
922	1.25	5718	4.50
923	1.30	5719	6.95
931A	3.75	RK5721	179.50
935	5.00	5727	1.75
957	.49	5744	1.30
958A	.49	5750	3.10
959	1.50	CK5787	4.95
CK1006	1.75	5814	1.75
1616	.75	5837	67.50
1620	2.95	5844	4.50
1623	1.65	5902	8.95
1625	.30	5904	8.95
1629	.30	5905	8.95
1630	89	5907	9.00
1636	1.25	5908	9.00

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6 mmfd.	30 KV	10.00
50 mmfd.	20 KV	10.00
50 mmfd.	32 KV	12.50
50 mmfd.	40 KV	14.50
100 mmfd.	10 KV	12.00
100 mmfd.	20 KV	14.00

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1N38	1.50	2K25	20.00
1N44	.99	2K26	45.00
1N47	4.50	2K28	25.00
1N55	2.75	2K33A	65.00
1N63/K63	1.95	2K33B	100.00
1N69	.59	2K34	139.50
1P28	9.00	2K39	110.00
1P29	2.00	2K41	125.00
1P36	2.75	2K42	139.50
1P39	1.20	2K45	75.00
1Z2	2.00	2K48	99.50
1624	1.40	2X2A	1.40
1641	1.95	3B22	1.95
VS-2	7.50	3B24	3.50
2K21	1.95	3B26	3.50
2C21/1642	.69	3B29	6.95
2C36	25.00	3C22	65.00
2C39	12.50	3C23	6.50
2C39A	12.50	3C24/24G	1.10
2C40	7.25	3C33	9.95
2C42	10.00	3C45	9.50

4J50	99.50	35TG	5.95	412A	write	723A	7.95
4J52	199.50	D42	write	417A	8.50	723A/B	12.00
4J57	149.00	QK60	35.00	418A	15.00	724B	1.00
4-65A	14.00	RK60/1641	1.95	434A	9.95	726A	8.00
4-125A	19.00	FG67/5728	15.00	KC4	39.50	726B	32.00
4-250A	29.50	RK73	.95	446A	1.19	730A	15.00
4X150A	27.50	75T	6.95	446B	3.50	750TL	65.00
4-400A	39.50	75TL	7.95	WL456	59.50	803	1.95
4X500A	75.00	FG95/5560	19.50	464A	3.50	805	2.95
5AP1	2.95	ML-100	write	CK512AX	1.30	807	1.50
5BP2A	2.95	HF120	9.95	WL530	16.95	811A	3.50
5BP4	2.50	FG104	29.50	CK536AX	.95	813	7.95
5CP1A	14.50	FG105	22.50	GL562	write	815	2.50
5C22	29.50	VT-127A	2.75	GL605	write	829	6.00
5CP7	9.50	VT158	17.50	WL616	99.50	829B	9.50
5D21	9.50	QK159	149.60	GL623	150.00	830B	1.50
5FP14	7.50	FG172	22.50	KU627	14.50	832A	6.50
5HP1	3.95	HF200	14.50	KU628	14.50	836	2.95
5HP4	3.95	WL200	write	WL-651	39.50	837	1.00
5JP1	17.50	207	65.00	WL652/657	39.00	838	2.98
5JP2	17.50	211/VT4C	.80	F660	150.00	846	write
5JP4	17.50	217C	1.95	F661	150.00	849	39.50
5JP5	17.50	221A	.98	700/B/C/D	16.50	851	35.00
5J23	29.50	FG-235A	49.50	701A	2.50	852	12.50
5J26	120.00	QK249	200.00	702A	1.95	860	3.50
5J29	10.00	249B	6.50	703A	1.75	861	10.00
5J30	19.95	250R	6.95	705A	1.60	865	.98
5J33	7.50	250TH	14.50	706AY	27.50	866A	1.00
5LP1	9.95	250TL	12.50	715B	3.50	869B	35.00
5MP1	3.95	251A	49.50	706BY	27.50	872A	1.75

2050	1.00	5916	9.00
2051	.80	5932	4.95
ZB3200	68.00	6005	2.75
5516	5.50	6110	8.95
5544	16.50	6121	9.95
5545	18.95	6147	4.30
5586	200.00	8005	4.95
5591/403B	3.00	8012	1.95
5611	115.00	8013	4.95
5633	8.95	8014A	65.00
5634	8.95	8020	1.25
5636	5.25	8025	2.75
5637	4.00	8025A	5.95
5643	6.95	9001	1.15
5647	5.95	9002	.98
5651	2.50	9003	1.30
5654	1.75	9005	1.50
5656	14.95	927	1.55
5657	150.00		
5670	3.50		
5672	1.29		
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.1	150(L)	5.54	60	25	1.30	500	150	4.20
.5	100(K)	3.79	75	25(H)	1.86	500	300(N)	8.42
.5	150(L)	5.34	75	25	1.30	585	150(L)	5.05
1	50(J)	2.34	75	50	1.47	750	25(H)	1.86
1	50	1.64	75	75(G)	3.15	750	150	4.20
1.1	50	1.64	75	300	6.30	780	100(K)	3.55
2	25(H)	1.86	80	50(J)	2.10	800	25	1.30
2	100(K)	3.79	80	500(R)	12.18	1000	25(H)	2.10
3	100(K)	3.79	100	25(H)	1.86	1000	25	1.47
3	225(P)	6.99	100	25	1.30	1000	50(J)	2.22
5	25	1.30	100	50	1.47	1200	225(P)	6.99
5	50(J)	2.10	100	100(K)	3.55	1200	300	6.30
5	100(K)	3.79	100	150(L)	5.05	1250	50(J)	2.22
6	25(H)	1.86	125	25(H)	1.86	1250	150(L)	5.34
6	50(J)	2.10	125	25	1.30	1500	25(H)	2.10
6	75(G)	3.15	150	50(J)	2.10	1500	25	1.47
7	25	1.30	175	25(H)	1.86	1500	50(J)	2.22
7.5	75(G)	3.15	175	500(R)	12.18	1600	50(J)	2.22
7.5	225(P)	6.99	185	25	1.30	1800	50(J)	2.22
8	50(J)	2.10	200	25(H)	1.86	1800	150(L)	5.62
8	50	1.47	200	25	1.30	2000	25(H)	2.10
8	500(R)	12.18	200	50	1.47	2000	50	1.55
10	25(H)	1.86	200	100(K)	3.55	2250	150(L)	5.62
10	50	1.47	200	150(L)	5.05	2800	25	1.47
10	100	2.97	250	25(H)	1.86	2500	50(J)	2.22
12	25(H)	1.86	300	50(J)	2.10	2500	100(K)	3.71
12	50	1.47	300	50	1.47	2500	150	5.62
12.5	500(R)	12.18	300	75(G)	3.15	2500	500(R)	12.18
13	100(K)	3.55	300	100(K)	3.55	3000	25	1.47
15	25(H)	1.86	350	25(H)	1.86	3000	100(K)	3.79
15	25	1.30	350	25	1.30	5000	25(H)	2.22
15	75(G)	3.15	350	150(L)	5.05	5000	50(J)	2.34
15	100	2.97	370	25	1.30	5000	100(K)	4.04
16	50	1.47	378	150(L)	5.05	7500	50(J)	2.34
20	25(H)	1.86	400	25	1.30	7500	100(K)	4.30
20	50(J)	2.10	400	75(G)	3.15	10K	50(J)	2.50
25	25(H)	1.86	500	25(H)	1.86	10K	50	1.75
30	50	1.47	500	25	1.30	10K	100(K)	4.54
37.5	50	1.47	500	50	1.47	15K	25	1.93
40	225(P)	6.99	500	75(G)	3.15	20K	4	.75
50	25	1.30	500	100(K)	3.55	20K	150(L)	6.98
50	50	1.47	500	150(L)	6.98			

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.0001	6 KV	12.18	.0008	6 KV	14.00
.00015	5 KV	12.18	.001	6 KV	14.00
.00015	6 KV	12.18	.0015	6 KV	14.67
.0002	6 KV	12.18	.02	3 KV	15.44
.00024	6 KV	12.76	.032	2 KV	15.44
.00025	6 KV	12.76	.04	1 KV	17.55
.0004	6 KV	13.31	.051	1.5 KV	18.21
.0005	6 KV	14.00	.08	1.5 KV	19.73
.00075	6 KV	14.00	.09	1.5 KV	20.25

G-2 TYPE

.0001	10 KV	19.67	.0005	10 KV	19.67
.00015	10 KV	19.67	.00065	10 KV	19.67
.0002	10 KV	19.67	.0008	10 KV	19.67
.00027	12 KV	19.67	.001	10 KV	19.67
.0003	10 KV	19.67	.01	5 KV	20.75
.000375	10 KV	19.67	.03	2 KV	21.00
.0004	5 KV	19.67	.045	2 KV	21.00

G-3 TYPE

.00005	20 KV	33.27	.0011	20 KV	43.50
.0001	20 KV	36.30	.0012	20 KV	44.62
.0001	25 KV	37.80	.00124	15 KV	44 75
.00015	20 KV	37.80	.0015	20 KV	45.38
.00025	20 KV	39.33	.0016	15 KV	42.96
.0003	20 KV	39.33	.002	12 KV	42.35
.0004	20 KV	41.15	.0025	12 KV	45.00
.00045	15 KV	41.15	.004	12 KV	45.38
.00047	20 KV	41.15	.005	5.5 KV	28.50
.0005	20 KV	41.15	.006	10 KV	45.38
.0008	20 KV	41.15	.015	3 KV	45.38
.00095	5 KV	42.35	.015	7 KV	45.33
.001	15 KV	42.35	.05	3 KV	45.81
.001	20 KV	42.35	.25	1.6 KV	45.81

G-4 TYPE

.00025	30 KV	66.35	.0025	25 KV	68.73
.0003	25 KV	66.35	.005	20 KV	75.68
.00032	25 KV	66.35	.006	15 KV	75.68
.00032	30 KV	66.35	.0066	15 KV	75.68
.0005	30 KV	66.35	.0075	15 KV	78.00
.0006	35 KV	67.50	.01	15 KV	81.73
.00062	30 KV	66.35	.01083	12 KV	81.73
.00065	35 KV	67.50	.01163	5 KV	30.60
.0008	30 KV	66.35	.03	8 KV	81.73
.001	25 KV	68.73	.056	5 KV	83.17
.0015	25 KV	68.73	.05668	2 KV	30.75

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.000155	30 KV	139.20	.000533	30 KV	151.25
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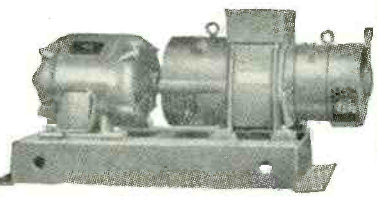
KATO 400 CYCLE POWER SUPPLY. Motor: 115/230 volts, 1 ph., 60 cyc. Direct connected to Alternator: Model 30EHOJ, 120/208 volts, 3 ph., 400 cyc., 3428 RPM. With end-mounted exciter. New.......$420.00

LINDOR PRECISION POWER SUPPLY. Motor: G.E., Synchronous, Type SK, 220/440 volts, 3 phase, 60 cycles, 1200 RPM, Frame 365. Direct connected to Alternator: 5 KVA, 4 KW, 115 volts, single phase, 400 cycles, 40 poles, self excited. Total harmonic content 5% line to line. Voltage regulation less than 2%. New $1650.00

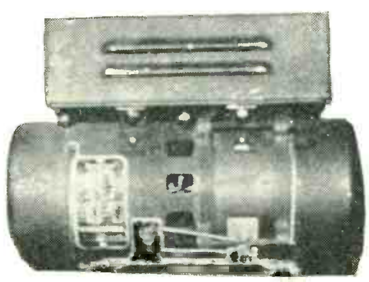


Bogue Laboratory 400 Cycle Supply. Motor 7.5 HP. 220/440-3-60 direct-coupled to self-excited alternator output. 5 KVA. 120/208 V. 3φ, 400 Cy. Voltage regulated. Harmonic content less than 1%. NEW $1475.00

BURKE 400 CYCLE MG SET. Motor: 1 HP, 115/230-1-60, 1750 RPM. V-belted to Alternator: 115 volts, 3 ph., 400 cyc. Self-excited. Total harmonic content less than 5%. Rebuilt.......................$390.00

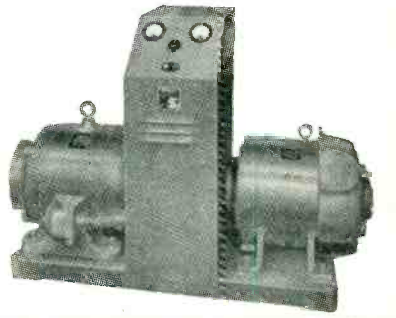
KATO LOW FREQUENCY MG SETS. Motor: 115 volts, 1 ph., 60 cyc. V-belted to Alternator: Model 23AA08, 500 watts, 115 volts, 1 ph., 25 cyc. Self-excited. New $295.00

AIRCRAFT INVERTER. Model MG149F. Input: 24 volts DC, 36 amperes, Output: 26 volts, 1 ph., 400 cyc., 250 VA, also 115 volts, 1 ph., 400 cyc., 500 VA. New $62.50



LELAND AIRCRAFT INVERTER. Type DA. Input: 28.5 volts DC, 12 amperes. 12000 RPM. Output: 115 VA, 115 volts, 3 ph., 400 cyc. Radio filtered...$55.00

LELAND AIRCRAFT INVERTER. Spec. 10486. Input: 27.5 volts, 12.5 amperes. 8000 RPM. Output: 175 VA, 115 volts, 3 ph., 400 cyc. Radio filtered...$85.00



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

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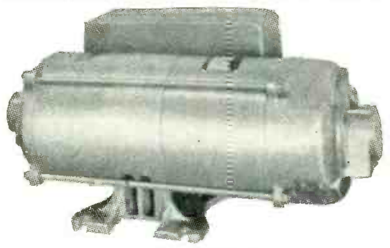
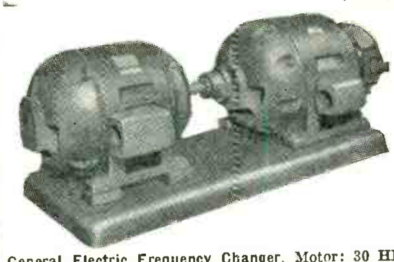


Model	Volts Input	Volts Output	Amps. Output	RPM	Price Each
5AM49AB16	440/3/60	62.5	1	1725	$58.50
5AM45DB26	440/3/60	125	1	3450	75.00
5AM45DB32A	440/3/60	250	.6	3450	52.50
5AM45DB11A	70/110 VDC	250	1	3800/5000	55.00
5AM45DB37	250 VDC	250	1	5000	55.00
5AM49AB3	440/3/60	115	3.25	3450	88.00
5AM49AB7A	440/3/60	250	1.5	3450	99.00
5AM31NJ18A	27 VDC	60	8.8	8300	12.50 (New)
5AM78AB10	32 VDC	250	3	2200	190.00
5AM78AB56A	115 VDC	250	3	1725	185.00
5AM78AB52	440/3/60	250	4	3450	225.00
5AM79AB68	220/440/3/60	60	25	1725	365.00 (4-brng.)
5AM79AB24B	220/440/3/60	60	25	1725	365.00 (4-brng.)
5AM79AB112	220/440/3/60	60	25	1725	365.00 (4-brng.)
5AM79AB69	220/440/3/60	125	12	1725	565.00 (4-brng.)
5AM78AB50A	440/3/60	250	6	3450	285.00 (TEFC)
5AM78AB40	440/3/60	250	6	3450	285.00
5AM602A3	220/440/3/60	250	6	1750	450.00 (4-brng.)
5AM614A8	220/440/3/60	200	25	1800	695.00 (4-brng.)
5AM614A3	220/440/3/60	200	25	1800	695.00 (4-brng.)



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

ONAN 800 CYCLE SUPPLY. Motor: Fairbanks-Morse, Type QZK, Frame RS404S, 50 HP, 220/440 volts, 3 ph., 60 cyc., 3500 RPM. Direct connected to Alternator: Onan, Model MG1001H, 25 KVA, 25 KW, 120 volts, 1 ph., 800 cyc., 208 amps. With end-mounted exciter. New $960.00

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AN/APA-11 Pulse analyzer
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This equip. is used for navigation and surveying. Operates in conjunction with AN/CPN-2 ground beacons. Operating freq. is 290mc. Accuracy is plus or minus 10 feet up to its range of 300 miles. Spares available. AN/CPN-2 ground beacons available. POR

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1N23B	1.70	6BZ7	.89	VT127	2.45	5651	1.30	6082	3.85	6201	3.50
1Z2	1.95	6CB6	.52	VT127A	3.95	5654	1.50	6088	1.95	8013A	3.75
2D21	.85	6F4	2.85	249T	4.00	5670	2.50	6095	1.45	9001	1.00
2D21W	2.00	6F6	.44	282A	5.00	5672	.95	6099	1.75	9003	1.25
2E24	1.60	6J4	4.75	371B	1.00	5676	.85				
2E26	3.00	6J6W	1.35	702A	2.50	5686	2.00				
3B22	1.50	6J6WA	2.25	805	3.00	5691	4.25				
3C24	1.75	6K4A	3.50	807	1.05	5692	5.65				
4-65A	12.50	6K7	.50	811	2.95	5725	2.85				
4-125A	17.00	6L7	.60	811A	3.10	5749	1.90				
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6AC7	.68	6U8	.79	866A	1.30	5814	1.95				
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FRESH STOCKS—JAN BRAND—NEW GUARANTEED

866A—69¢ | **723A/B $10.00** | **872A $1.25** | **304TL $3.50**

OD3/VR150	$ .69	100TH	4.95	717A	.75	955	.25
1B24	5.95	120	6.95	718AY	16.50	957	.25
1B26	1.50	123A	4.95	718EY	16.50	958A	.35
2B22	1.50	127A	1.95	720EY	25.75	1005	.50
2C21	.59	204A	7.95	723A/B	10.00	1613	1.50
2C26A	.19	205	.75	803	2.25	1616	.49
2C34	.19	215A	1.95	804	9.95	1619	.25
2J21A	3.95	250R	3.50	805	1.95	1625	.19
2J22	3.95	250TL	9.95	806	7.95	1626	.15
2J39	7.95	257A	2.50	814	2.75	1629	.19
3AP1	3.50	274B	1.00	826	.50	1632	.30
3C24	.75	282A	4.50	830B	1.29	1642	.65
3DP1	1.85	304TH	4.50	837	.98	2051	.69
3FP7	1.50	304TL	3.50	838	2.49	5851	4.00
3GP1	1.50	307A	1.50	843	.29	7193	.50
4B25	6.95	323A	4.50	851	$29.50	8002R	39.50
5AP1	2.50	327A	2.25	860	2.50	8025	2.00
5AP4	3.95	368AS	3.50	861	9.50	9001	.75
5BP1	2.50	371A	.75	865	.75	9002	.59
5BP4	2.50	394A	1.50	866A	.69	9003	1.00
15R	.25	HY615	.25	872A	1.25	9004	.25
RX21	6.50	703A	1.75	875A	1.00	9005	1.50
FG27A	14.95	704A	.65	876	1.00	1A4	$ .25
RK34	.30	708A	1.25	927	1.75	1A6	.25
35T	4.95	715A	1.75	954	.15	1B5	.35

1F4	.15	6C4	.39
1F5	.15	6C6	.29
1L4	.35	6G6G	.49
1LA4	.39	6H6	$ .39
1S4	.49	6SG7	.49
1S5	.49	6SH7	.49

Special—Brand new 10" TV Cathode Ray Tube—Replaces 90% 10" Tubes $5.95

RADIO RECEIVING TUBE SPECIALS

3D6 . . .29¢ 6V6G . .39¢
6K7G . .24¢ 12A6 . .29¢

1T4	$ .49	6U5	.49
2X2	.75	12SC7	.49
3A4	.49	12SF5	.39
3S4	.49	12SH7	.49
3V4	.49	12SN7	.49
6B8G	.19	12SR7	.49

- Partial Listing—Send for prices on any radio or transmitting tube not listed—We are one of America's largest export suppliers.
- Special discounts for large quantity users.
- Prices for domestic buyers FOB New York. 25% deposit with order. On export orders, FAS Net.

WE GIVE SPECIAL ATTENTION TO FOREIGN GOVERNMENT PURCHASING AGENCIES OR AGENTS

GROSSMAN RADIO & ELECTRIC CO.
81 SPRING ST. NEW YORK 12, N. Y. TEL: WO 6-0790 CABLE: GRECOELEC

GIGANTIC SAVE-TO-70% **MAIL SALE** WAR SURPLUS EXCESS INVENTORY BANKRUPT STOCK

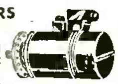
AUTOMATIC REMOTE CONTROL SWITCHES

*Amazing electro magnetic switch. Complete with dial. Any circuit from 1 to 100 can be selected simply by dialing the number, uncanny response. Will work over lines up to 20 units. Used, excellent.

*Fine for inter-coms. Private automatic phone systems, remote control, experimental, etc.

New Cost Over $200.00.
Sale, $13.95 Prepaid

AC-DC GENERATORS (115-volts)

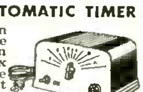


*Brand New. General Electric and Bendix dual voltage units. Use for welders, fast chargers, lights stoves, etc. Generates 115-volt, 2000-watt, 800-cycle AC 30-volt, 200 ampere DC. Govt. cost over $300.00.

Sale $29.48 Prepaid.

*Same unit except 125 amperes DC and 115-volt AC. Sale $23.91 Ppd.

ELECTRONIC AUTOMATIC TIMER

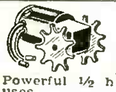


*Genuine Telechron 115-volt, 60-cycle Clock Timer in beautiful red onyx case. Will handle 1000-watt load. Set for any time 0 to 15 Minutes. Turns power off at proper time. Has pilot light and alarm buzzer.

*Many experimental and laboratory uses. Use for photography, sun lamps, timing studies.

List $19.95 Sale $4.95 Prepaid

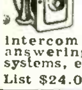
D-C GEARED MOTOR



*AC-DC type. 24-volt, 20 ampere Output speed 200 r.p.m. Powerful ½ h.p. Many interesting uses.

Cost $29.50 Sale $3.25 Prepaid

CITY EXTENSION TELEPHONES



*Excellent Western Electric wall phones in satin finish black cases. Use for intercom service, extensions and answering phones, or on private systems, etc.

List $24.00 Sale $4.79 Prepaid

LABORATORY RELAYS

*Wonderful buy in sensitive laboratory type adjustable double coil relay. Micrometer adjustment. 150 ohm coils. Heavy contacts. Use for either make or break. Hundreds uses.

Original Cost $11.50
Sale $2.97 Prepaid

WESTON METERS

*Finest Model 643 expensive 4½" meters. A wonderful buy.
(A) DC ammeter (0-300 amps) . . . $7.92
(B) DC Voltmeter (0-150 volts $3.79
(C) DC Basic milliammeter (0-2 m. a.) uncalibrated $2.19
(D) Laboratory Type (8" dial) ohm-meter $12.95

PHOTOGRAPHIC PAPER AND FILM

Eastman Kodak and other film and paper purchased from the Government. Outdated but guaranteed good. Save to 70%. Write for bargain sheet on surplus paper and film.

SHEET FILM — SAVE TO 70%

11 x 14 — Super Pan-Press Sports Type — 10 sheets per box . . . $3.15
11 x 14 — Super Pan-Press Type B 10 sheets per box $3.21
8 x 10 — Reprolith Ortho 25 sheets per box $2.95
11 x 14 — Super Ortho Press 10 sheets per box $3.09

BOXED PAPER

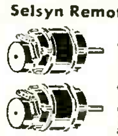
13"x13" — Contact paper sing. wt. glossy 250 sheets per box contrast 1, 2 or 3 . . . . . $9.07
10" x 10" — Enlarging paper S W 100 sheets per box contrast 1, 2, 3 or 4 . . . . . $3.49

110-V 3KW AC GENERATOR

*Hobart 3000-4000-w. 115-v. AC generator. Complete with full instrument panel, etc. Ready to use. Drive with engine, tractor, etc. Furnish emergency with full time power. Govt. cost over $400. SPECIAL. $169.50 Prepaid.

SPECIAL OF THE MONTH

Selsyn Remote Control Motors



*The war's most amazing invention. Self-synchronous motors enable the transmission of mechanical movement via electric wires over any distance. Hundreds of fascinating experimental applications. Remote wind direction and velocity indicators, positive controls, antenna rotational units, theft alarms, remote depth indicators.

*Genuine new precision G.E. and Bendix ball bearing units. Silver slip rings and brushes. Built like a fine watch.

*To use simply connect each unit to nearest 115-volt AC line. Then, connect two selsyns together using three wires. Any movement of shaft of Selsyn No. 1 causes identical movement of shaft on Selsyn No. 2. Full experimental instructions furnished. Cost $125.00 Sale $12.97 Per Pair Prepaid.

ELECTRONIC MISCELLANEOUS

Experimental instruction sheets furnished with all items.
*W. E. Photo Cell ($6.50) . . . $ .49
*Black Light Tube (4-watt) 48
*Thyratron Trigger Tube ($4.95) .98
*Hi-voltage Miniature Rectifier Tube 21
*Telephone Type 400 Ohm Relays 69
*Ouncer Type Trans. 100-4000 ohms 59
*Tripping Fire-Burglar Alarm Relay 99
*Laboratory 25-amp. Cct. Breaker $2.24
*Laboratory Misc. Electronic Assortment (6 pieces). Guaranteed to please or money back $3.49
*Airway Beacon Bulbs (1000-watt, 110-volt) 97
*Nichrome Resistor-Heater (20 amp. 110-volt) 99
*Selenium Rectifier Lab. Asst. (3) $1.41

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Thousands of items. Tools, electronics, watches, transits, tarps, microscopes, etc. Get finest Govt. items at fraction of original cost.

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Build TV-FM-AM Sweep Generator
You can build "Versatile Sweep Frequency Generator" with APN-1 magnetic units $5.95

AN/APR5A Airborne superhet radar search rec. Freq. range 1000 to 3000MC. Rec. has a 10MC IF band width operating from 80/115VAC, single phase 60 to 2600 cps. and one amp. at 26VDC . . . complete with tubes . . . like new $250.00

AN/APT5 TRANSMITTER . . . operates over a freq. of 300 to 1400 MC; output 30 watts. The carrier freq. is noise-modulated with effective random noise freq. up to 2MC. Complete with tubes . . . like new $99.50

I-122 SIGNAL GENERATOR RF signal 15 to 25 MC and 90 to 125 MC; modulated at 400 cps. or 625 cps. Power Supply 100 to 135 VAC, 25 to 60 cps. like new . . . $39.50
Spare parts kit for above . . . . . $5.95 (new)

AN/APN 9 Loran long range navigation system as used in ships and aircraft. Brand new—original cartons Ea. $295.00
AN/APN4 - "B"—Brand new—Complete . . . . . $129.50 per set

I.D. 6A/APN-4 Loran Indicator, BRAND NEW, complete with 5CP1 tube and 100 KC crystal at $29.50

R-9A/APN4-4—160 meter Loran Receiver, less tubes, Brand New. Complete with conversion diagrams $14.50
Both I.D. 6A and R-9A—$41.50

Write for prices and bulletin
25% Deposit on orders. Shipments F.O.B. Chicago

RW Electronics
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2430 S. Michigan Ave. Chicago 16, Ill.
Phone: CAlumet 5-1281

PRECISION TIMERS

1/100's of a Second Graduation
1 RPS, Totalizes 60 seconds
Model S1, 115 v 60 cys
Manual reset $19.50
With electric reset $24.50
Postpaid Anywhere in U. S. A.

DRILLICK ELECTRONIC SALES CO.
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Harjo CHECK THESE VALUES!

Orig. Gov't. Cost Approx. $141

MINIATURE LINE MATCHING TRANSFORMERS

Does Functions of $55 parts! $1

With Schematic (add 25c postage)

For blocking oscillators on TV Rcvrs & TV camera input circuits; tone oscillator transformer for electric organ; for digital computor systems, blocking and count down; for phone patches, transistor circuits, 1000's other uses. Weights only 4-os., hermetically sealed. 4 windinge—2 input of 150 ohms—and 2 output of 1 of 105 ohms and 1 of 600 ohms. Rated 6 MW 200-5000 Cy. 500 V. RMS test.

TEST EQUIPMENT

TS-11	$45.00
TS-13	650.00
TS-34	250.00
TS-47/APR	200.00
TS-34	250.00
TS-89	32.50
TS-100	85.00
TS-101	7.50
TS-126	75.00
TS-131	14.95
TS-184	45.00
TS-268	37.50
IE-19	200.00
I-222	89.50
I-139A	12.50
I-183A Freq. Meter	22.50
I-185A Oscillator	24.50
LZ Sig. Gen (S band)	15.00
LM	85.00
BC-221 Meter	89.50

COLLINS AUTOTUNE ASSEMBLY

With 110V. 60Cy. AC. MOTOR.

Tunes automatically to any of 10 preset positions. Use for tuning xmtrs. industrial devices, etc. Orig. gov't cost, $300. New, boxed $39.50

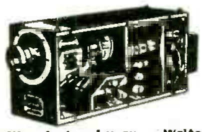
POWER SUPPLIES INVERTERS

MG-149Fx Rotary Converters, certified $45.00
RA-34 Hi-Voltage for BC-191, etc. 149.50
RA-62 Hi-Voltage for SCR 522 .... 150.00

RCA Surplus TV CAMERA

Special

$225



With 1846 Iconoscope and 6-stage video amplifier and clipper. For use in movie pick-up chains and training and experimental work. Selling fast so hurry. Write for complete information.

CONTROL RECTIFIER $14.95

Input 115V, #1 phase, 400 cy. 1.6 amps. 175 watts. Output 115 VDC. 0 to plus or minus .6 amps. Orig used with model SF Radar equipt. Less tubes, xlnt. cond.

INVERTEEN CAPACITOR

Model 1313852 120 MFD @ 3000 V. Made for DC welding and other uses. Contains 1.7 gals. non-inflammable liquid. New $69.50

TSX-4SE PULSE ANALYZER

3 cm Spectrum analyzer. Similar to TS-148, but with greater sensitivity. Freq. range: 8500-9600 MC. Features: Absorption wavemeter, waveguide—beyond cutoff, attenuator, 20 mc I.F. Strip, 120 db gain. Operates from 115 V/200 V 50-1200 CPS. PRICE ON REQUEST!

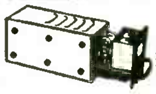
701A XMTR. TUBES

A great screen grid xmtr tube for new final AM or SSB. New, oug. boxes. Complete with dope sheet $2.95 ea. or 2 for $5

SOCKET for ABOVE TUBE .... $2 postpaid

FILAMENT TRANSFORMERS for 701A, 8V. at 7½ amps 2.95

3-INCH BLACK DIALFACE 0-750 MA 3.95
500-0-500 MICRO 3.95
PANEL METERS, 3-inch square Weston 0-2.5 amps DC 3.95



TURBO AMPLIFIERS

New turbo amplifier. Includes 2-7C5, 1-7F7, 1-7Z4. Ideal for pre-amps, moblie equp. & lab supplies .... $2.95.

NETWORK SECTIONS
- D168435, used in TS-34 .... $9.50
- D163331 .... 12.50
- D163330 .... 25.50

RELAY ASSY BENDIX BC-640-B DWG C-58363, 2Z7699 2.5 .... $6.50

POTENTIOMETERS, wire-wound resistors, all sizes. Write for complete list!

OIL CONDENSERS, bathtub, channel and hi-voltate type. Write for complete list!

RESISTORS, insulated, stnd. brands, 5%, 10%, ½ & 1 watt asst. .... 100 for $1.79 postpaid

TV TUNER standard coil, cascode with 6BQ7, 6J6 new 13.95

CERAMIC CONDENSERS, kit of 100 asst. brand new, standard brands. $10 value $1.00

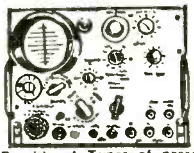
NEW POWER TRANSFORMER 110v. 60cy. primary, 150v. 30ma. secondary 6.3-1 amps. Fil. FB for grid dip kits, test equipment, etc. ...... 79c each or 4 for $3

TRANSMITTERS & RECEIVERS

ARC-3 complete, certified	$580.00
BC-640 & BC-639, RA-42	750.00
AN/TRT-1 Mine Trans.	100.00
ART-13	350.00
BC-797 Ground Stas.	750.00
SCR-284	100.00
BC-1333 Marker Rcvrs. Certified	75.00
BC-733D CAATC	35.00
ASB-7 Xmtrs with tubes. For 420 MC & TV relay work	7.95
ANDREW TYPE 876 Dry Air Pump for use with coax transmission lines. New	9.95

SOUND POWERED HEAD & CHEST SET Navy type. No batteries needed. Ideal for TV antenna installations. 20' cord. New. A $25 value. Special at $7.95

WESTERN ELECTRIC HANDSET. Stnd. telephone type with cord. For mobile and home systems. Xlnt condition $2.95



Model AN/APA-10 PANORAMIC ADAPTER

Provides 4 Types of presentation: (1) Panoramic (2) Aural (3) Oscillographic (4) Oscilloscopic. Designed for use with AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or other equip. with I. F. or 455 KC 5.2 mc or 30 mc. Includes 21 tubes with 3" scope tube. Special $99.50

HAZELTINE PULSE GENERATOR Model 1017—Electrical characteristics: Pulse freq.; initiating and sliding pulse—external. Pulse width; initiating and sliding pulses, plus 150 v. Sliding pulse delay: variable over full trace length. Sweep duration; 50, 200 and 1000 microseconds. TUBES: 16—6SJ7; 3—6L6; 2—6J5; 2—6SN7; 1—5U4G; 1—6SK7; 1—6Y6G; 1—991; 1—9002. Power input, 110-125V, 60 cy. single phase. Dimensions 13½" x 20½" x 23". Wt. 85-lbs. Comes with schematic and complete instructions $49.50

TS45/APM X-BAND SIGNAL GENERATOR

for small labs, schools, etc. $125.00

Harjo Sales Co.

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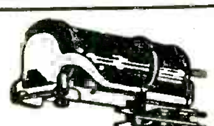
TELEPHONE RELAYS



Large Stock of
CLARE, TYPES C D & E
COOKE, AUTOMATIC—ELECTRIC
ALL TYPES of COILS and PILE-UPS

Send Us Your Specs. for Our Quote

CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

	Coil	Contacts	Operates at	Price
1)	6500 ohms	2A	5 MA	$2.50 ea.
2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
4)	3600 ohms	1C	6 MA	2.00 ea.
5)	4850 ohms	1A	5 MA	2.00 ea.
6)	3300 ohms	(None)	ACTUATOR	1.50 ea.
7)	3300 ohms	1A	Micro-Switch	2.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE G TELEPHONE RELAYS

1)	1300 ohms	1A-1C	24 or 48V	$2.50 ea
2)	400 ohms	1A	24V	1.65 ea
3)	500 ohms	1D	24V	1.65 ea
4)	200 ohms	1A	24V	1.50 ea

CLARE TYPE C STANDARD SIZE D.C. TELEPHONE RELAYS

	Coil	Contacts	Operates at	Price.
1)	1300 ohm	1B	24 to 85V.	$2.25 ea.
2)	1300 ohm	2A-1B	24 to 85V.	2.75 ea.
3)	1300 ohm	2C-1A	24 to 85V.	3.00 ea.
4)	1300 ohm	4C-2A	30 to 85V.	4.00 ea.
5)	1300 ohm	2A-1B-1C-1D	30 to 85V.	3.00 ea.
6)	1300 ohm	6C	30 to 85V.	4.50 ea.
7)	2000 ohm	2C-1A	24 to 110V.	3.00 ea.
8)	2000 ohm	4C-2A	30 to 110V.	4.00 ea.
9)	2000 ohm	6C	30 to 110V.	4.50 ea.
10)	2000 ohm	8A	36 to 110V.	3.50 ea.
11)	3000 ohm	3A	24 to 150V.	2.75 ea.
12)	3600 ohm	2C-1A	24 to 150V.	3.00 ea.
13)	110V. AC	2C-1A	110V. AC 60cy	3.50 ea.

CONTACT SYMBOLS

A=Norm. Open B=Norm. Closed C=S.P.D.T. D=Make Before Break

Chase

Electronic Supply Co.
105-07 225 St.
Queens Village, N. Y.
HOllis 4-5033

At the height of our busiest season, we've CUT OUR PRICES on popular Industrial, Receiving, Special-Purpose Tubes!

New 1955 electronic parts mail-order catalog just published! Better than ever!

OB3/VR-90*	$0.90
OC3/VR-105*	.85
OD3/VR-150	.69
1B22*	1.11
1B23*	4.50
1B27	8.95
1B32	1.49
1P23	1.95
2AP1	6.90
2B22	1.50
2C33	2.45
2C40	8.50
2C44	.89
2E22	1.50
2J21	4.45
2J21A	4.90
2J22	4.90
2J27	8.95
2J50	49.50
2J54*	49.50
2J55	59.45
2J61A*	21.95
2K55	24.50
2X2	.39
2X2A*	1.20
3AP1*	7.50
3BP1*	3.45
3C23	6.75
3C24	1.49
3CP1	1.69
3DP1*	3.50
3FP7	1.69
3HP7*	3.50
3JP12	3.99
4B22/EL-5B	3.25
4B25/EL-6-CF	3.25
4C27*	8.95
4J36	90.00
4J37	90.00
5BP1	2.99
5BP4	3.25
5CP1*	4.49
5D21	9.95
5FP7*	1.65
5JP1	14.95
5JP2	12.50
7BP7*	4.95
7CP1	9.95
9LP7	1.89
10 Special	.88
10Y	.69
15R	.30
CE-22	.55
23D4	1.10
24G	1.49
RK-25*	1.95
FG-27-A	4.90
30 Special	.32
45 Special	.30
HK-54	3.95
RK-65*	19.95
QK-72	50.00
VR-92	.39
VR-78*	.65
211/VT-4C	.79
227A	2.98
RX-233A	6.75
274B	1.49
304TH	8.95
316A	.98
327A*	3.50
350A	2.49
359B	4.75
371B	.69
388A	1.39
394BA	2.45
417A*	11.95
GL-434A	11.50
GL-446A	1.39
450TL*	38.75
464A	4.90
CK-501LX	1.49
HY-615*	.49
ZP-653	24.50
702A	1.15
705A	1.49
706B*	16.95
707A*	5.95
708A*	3.25
710A*	6.50
714A*	8.45
715A*	2.85
715B	3.95
721A	1.50
723A	8.95
723A/B	14.95
724A*	1.25
724B*	2.90
725A*	6.75
726A*	9.95
801	.75
803	3.10
805	2.50
807	1.40
810	9.95
811	2.45
813	9.95
814	2.25
815	3.00
816*	1.10
826	.85
830B	1.75
832*	6.95
832A*	8.95
838	2.50
866/866A	1.00
872A	1.95
874*	.95
884	1.00
954	.29
VR59/955	.35
956*	.35
957	.29
958A*	.59
959*	1.40
1616	.75
1619*	.39
1625	.35
1626	.30
1629	.40
1638*	.89
1655	.75
2051*	1.00
UX6653	.65
8011	.95
9001	.95
9002*	.90
9003	.99
9004	.35
9006	.30

* limited quantity

RADIO SHACK CORPORATION

167 WASHINGTON ST., BOSTON 8, MASS.

SPECIAL 304TH Just $8.95

Your inquiry

will have

Special Value . . .

If you mention this magazine, when writing advertisers. Naturally, the publisher will appreciate it . . . but, more important, it will identify you as one of the men the advertiser wants to reach with this message . . . and help to make possible enlarged future service to you as a reader.

INDEX TO THE SEARCHLIGHT ADVERTISERS

OCTOBER, 1954

This index is published as a convenience to the readers. Care is taken to make it accurate but ELECTRONICS assumes no responsibility for errors or omissions.

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

(Continued on opposite page)

INDEX TO THE SEARCHLIGHT ADVERTISERS

October, 1954

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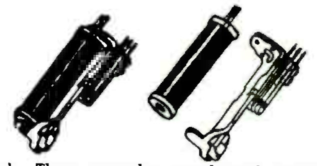
(Continued from opposite page)

RELAYS RELAYS

OVER 400,000 IN STOCK
1200 DIFFERENT TYPES

TELEPHONE TYPE RELAYS



These relays have been standardized so that coils and frames of most manufacturers can be interchanged without affecting adjustments. A wide variety of applicable combinations are thus possible from a comparatively small number of relays.

Listed below are frames and coils from our stock. They may be purchased separately. However, a complete relay consists of coil and frame. In ordering complete relays specify which coil with which frame, i.e.: F101 with K117.

Representative completed relays are also listed with voltage and current ratings. Values are indicative of sensitivity that may be expected from similar combinations. The voltage, current and resistance ratings listed under "Automatic Electric Time Relay" are typical of all such coils.

Get your name on our mailing list. Something new and interesting in the near future.

CLARE, 6500 ohm, 8 ma DC, 3 makes (3As) #R276 $4.25

CLARE K101, 6500 ohm, SPDT, 2 ma DC, Fast Action R588 .... $4.25

FRAMES

(For Cost of Relay Add Price of Frame to Price of Coil)

Stock No.	Contacts	Price each	Stock No.	Contacts	Price each
F101	1A	$1.25	F112	2A, 2B, 2C	3.00
F102	2A	1.50	F129	2A, 2B, 6C	5.00
F103	3A	1.75	F114	3A, 1B	2.00
F104	4A	2.00	F162	3A, 1B, 1C	2.25
F138	5A	2.25	F163	3A, 1B, 1D	2.25
F139	10A	3.50	F115	3A, 2C	2.75
F128	12A	4.00	F164	3A, 4C, 1D	3.75
F106	1A, 1B	1.50	F165	4A, 1B	2.00
F107	1A, 2B	1.75	F117	5A, 1C	2.75
F140	1A, 3B	2.00	F166	6A, 2B	2.50
F108	1A, 1B, 1C	2.00	F143	6A, 4C	4.50
F152	1A, 1B, 2C	1.80	F131	9A, 1B, 1C	4.00
F153	1A, 2B, 1C	2.00	F120	1B	1.25
F154	1A, 2B, 1E	2.50	F132	2B	1.50
F109	1A, 1C	1.75	F167	2B, 1C, 1D	2.25
F155	1A, 2C	2.00	F168	2B, 3C	2.75
F141	1A, 3C	2.75	F133	1B, 1C	1.75
F147	1A, 2D	2.75	F144	1B, 4C	3.25
F156	1A, 4C, 2D	3.75	F121	5B, 1C	2.75
F111	2A, 1B	1.75	F122	1C	1.50
F157	2A, 1B, 1C	2.00	F169	1C, 2D	2.25
F158	2A, 1B, 2C, 1D	2.90	F123	2C	2.00
F159	2A, 1D	1.75	F145	3C	2.50
F142	2A, 2B	2.00	F124	4C	3.00
F160	2A, 2B, 1C	2.75	F149	1C, 1D	2.25
F137	2A, 1C	2.00	F150	3C, 1D	3.25
F171	2A, 2C	2.50	F170	7C, 1D	4.25
F161	2A, 3C	3.75	F151	1D	1.75

Additional pileups also available
A = Normally open; B = Normally closed;
C = Double throw; D = Make before break

ELECTRICAL COUNTER; Automatic Electric Series CDC; Non-Reset type; Auxiliary SPST (1A) Contacts; Speed; 4 steps/sec; 4 digits; 223 ohms; 24VDC; #R897 .... $5.00

AUTOMATIC ELECTRIC TIME DELAY

AWS Weighted Spring Assembly; when used with ASO or ASA relay provides an overall operating delay of approx. 2 seconds. Provided with single normally open contacts.

Volts Nom.	Volts Max	Nom. Ma	Ohms	A. E.#		Each
6	21	120	50	RE27	#R307..	3.00
12	36	80	150	RE28	#R308..	3.00
18	47	72	250	RE29	#R309..	3.25
24	66	48	500	RE30	#R310..	3.25
48	81	37	1300	RE31	#R311..	3.75
115	170	36	3300	RE32	#R312..	4.25

AVR Vibrating Reed Assembly; When used with ASO, BSO, BSA, or ASA to secure overall release delay adjustable between 1 and 15 seconds. Can also be used with slow-operate relay to secure operate delay adjustable between 1 and 15 seconds and in self-cycling circuits to generate time pulses.

24	49	60	200	RF71	#R313..	3.50
115	202	17	3300	RF73	#R314..	4.00

A18258 BENDIX (Cook 102) 8-12 VDC, Copper Slug, Slow Release, SPDT, 200 ohm, Part of SCR 522, #365 .... $2.49

R5229A1 AUTOMATIC 6VDC, 3PST n.o. (3As), 75 ohms, Slow Release, #412 .... $2.50

R5021A1 AUTOMATIC 1300 ohm, 20 ma DC, SPST n.c. (1B), #413 .... $2.95

COILS

(For Cost of Relay Add Price of Coil to Price of Frame)

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K101	0.75	$1.25	K134	700	1.50
K131	5.0	1.25	K107	750	1.50
K102	12	1.25	K135	800	1.75
K156	50	1.25	K109	1000	1.76
K157	70	1.25	K111	1300	1.75
K168	100	1.25	K158	1400	2.00
K132	175	1.25	K112	2000	2.25
K169	200	1.25	K159	2250	2.50
K153	300	1.50	K155	2500	2.50
K154	400	1.50	K113	3000	2.50
K104	450	1.50	K116	6500	2.75
K105	500	1.50	K167	12,000	3.00
K133	600	1.50	K118	40,000	3.25

SLOW-ACTION COILS

SLOW-MAKE			SLOW-RELEASE		
Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K160	20	$1.50	K161	30	$1.50
K122	33	1.50	K149	3.9	1.50
K146	125/1300	2.50	K123	75	1.50
K171	500	2.00	K124	200	1.50
K147	500/1500	2.50	K150	800]	2.00
K148	1300	2.00	K151	1000	2.00
K146	1300/125	2.50	K152	1300	2.25
K147	1500/50	2.50			
K172	1800	2.50			

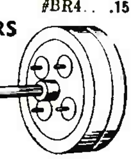
DUAL COILS

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K162	20/400	$2.25	K106	500/1100	2.00
K163	25/200	2.25	K144	500/1800	2.50
K141	50/2000	2.25	K165	550/550	2.25
K166	125/125	2.25	K170	800/800	2.25
K142	125/1300	2.25	K143	1000/200	2.00
K164	200/200	2.25	K106	1100/500	2.00
K163	200/25	2.25	K142	1300/125	2.25
K143	200/1000	2.00	K144	1800/500	2.50
K162	400/20	2.25	K141	2000/50	2 25

ACCESSORIES

Clare	CR1	Molded Bakelite Cover 2⅛" x 2⅜" x 4¼" overall	#CR1..	.90
Clare	CR3	Steel Cover 2 15/16" x 1 13/16" x 4⅜" overall	#CR3..	.95
Clare	CR5	Steel Cover 2¾" x 1 15/16" x 4⅜" overall	#CR5..	.95
Clare	BR2	Long Relay Bracket	#BR2..	.20
Clare	BR4	Short Relay Bracket	#BR4..	.15

PHASE SHIFT CAPACITORS



W.E. #D150734 S.C. Stock No. 2C6996-1053A/C2. As used in BC1053A, SCR-545, Mark 34 and other Radar equipment. New, in original boxes.

$25.00 each
10 for $225.00

H-F TIE POST

Low-Loss Yellow Melamine insulation, pictured actual size (4-40 Thread) $7.50/C $67.50/M

TERMS:—All prices F.O.B. Our Plant. Rated Firms Net 10 Days: All Others Remittance with Order.

Orders Under $10 Remittance With Order, Plus Approximate Shipping Charges (overage will be returned.)

324 CANAL ST., N.Y.C., 13, N.Y. WAlker 5-9642

Universal general corp.

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BUSINESS

Service:

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Classified Advertising Division

McGraw-Hill Publications, Inc.
330 W. 42nd St., New York 36, N. Y.

NEW YORK'S RADIO TUBE EXCHANGE

TERRIFIC SLASHES in PRICE up to 70% from PREVIOUS LOW PRICES

TYPE	PRICE
OA2	$1.00
OA3	1.10
OB2	.99
OB3	1.10
OC3	.96
OD3	.89
C1B	2.95
1B21	1.50
1B22	1.50
1B23	6.95
1B24	12.00
1B26	1.75
1B27	12.50
1B32	2.95
1B38	35.00
1B50	23.00
1B51	7.50
1B56	35.00
1B60	35.00
1N21	1.25
1N21A	1.75
1N21B	2.75
1N21C	19.50
1N22	1.00
1N23	1.95
1N23A	2.75
1M23B	2.75
1N23C	7.50
1N25	4.50
1N26	6.75
1N27	3.50
1N34A	.79
1N43	2.25
1P25	75.00
2B4	1.25
2B22	1.75
2C34	.15
2C40	9.00
2C42	12.00
2C43	14.50
2C44	.60
2C46	7.50
2E22	2.25
2J21A	12.00
2J22	9.00
2J26	15.00
2J27	15.00
2J31	24.00
2J32	29.00
2J33	32.00
2J34	36.00
2J36	90.00
2J38	8.95
2J39	8.95
2J40	29.00
2J42	135.00
2J49	60.00
2J50	55.00
2J55	150.00
2J56	110.00
2J61	35.00
2J62	35.00
2K22	15.00
2K23	15.00
2K25	27.50
2K26	68.00
2K28	35.00
2K29	35.00
2K33A	75.00
2K39	140.00
2K41	135.00
2K45	80.00
2K50	275.00
2K54	45.00
2K55	25.00
2K56	72.00
3AP1A	10.00
3BP1	7.20
3B24	5.50
3B25	5.50
3B26	5.00
3B28	8.00
EL3C	5.50
3C22	99.00
3C24	1.50
3C31	2.95
3DP1	7.50
3DP1A	10.00
3DP1A-52	10.00
3EP1	5.00
3E29	15.50
3FP7	5.00
3HP7	5.00
3GP1	5.00
3J21	75.00
4B26	5.40
4C27	22.50
4C28	35.00
4E27	16.00
4J25	150.00
4J26	150.00
4J27	150.00
4J28	150.00
4J29	150.00
4J30	150.00

TYPE	PRICE
4J31	150.00
4J32	150.00
4J33	150.00
4J34	100.00
4J35	150.00
4J36	150.00
4J37	150.00
4J38	150.00
4J39	150.00
4J40	150.00
4J41	150.00
4J42	190.00
4J51	190.00
4J52	225.00
4J53	225.00
C5B	250.00
5BP1	3.95
5BP2A	12.00
5BP4	3.95
5CP1	7.50
5CP7	6.95
5CP7A	18.00
5D21	18.00
5EP7	1.95
5JP1	27.50
5JP2	19.50
5JP4	27.50
5J23	45.00
C6A	11.00
C6J	7.50
7BP7	5.00
7DP4	9.00
12AP4	50.00
12DP7	24.00
LM15	225.00
15E	1.75
15R	.75
NE16	.59
20—4	.75
KY21A	8.25
RX21	8.00
HK24G	1.50
25T	2.95
45 Special	.35
RK39	2.75
HF50	1.75
VT52	.35
HK54	4.50
RK72	1.00
RK73	1.00
FG95	19.95
100TH	7.95
FG105	20.00
122A	1.75
203A	7.50
211	.95
217C	12.00
242C	10.00
244A	9.50
249C	4.25
250TH	19.95
250TL	12.00
282A	3.00
274B	2.75
304TH	10.00
304TL	10.00
307A	3.50
310A	4.50
310B	4.95
311A	6.50
312A	3.50
323A	15.00
327A	3.75
323A	6.75
350A	7.50
350B	5.95
HK354C	15.00
357A	15.00
368AS	4.95
371B	1.50
385A	4.50
388A	1.80
393A	7.50
394A	3.95
MX408U	.50
417A	15.00
434A	15.00
446A	1.95
446B	3.95
450TL	45.00
450TH	52.50
464A	7.50
471A	1.25
527	18.00
WL530	23.00
WL531	22.50
WL532	1.75
WL533	15.00
HK654	35.00
700A/D	10.00
701A	4.50
703A	3.95
704A	1.95
705A	21.75
706AY/FY	25.00

TYPE	PRICE
707A	9.75
707B	15.00
714AY	18.00
715A	4.50
715B	9.00
715C	22.50
717A	1.50
718AY/EY	30.00
719A	22.50
720AY/GY	150.00
721A	3.50
722A	3.50
723A/B	18.00
724A	1.95
724B	2.25
725A	18.00
726A	18.00
726B	45.00
726C	45.00
723AY/GY	15.00
730A	22.50
750TL	99.00
801A	.90
802	3.95
803	5.95
805	4.95
807	1.50
808	1.95
809	2.95
810	10.50
811A	3.75
812A	3.95
813	13.75
814	3.75
815	6.25
816	1.45
829	11.00
829A	12.00
829B	15.00
830B	2.00
832A	9.95
833A	45.00
834	7.50
836	3.95
837	2.75
838	5.95
849	35.00
860	3.50
861	25.00
866A	1.50
869B	67.50
869BX	50.00
872A	3.50
878	1.50
879	.50
884	1.50
885	1.50
914A	75.00
931A	5.00
954	.35
955	.50
956	.75
957	.25
958A	.60
959	2.25
E114A	.25
1280	.95
1500T	135.00
HK1554	75.00
1603	5.00
1612	1.50
1613	1.25
1616	1.25
1619	.45
1622	1.50
1624	1.75
1625	.35
1626	.25
1851	1.80
2000T	150.00
2050	1.80
2051	1.00
Various 5000 and 6000 series of new production	
5280	475.00
8012	2.00
8012A	2.50
8013	3.00
8013A	3.50
8019	1.75
8020	1.80
8025	3.75
PD8365	96.00
9001	1.25
9002	.90
9003	1.25
9004	.35
9005	2.75
9006	.25

Thousands of other tubes

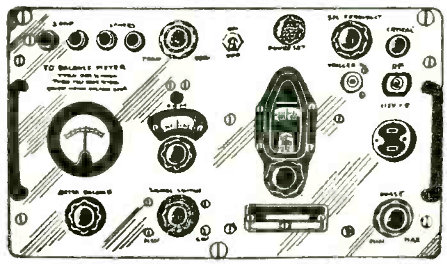
NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or reasonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

NEW UNUSED SURPLUS TS 259 K BAND
23400-24500 MEGACYCLES SIGNAL GENERATOR

NEW
TS-147 B/UP TEST SET
TS-147 C/UP TEST SET
Hard-to-get X-Band SIGNAL GENERATOR Now Available



Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

SPECIAL! 5,000 V. POWER SUPPLY
For IP25 Infrared Image Convertor from 3 V. Battery Sources. NEW, Complete with RCA 1654 Tube.......................... **$9.90**

Other test equipment
checked out; used, surplus

- TSKI/SE K Band Spectrum Analyzer
- TS3A/AP Frequency and power meter S Band
- RF4A/AP Phantom Target S Band
- TS12/AP VSWR Test Set for X Band
- TS13/AP X Band Signal Generator
- TS14/AP Signal Generator
- TS33/AP X Band Power and Frequency Meter
- TS34/AP Western Electric Synchroscope
- T35/AP X Band Signal Generator
- TS36 AP X Band Power Meter
- 1-96A Signal Generator
- TS45 X Band Signal Generator
- TS47/APR 40-400 MC Signal Generator
- TS69/AP Frequency Meter 400-1000MC
- TS100 Scope
- TS102A/AP Range Calibrator
- TS108 Power Load
- TS110/AP S Band Echo Box
- TS125/AP S Band Power Meter
- TS126/AP Synchroscope
- TS147 X Band Signal Generator
- TS270 S Band Echo Box
- TS174/AP Signal Generator
- TS175/AP Signal Generator
- TS226 Power Meter
- TS239A-TS239C Synchroscope
- TS323 Frequency Meter
- TF890/1 X Band Spectrum Analyzer
- 834 General Radio Frequency Meter

SURPLUS EQUIPMENT

- APA10 Oscilloscope and panoramic Receiver
- APA38 Panoramic Receiver
- APS 3 and APS 4 Radar
- APR4 Receiver and Tuning Units
- APR5A Microwave Receiver
- APT2-APT5 Radar Jamming Transmitter

FREQUENCY CONVERTORS
INVERTORS from 60 cycle to 400 or 800 cycle.
We supply various motor generators with frequency and voltage automatically controlled, from 300 watts to 1500 watts and higher. ATTRACTIVE PRICES.

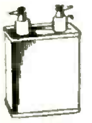
MINIMUM ORDER 25 Dollars

SPECIAL
Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated. externally or internally.

YOU CAN REACH US ON TWX NY1-3235

Large quantities of quartz crystals mounted and unmounted.
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80.
Large quantity of Polystyrene beaded coaxial Cable.

Phone: WOrth 4-8262
LIBERTY ELECTRONICS, INC.
135 LIBERTY STREET, NEW YORK 6, N. Y.
Cables: TELSERUP



OIL CONDENSER SPECIAL

10 MFD 600 VDC $1.75 ea.

LOTS OF 3

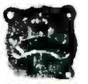
Case Dimensions, Not Including Insulators, 4½H—3¾W—1¼" D Less Than 3...$1.98
2 MFD 600V 49c; 10 For $3.50

LABORATORY PRECISION POT

20,000 Ohm Wire Wound 2¾" Diameter, Potentiometer. GR Type....$1.98; 2 for $3.50

WRITE FOR QUANTITY PRICE

METER SALE



50% OFF REG RESALE PRICE

0–1MADC/3½" RND/MR35 W001DCMA/$8.33 Reg....$3.95
0–5MADC/3½" RND/MR35 W005DCMA/$8.33 Reg....$3.95
0–100MADC/3½" RND/MR35W100DCMA/$8.33 Reg....$3.95
0–30VDC/2½" RND/Aircraft "AN"....$2.98
0–800VDC/Weston 301/3½" SQ/1000-Ohms Per Volt/$25.00 List....$8.95
0–1500VDC/3½" RND/$12.95 Reg....$5.95
0–150VAC/Westinghouse 3" SQ....$4.95
120–0–120ADC/with-Shunt; "AN"....$4.95
0–3–15 Amps AC Weston 528....$5.95

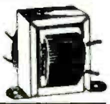
HI-MEG HI-VOLT RESISTORS

.75 MEG "MVP" 10W 10KV... .79 10 for $5.00
2 MEG "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... .89 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 "MVD" 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

TRANSFORMERS
ALL 115V 60 CYC INPUT

5000VDC/5MA, 300VDC/275MA, 5V/3A, 5.4V/8A, 6.4V/10.3A, 2.5V/3A OIL FILLED....$4.98
2500V/20MA, 6.3V/.6A, 2.5V/1.75A 4/BC412 Scope Replmnt....$7.98
1600VCT/5MA, 6.3VCT/3A, 6.3 CVT/10A, 2.5VCT/5A $7.95; 2 for $14.00
950VCT/100MA, 5V/2.5A, 5V/5A, 45V/1A, 10V/1.5A WESTERN ELECT....$4.98; 3 for $13
900V/35MA, 2X2.5V/2A, Xclent 1800V DBLR TWO 2X2 FIL WNDGS....$1.98
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
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC & 115 & 230 VAC @....$1.49
2X330VCT 10MA, EACH WNDG....$1.39

TRANSFORMER SPECIAL!!



6.3 Volt 3¾ Amp.

CONTINUOUS DTY
115VAC input
SIZE 2 5/16H/2L/1½" W
HVY DTY CHANNEL MTG
8 INCH WIRE LEADS
$1.00; 12 for $10

Filament Trans. 115V/60 Cy. Input

2.5VCT/10A 5KVINS $3.59; Same 10KV $3.98
2.5VCT/10A 12.5 KVINS....$5.50; 3 for 14.00
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 2⅝W 3⅛H 2¾D $3.59 @ 3 for 10; 12 for $36
42.5V/2A Sel. Rect. Xfmr....$4.98; 2 for $8.00
64V/1Amp Hmsld....$3.49; 2 for $5.00
PRI 110 & 220V SEC 16.6V/1.25A, 12.6VCT3.5A $4.98: 2 for $8.00

FILTER CHOKES

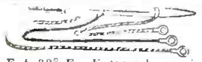
10 Hy/75ma....$1.25
10Hy/125ma/UTC/Csd Hmsld/1 KVins....1.98
50Hy/125ma/Csd/H'Sd....2.89
20Hy/300ma or 15Hy/400ma/ 12KVins Kenyon Csd....8.95
13.5Hy/1 Amp/17KVins/Raytheon....35.00
Dual 2Hy/300ma USN....95c; 2 for 1.49
6 Hy 175ma 250 Ohm....$1.49; 2 for 2.49
10 Hy 100ma Freed....1.39
3.5 Hy/300 ma/60 Ohm....$1.69; 2 for $3

230 TO 115V AUTOFORMERS

For 220–240V/50–60cy Input. To 110–120V or Step-up with Cord Plug & Receptacle.
TPA050/50W....$2.55; TPA075/75W....$3.65
TPA100/100W....4.00; TPA200/200W....5.75
TPA250/250W....6.75; TPA300/300W....7.25
TPA500/500W....8.25; TPA750/750W....11.75
Model TPA1000/1000 Watts/1KW....16.95
TPA1500/1500W $22.50; TPA2000/2KW..28.95
Model TPA3000/3000 Watts/3KW....49.95

Write for Qty Prices—Exporters

MERCURY THERMO REGULATOR

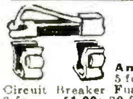


DUAL CKT, 105° F & 32° F. Extremely sensitive & accurate for most exacting requirements—Research, Fire Prev., Freeze, Pt Control, or Max Min Temp Control. Brand New, w/data & ckt. **Ea. 98c: 12 for $10.00**

CIRCUIT BREAKERS

Heinmann Magn Bkrs. **Amps**: 220, 3, 7, 9, 12, 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
Klixon Therma Push Button Bkrs **Amps**: 5, 10, 15, 20, 25, 30....89c; 10 for $7.98: 50 for $34

CIRCUIT BREAKER FUSES



PUSH TO RESET

Amps 5–7–10–15–20 Ea. 27c, 5 for $1; 25 for $5; 100 Asst $15.
Circuit Breaker Fuse W/2 Mounting Clips 39c, 3 for $1.00; 20 for....$5.98; 100 for....$20.
Fuse is 3AG Size. Operates up to 24 Volts; Please State Amps (current) desired.

OIL CONDENSERS

NEW WAREHOUSE LIST
.00025MFD/25KV....$4.00: 2/$7
.0016MFD/15KV....$7.00: 2/$12
2X.1MFD/2000V....$1.39; 2/$2
.5MFD/600V....25c; 6/$1
.5MFD/1500V....85c; 3 for $2.00
1MFD/500V....33c; 4 for $1.00
1MFD/600V....39c; 3 for $1.00
4MFD/3000V....$7.98; 2 for $14.00
4MFD/5000V....$19.95; 2 for $35.00
5MFD/600V....$1.50; 3 for $4.00
16MFD/600VAC/1800VDC....$5.95; 2 for $10.00
10MFD/600V(2.5–2.5 5MFD)oil 1.98; 12 for $18

Write for Quantity Price

"TAB" THAT'S A BUY

"TAB" LAB GRAB BAG

PRICED LOW FOR QUICK TURNOVER

Helipot 100 Ohm/0.5%/10 Turn....$7.98
Helipot 2000 Ohm/0.5%/10 Turn...$7.98: 2/$15
Micropot 20,000 Ohm/0.1%/10 T..$7.98: 10/$65
Helipot 30,000 Ohm/0.5%/10 Turn..$7.98: 2/$15
Helipot 50,000 Ohm/0.5%/10 Turn..$7.98: 2/$15
Blower 40CFM 24VDC....$5.00: 2/$8.00
RF Choke 20MH/200MA "PI"....39c; 10/$2
Relay DPDT 12VDC Telephone....98c: 6/$5
Delay Line 0.4U Secds/3"L 9/16"D...$4.00: 2/$7
Toroid UTC/D8881/ 12HY/HIQ....$3.50: 2/$6
Toroid W.E. D163448/.25 Hy/HIQ...$4.00: 2/$7
GE 0.5Hy/1% Tol/HIQ/MUMTL....$2.00: 2/$3

BOXED CRYSTAL DIODES IN LEAD*

1N23B*....$2.; 5 for $9.; 50 for $70
1N21A*....$1.55; 5 for $7.00
1N21B*....$2.10; 5 for $9.50
1N21C*....Each $21.50
1N25*....$5.95; 6 for $33.; 20 for $100
1N32*.$22.95; 6 for $128.; 12 for $240
1N41....$8.95; 2 for $15.00
1N42....$16.95; 2 for $23.00
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
1N21 Boxed....30c; 50 for $12.50; 100 for $20

NEW RELAY LIST
Tremendous Bargain Prices

R1ST1 Stevens Arnold Resonant Relay #189 Freq 240cy....$5.98; 3 for $15.
R3WE2 Western Elect D-163781 SPST/10VDC/2500. Ohm/4MA Plug-in Sig #2Z7587-17 P/O SCR 545A, Mercury Hi-and $16.95: 3 for $48.
R4KU1 SPST/MINI/115VAC/4A CTS....$1.39
R5KU2 SPDT/MINI/115VAC/4A CTS....$1.59
R6KU3 Kurman DPINO & INC/4MADC/700. Ohm/5A CTS....$4.49: 3 for $12.
R7CL1 Clare SK5010 VAC SLD/DPDT/18–28 VDC/3A CTS Octal Base....$2.98; 3 for 7.50
R8RB1 SPNO/MINI/115VAC/8A CTS....$1.89
R9AC1 Allied-FX SPST/MINI/4MADC/3000. Ohm/3A CTS....$1.25; 3 for 2.98
R10SD1 S'Dunn SPST/115VAC/6-30ACTS.$2.00
R11AC2 Allied-BJ DPDT/115VDC/5A CTS $1.39
R12AC3 Allied-BJ DPDT/6VDC/5A CTS..$1.49
R13LE1 Leach-DPDT/28VDC/5ACTS....$1.98
R14AU1 DPDT & SPNO/12VDC/10A CTS.$2.25
R15GE1 G.E. CR2792B117A3/SPST/28VDC/50A CTS....$1.98: 2 for 3.50
R16GE2 G.E. K35J406/SPDT/2000. Ohm/8MA/5A CTS Plug-in....$2.95; 2 for $5.
R17GM1 GM/SPST/24VDC/20A CTS....$1.49
R18LE2 Leach/DPST/115VDC/10A CTS..$1.49
R19SD2 S'Dunn-32AXX100/Reset & Overload/115VAC/10MA....$4.95; 2 for $9.
R20CH1 C'Hammer-B8/7-24VDC/200–1200Amp $2.98; 2 for $5.
R21GA1 DPST/6VDC/10ACTS..$1.98; 2 for $3.
R22AD1 Advance-4001 B/DPDT & SPNO/115 VDC/RF-Ceramic Insulation....$4.50: 2 for $8.
R23AB1 A'Bradley-810/Magnetic Overload, Adjustable 18.1-15.2-12-9-6.3 Amp, 600V/Max..$3.98
Selium Rectifier–FW 115VAC/40MA....79c

WRITE FOR QUANTITY PRICE

NEW "TABTRON" SELENIUM RECTIFIERS
ENGINEERED FOR INDUSTRIAL USE

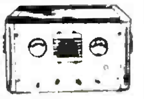
"TAB" specializes in power rectifiers to your specifications. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase, also magamps. Write for rectifier catalog.

	* FULL WAVE BRIDGE						Ctr Tap	3 Phase–Bridge	
Max Amps	18VAC* 14VDC	36VAC* 28VDC	72VAC* 56VDC	130VAC* 100VDC	144VAC* 118VDC	266VAC* 217VDC	AC/DC 30/12	120VAC 150VDC	240VAC 300VDC
1	$1.40	$2.40	$4.60	$8.50	$12.75	$22.25	$2.10	14.90	28.95
2	2.10	3.00	6.00	10.50	15.75	28.85	Q	15.90	30.90
2½	3.00	4.20	8.00	13.00	18.75	31.85	Q	Q	Q
4	3.75	7.50	14.50	22.25	26.75	38.85	2.95	18.90	36.95
6	4.50	9.00	17.50	33.00	34.75	54.85	3.25	20.90	39.95
10	6.60	12.75	25.00	42.50	44.75	84.85	4.75	36.90	71.95
12	8.20	16.25	30.00	46.00	54.75	99.85	5.95	41.90	81.95
20	13.25	25.50	49.00	79.50	82.75	160.85	7.95	50.90	97.95
24	16.25	32.50	58.00	86.50	94.75	190.85	9.95	89.90	159.95
30	20.00	38.00	72.00	121.50	128.75	235.85	Q	117.90	225.95
36	25.00	48.50	88.00	158.50	165.75	295.85	14.95	134.90	269.95
50	32.00	62.50	Q	189.75	195.75	405.85	23.95	179.90	359.95
100	60.00	120.00	Q	380.75	390.75	795.85	39.95	359.90	719.95

New Rectifier & Transformer Combo
Sel/Bridge 115 Volt 60 cyc Input

up to 14VDC at 12 amps Cont. Duty....$19.98
up to 28VDC at 4 amps Cont. Duty....14.98
up to 28VDC at 12 amps Cont. Duty....29.98
up to 28VDC at 24 amps Cont. Duty....63.98
up to 28VDC at 50 amps Cont. Duty....127.00

NEW HIGH CURRENT POWER SUPPLIES GTD*



Variable 0–28VDC. Completely Build, Ready to Go. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. In Heavy Duty Steel Cabinet Standard 115V/60cy Input 220V & Others to Order. * One Year.

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

T816 0–8 or 16VDC Variable up to 10 Amps, Rated 6 or 12VDC Filtered. Continuous Duty....$34.00
T2V2A BATT 2 VOLT CHARGER....$3.98
T6V4A BATT 6 VOLT CHARGER....$5.98
T12V2A BATT 12 VOLT CHARGER....$9.98

NEW RECTIFIERS XFMRS

PRIMARY 115V 60 cyc
SEC 18–15–9–0–9–15–18 Volts
4 amp....$8.65: 2 for $15.75
12 amp....$16.65: 2 for $29.95
24 amp....$35.75: 2 for $69.95
30–32–34–36V/48A....59.50
50 amp....$59.00: 2/$112
100 amp....$108.00: 2/$210
18 Volt 2 amp....$2.25 @ 2 for $4
25.2V/2A or 12.6V/4A or 2X12.6V/2A Cased 2⅝W/3⅛H/2¾"D....$3.59: 3/$10.: 12/$36

NEW RECTIFIER CHOKES

CH07/4 Amp/.07HY/6 *Ohm*/10 Lbs....$7.95
CH01/12 Amp/.01HY/.1 *Ohm*/12 Lbs....$14.95
CH004/24 Amp/.004HY/.025 *Ohm*/20 Lbs..$29.95

866A KIT

(2) 866A Tubes & Sockets, & Trans 2.5 VCT/10A HVINS....$4.98

DC POWER-SUPPLY

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
Model 4DCF (4 amp)....$20.98

SELSYNS—SYNCHROS

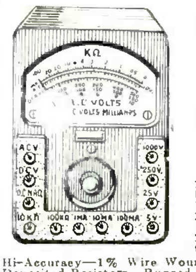
AY1/Autosyn/26V/400Cy/E.P....$3.98
AY5/Autosyn/26V/400Cy/E.P....3.98
CK-2/Low-In-Servo Motor/EP....20.00
AY20/Autosyn/26V/400Cy/E.P....4.98
AY6/Autosyn/26V/400Cy/E.P....7.98

C44968/Synchro Repeator/115V/60Cy....$16
C56701/Type II-4/Syn Rptr/115V/60Cy....$21
C56776/Type II-5/Syn RPTR/115V/60Cy....$15
C69406-1/Type II-2/Syn Rptr/115V/60Cy....$21
C76166/Syn Voltage Rcvr/115V/60Cy....16.50
C78248/Syn Transmitter/115V/60Cy.$16; 2/$28
C78249/Syn Diff/115V/60Cy....$7; 2/$12
C78386/Type XV/Synchro Transf/115V/60Cy....29.50
C78670/Synchro Special/50V/50Cy....21.00
3" Magslip/Hunter MKII....12.50

2J1F1/Synchro Gen/115/57.5V/400Cy.$9; 2/$16
2J1F3/Synchro Gen/115/57.5V/400Cy....$9.00
2J1G1/Syn Tran/57.5/57.5V/400Cy....$6; 2/$11
2J5HA1/Gen/115/105V/60Cy....57.00
2JD5HA1/Syn Mtr/115/105V/60Cy/GE....57.00

1CT/Synchro Trnsf 90/55V/60Cy/BNDX....$59
5CT/MKIII/MOD2/90/55V/60Cy/GE....$43
5F/MK4/MOD IV/115V/60Cy....$43
5G/MK1/MOD6/115/90V-60Cy/BNDX....$45
5G Special KS5950/115/90V-400Cy/BNDX..$27
6G/SYN Gen/MK2/MOD IV/115V/60Cy/BNDX....$49

NEWLY IMPORTED AC-DC VOM



MODEL 12C MULTITESTER $10.99

(+40c Ship In U. S. A.)
1000 Ohms Per/V Reads AC & DC Volts: 0 to 5, 25, 250 & 1000 Volts. DCMA: 0 to 1, 10, 100 MA Ohms: 0 to 10K & 100K

Hi-Accuracy—1% Wire Wound Resistors & HV Deposited Resistors. Rugged Jeweled D'Arsonval Microamp Meter Movement Excellent Damping. Xtra Long Meter Scales, with Vivid Red & Black Calibrations. The Size of 2 Packs of King Cigarettes. 1¼"D, 4⅝"L, 3¼"W. A Must for Every Eng, Ham, Experimenter, Serviceman, or Beginner. Built Ready to Work (No Kit) Complete with Test Leads.
Model 552 Smallest Precision Built, Hi-Accuracy, Pocket Multitester, 1% Deposited Carbon Resistors, Jeweled D'Arsonval Microamp Meter Movement, Xtra Long Meter Scale. AC & DC Volts: 0–10 250 & 500V. DCMA: 0–1 & 250 MA. Ohms: 0–100K. Miniature Size 2½"D, 4"L, 3½"W. With Test Leads....$7.99
Plus 40c for Shipping in U. S. A. **"TAB" Imported, Sold on Money Back Guarantee.**
Write for Quantity Price.

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	1.25; 3 for 3.15
B	.01	600	30c; 5 for 1.35
B	.01	1200	50c; 5 for 2.25
A	.005	2500	60c; 5 for 2.75
B	.004	600	40c; 3 for 1.05
B	.002	1200	30c; 4 for 1.00
A	.002	2500	98c; 3 for 2.25
A	.001	1200	25c; 3 for .66
C	.0007	3000	89c; 3 for 2.39
A	.0004	2500	39c; 6 for 1.95
A	.0001	600	25c; 5 for 1.00
C	.0001	3000	89c; 3 for 2.00
C	.0001	5000	1.49; 4 for 5.00
C	.00005	3000	39c; 4 for 1.00

Write for Mica Condenser Catalog

SOCKET ASSEMBLIES

¼" Jewel Bayonet Socket Light Dimmer (Shutter) **33¢ EA.** Reg 97c
Less Than (3) Ea....39c Lots of 5
Dialco 31101 Pilot Light 1" Jewel 115V. High Polish Finish. Reg. $1.03
"TAB" Price....85c @ 10 for $5.00
Neon Panel Lite Dialco 95408 in Red, Amber & Clear Spec....81c: 12 for $8

TOGGLE SWITCHES

SPDT 15A 125V Center Off AN3022-1B....69c; 5/$2.50
SPST 5A/125V used LN 4/$1.00
SPDT 15A/125V Center Off MOM....79c; 3/$2.00: 20/$10
SPDT 15A/125V AN3022-3B EA 59c: 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.

TUBES

"TAB" TESTED & GUARANTEED

PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	$0.88	4J31	99.51	6SJ7	.58	CV148	9.90	927/CE25	1.70
OA3/VR75	1.04	4J52	199.99	6SK7GT	.56	FG166	48.40	CK1005	.68
OB2	1.37	EL5BHD	15.99	6SL7GT	.64	FG172	29.00	1613	.82
OB3/VR90	.96	5C21/C6J	9.89	6SN7GT	.68	211/VT4C	.88	1614	1.95
OC3/VR105	.92	5C22	38.95	6SQ7GT	.62	RX215	7.98	1625	.32
OD3/VR150	.92	5D21	14.98	6SR7	.62	RX233A	3.49	1632	.68
1B3/8016	.80	5R4GY	1.20	6T8	.96	250TH	18.97	1633	.98
1B22	1.82	5R4GYW	1.75	6U4	.74	250TL	17.75	1636	3.08
1B23	8.87	5T4	1.48	6U8	.99	304TH	12.49	1642	.62
1B24	8.98	5U4G	.55	6V6	1.39	304TL	12.49	1644	.92
1B26	2.24	5V4G	.95	6V6GT	.59	371B	.88	2050	1.48
1B27	11.98	5Z3	.99	6W4GT	.52	388A	1.48	2050W	2.48
1B32/532A	2.48	5Z4	1.49	6X4	.49	GL434A	12.69	5618	3.50
1B35	9.15	6A3	.90	6X5GT	.54	446A	1.05	5635	11.57
1B37	14.87	6A7	.85	6Y6G	.88	446B	3.48	5637	6.53
1B38	29.45	6A8GT	.90	7A8	.68	450TH	49.97	5640	11.57
1B42	17.48	6AC7	.80	7C7	.76	450TL	52.00	5641	7.52
1B46	1.98	6AG5	.71	7F7	.82	460/HF200	15.95	5643	11.57
1B63	45.00	6AG7	1.14	7F8	1.24	CK502AX	1.49	5644	11.57
1L4	.48	6AH6	1.21	7H7	.72	CK503AX	1.49	5646	11.57
1L6	1.35	6AJ5	1.40	7N7	.92	CK505AX	1.79	5651	2.24
1LD5	.98	6AK5	.87	7V7	1.06	CK512AX	1.45	5654	1.72
1LN5	.78	6AK5W	2.79	7Y4	.68	CK531DX	1.89	5656	12.08
1P5	.78	6AK6	.92	8D21	298.00	531	5.72	RK5657	298.48
1U4	.52	6AL5	.48	12AL5	.54	CK532DX	1.89	5663	1.06
1U5	.54	6AL7GT	.98	12AT6	.54	WL532A	3.68	5670	3.44
1V2	.70	6AN5	3.27	12AT7	.89	CK536AX	.99	CK5672	1.20
1X2A	.98	6AQ5	.52	12AU6	.72	CK539DX	2.19	CK5678	1.28
2C36	27.00	6AQ5W	2.78	12AU7	.69	CK541DX	1.99	5687	3.74
2C39A	26.98	6AQ6	.81	12AV6	.52	CK543DX	.99	5691	7.54
2C40	4.98	6AQ7GT	1.29	12AV7	.98	CK544DX	.99	5692	8.52
2C43	17.48	6AR6	3.27	12AW6	1.18	CK546DX	1.99	5693	6.24
2C44	1.15	6AS5	.79	12AX7	.98	CK571AX/		5694	3.65
2C51	3.88	6AS6	2.22	12AY7	1.69	5886	2.49	CK5702	2.90
2D21	1.18	6AS7G	3.48	12BA6	.59	CK573AX/		CK5703	1.29
2E43	1.49	6AT6	.54	12BA7	.94	6029	3.49	5713	120.00
2J31	27.00	6AU5GT	1.10	12BD6	.59	WL652	65.00	WL5736	130.00
2J32	29.48	6AU6	.56	12BE6	.59	WL676	34.98	5749	1.72
2J33	27.00	6AV5GT	.98	12BF6	.85	703A	4.72	5761	2.88
2J34	24.98	6AV6	.49	12BH7	1.29	705A	1.89	5769	298.00
2J37	12.70	6B4G	1.18	12SA7GT	.68	707A	7.90	5812	2.99
2J38	69.98	6B8G	.60	12SC7	1.08	707B	14.88	5814	2.08
2J39	6.98	6BA6	.54	12SF5GT	.54	715A	4.96	5820	148.00
2J42	148.98	6BA7	1.09	12SF7GT	.84	715B	7.94	5840	7.98
2J48	24.45	6BC5	.63	12SG7	.90	715C	17.98	5844	2.98
2J49	84.00	6BC7	1.23	12SH7	.63	717A	.88	5881	2.70
2J50	99.98	6BD6	.83	12SJ7GT	.54	719A	24.48	7012	2.58
2J51	238.98	6BE6	.54	12SK7	.66	721A	3.92	8013	3.92
2J56	149.00	6BF5	.98	12SL7GT	.62	722A/287	1.94		
2J62	49.45	6BG6G	1.58	12SN7GT	.68	723A/B	16.98	Xtal Diodes	
2K22	23.48	6BH6	.63	12SQ7GT	.54	724A	3.95		
2K23	11.48	6BJ6	.69	12SR7	.66	724B	2.74		
2K25	28.49	6BK7	1.58	FG17	3.90	725A	9.98	1N21A	$1.55
2K25/723AB	23.88	6BL7GT	1.19	24G/3C24	1.32	726A	14.48	1N21B	2.10
2K28	27.48	6BN7	2.69	25BQ6GT	.98	726B	44.88	1N22	1.22
2K33	219.48	6BQ6GT	1.20	26L6GT	.67	726C	64.88	1N23	1.35
2K39	134.99	6BQ7	1.65	25Z5	.78	801A	.42	1N23A	1.89
2K41	126.00	6C4	.52	25Z6GT	.58	803	3.48	1N23B	2.00
2K42	145.00	6C21	24.50	FG-27A	8.24	805	3.22	1N25	4.98
2K45	129.48	6CB6	.59	35Z5GT	.54	807	1.54	1N26	8.75
2K48	99.48	6CD6G	1.69	35T	4.88	808	2.62	1N27	1.55
2P23	298.00	6D4	2.70	35L6	.67	809	3.58	1N34	.64
2X2	.42	6D6	.84	35Y4	.68	810	10.88	1N34A	.88
3B22	2.48	6F4	6.20	45Z3	.88	811	3.00	1N35	1.65
3B23/RK22	4.95	6F6	.79	48	1.98	812	2.70	1N38A	1.29
3B24	4.70	C6J/5C21	9.89	50A5	.76	813	11.48	1N41	8.95
3B26	3.70	6J4	6.66	50C5	.54	814	4.98	1N42	16.95
3B28	7.90	6J5	.54	50L6GT	.62	815	5.98	1N45	1.45
3C22	85.00	6J6	.58	RK61/XFG1	2.65	829	7.94	1N46	.69
3C23	8.67	6K6GT	.54	FG67	14.68	829B	12.48	1N47	4.00
3C31/C1B	3.45	6K7	.58	HY69	4.98	832	7.72	1N48	.47
3C33	9.51	6K8	1.08	71A	.74	832A	9.92	1N51	.45
3C45	9.98	6L6	1.48	78	.78	833A	39.45	1N54	.78
3D6/1299	.69	6L6G	1.08	80	.58	836	5.95	1N54A	1.00
3D21A	8.15	6L6GA	1.08	81	1.39	837	1.42	1N58A	1.15
3D22	13.97	6L6GAY	1.98	83	1.12	849	29.45	1N60	.60
3D23	4.90	6SA7GT	.66	83V	1.22	860	4.48	1N63/K63	2.49
3E29	14.49	6SC7	.90	84/6Z4	.62	865	1.26	1N64	.69
4C35	21.49	6SF5	.78	100TH	9.88	866A	1.50		
4D21	18.99	6SF7	.73	FG104	24.58	872A	3.29	OTHER TYPES	
4E27	22.49	6SG7	.64	FG105	19.48	917	2.59	IN STOCK	
4J22	129.51	6SH7	.61	VXR130	4.50	925	2.14	WRITE	

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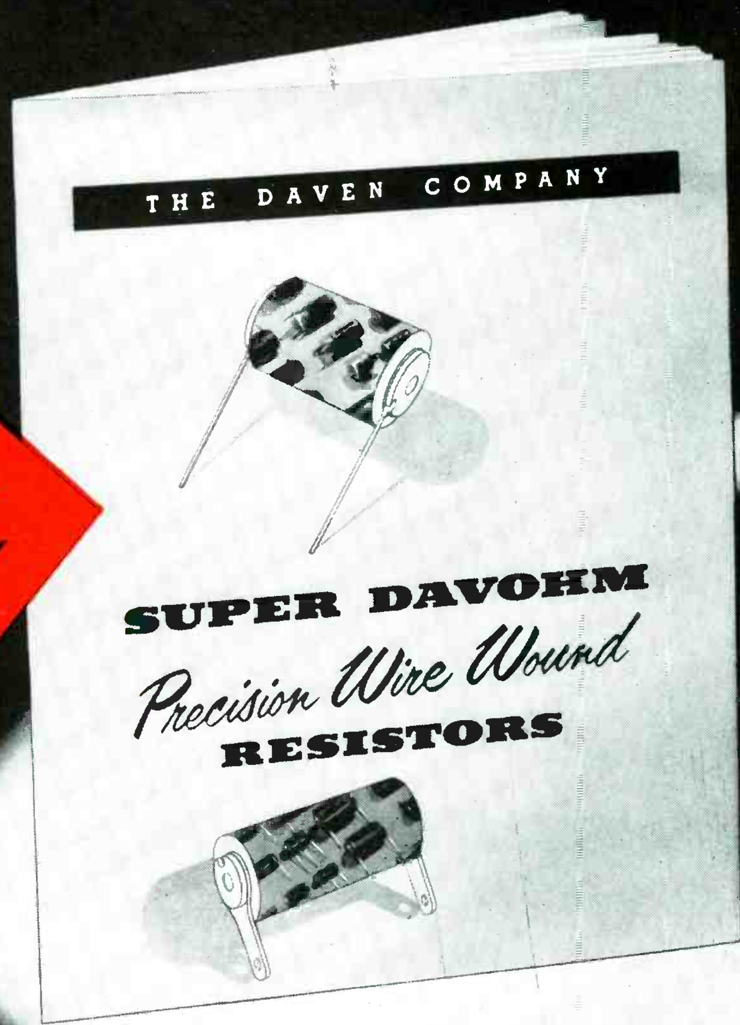

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