electronics

A McGRAW-HILL PUBLICATION

MARCH · 1952

PRICE 75 CENTS

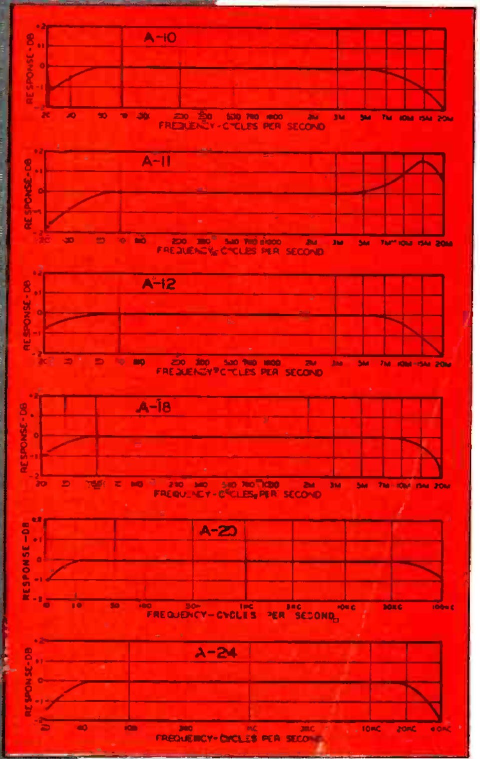
MOUNTAIN-TOP RADIATORS SIMULATE PLANE ANTENNAS

ULTRA COMPACT UNITS...OUNCER UNITS

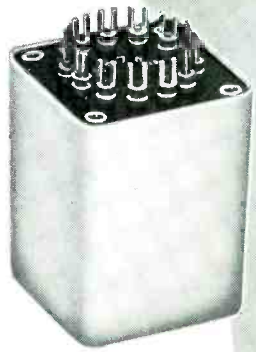
HIGH FIDELITY . . . . SMALL SIZE . . . . FROM STOCK

UTC Ultra compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. High fidelity is obtainable in all individual units, the frequency response being ± 2 DB from 30 to 20,000 cycles.

True hum balancing coil structure combined with a high conductivity die cast outer case, effects good inductive shielding.



Type No.	Application	Primary Impedance	Secondary Impedance	List Price
A-10	Low impedance mike, pickup, or multiple line to grid	50, 125/150, 200/250, 333, 500/600 ohms	50 ohms	$16.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids (multiple alloy shields for low hum pickup)	50, 200, 500	50,000 ohms	18.00
A-12	Low impedance mike, pickup, or multiple line to grids	50, 125/150, 200/250, 333, 500/600 ohms	80,000 ohms overall, in two sections	16.00
A-14	Dynamic microphone to one or two grids	30 ohms	50,000 ohms overall, in two sections	17.00
A-20	Mixing, mike, pickup, or multiple line to line	50, 125/150, 200/250, 333, 500/600 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-21	mixing, low impedance mike, pickup, or line to line (multiple alloy shields for low hum pickup)	50, 200/250, 500/600	50, 200/250, 500/600	18.00
A-16	Single plate to single grid	15,000 ohms	60,000 ohms, 2:1 ratio	15.00
A-17	Single plate to single grid 8 MA unbalanced D.C.	As above	As above	17.00
A-18	Single plate to two grids. Split primary	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	16.00
A-19	Single plate to two grids 8 MA unbalanced D.C.	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	19.00
A-24	Single plate to multiple line	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	17.00
A-26	Push pull low level plates to multiple line	30,000 ohms plate to plate	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-27	Crystal microphone to multiple line	100,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-30	Audio choke, 250 henrys @ 5 MA 6000 ohms D.C., 65 henrys @ 10 MA 1500 ohms D.C.			12.00
A-32	Filter choke 60 henrys @ 15 MA 2000 ohms D.C., 15 henrys @ 30 MA 500 ohms D.C.			10.00

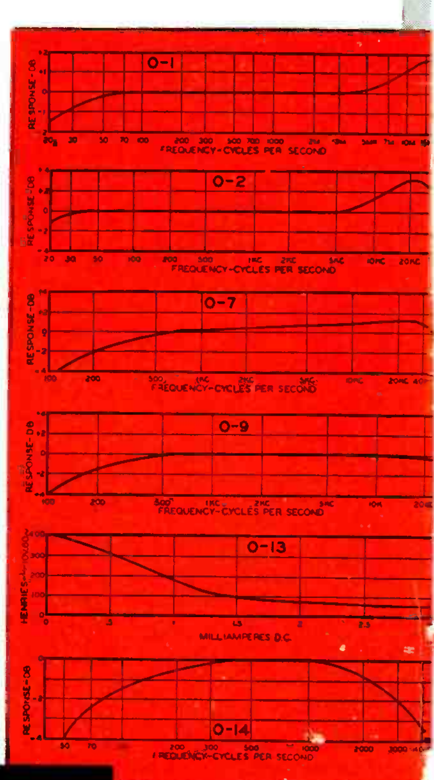


TYPE A CASE
1½" x 1½" x 2" high

UTC OUNCER components represent the acme in compact quality transformers. These units, which weigh one ounce, are fully impregnated and sealed in a drawn aluminum housing ⅞" diameter... mounting opposite terminal board. High fidelity characteristics are provided, uniform from 40 to 15,000 cycles, except for 0-14, 0-15, and units carrying DC which are intended for voice frequencies from 150 to 4,000 cycles. Maximum level 0 DB.

OUNCER CASE
⅞" Dia. x 1⅛" high

Type No.	Application	Pri. Imp.	Sec. Imp.	List Price
0-1	Mike, pickup or line to 1 grid	50, 200/250 500/600	50,000	$14.00
0-2	Mike, pickup or line to 2 grids	50, 200/250 500/600	50,000	14.00
0-3	Dynamic mike to 1 grid	7.5/30	50,000	13.00
0-4	Single plate to 1 grid	15,000	60,000	11.00
0-5	Plate to grid, D.C. in Pri.	15,000	60,000	11.00
0-6	Single plate to 2 grids	15,000	95,000	13.00
0-7	Plate to 2 grids, D.C. in Pri.	15,000	95,000	13.00
0-8	Single plate to line	15,000	50, 200/250, 500/600	14.00
0-9	Plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600	14.00
0-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600	14.00
0-11	Crystal mike to line	50,000	50, 200/250, 500/600	14.00
0-12	Mixing and matching	50, 200/250	50, 200/250, 500/600	13.00
0-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C.,		6000 ohms	10.00
0-14	50:1 mike or line to grid	200	½ megohm	14.00
0-15	10:1 single plate to grid	15,000	1 megohm	14.00



United Transformer Co.
150 VARICK STREET • NEW YORK 13, N. Y.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

electronics

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NEW

marion "tamper-proof" hermetically sealed running time meter

REGISTERS OPERATING TIME OF MACHINE TOOLS, ELECTRONIC, ELECTRICAL OR GENERAL INDUSTRIAL EQUIPMENT

SPECIFICATIONS

- Registers in 1/10 hour steps to 9999.9 or hour steps to 99999
- Hermetically sealed, glass to metal
- Moisture-proof, dust-proof
- Drawn steel case provides magnetic shielding
- Self-starting synchronous motor
- Moderately priced

Marion's new Running Time Meter is absolutely tamper-proof because it is sealed in a drawn steel case. Designed for a wide range of operating temperatures, it is also ideal for use in hazardous atmospheres. The easy-to-read dial is viewed through tempered glass crystal which is fused directly to the case.

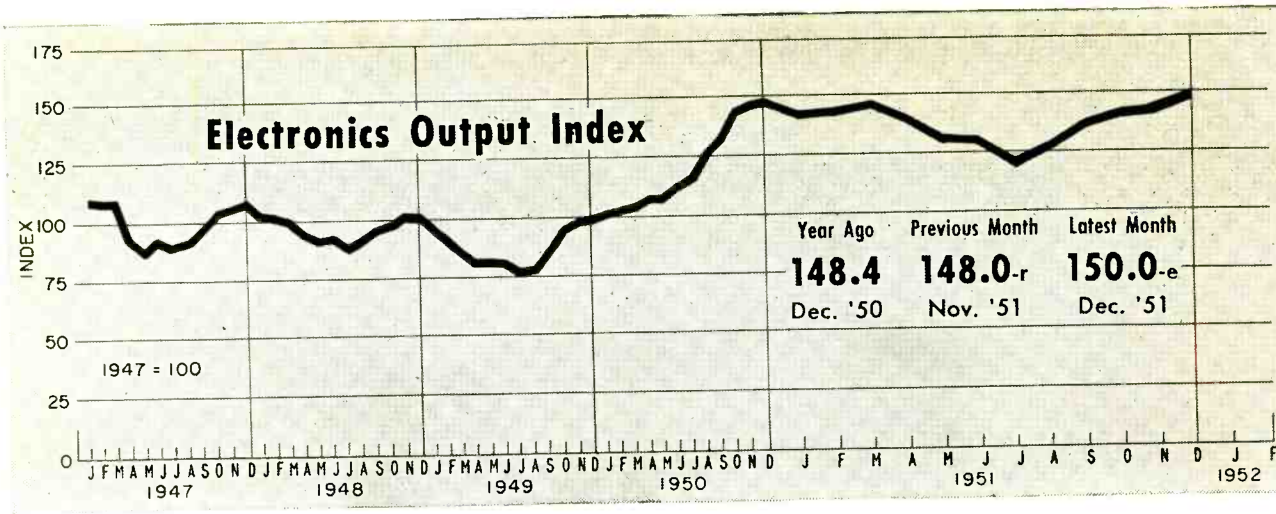
Powered by a durable self-starting synchronous motor, available for 110-125, 220-250 volts . . . 50 or 60 cycle A. C. . . . the Marion Running Time Meter occupies no more panel space than an ordinary 3½" meter.

Demands of our national mobilization program come first, of course, but we will gladly supply further information and serve you to the best of our ability.

MARION ELECTRICAL INSTRUMENT CO., 401 CANAL ST., MANCHESTER, N. H.

marion meters

MANUFACTURERS OF MARION Ruggedized PANEL METERS



FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago Dec '50	Previous Month Nov '51	Latest Month Dec '51
Television sets	858,500	415,332	453,098-p
Home Radio sets	957,100	477,734	555,133-p
Portable sets	95,000	64,111	75,799-p
Auto sets	453,500	206,069	213,492-p

RECEIVER SALES

(Source: Licensee figures)	Nov '50	Oct '51	Nov '51
Television sets, units	659,758	608,274	559,923
Electric radio sets, units	562,979	540,915	519,888
Battery sets, units	70,143	65,703	69,599
Auto sets, units	469,218	265,215	238,275
Television sets, value	$131,759,339	$96,111,904	$95,055,472
Electric radio sets, value	$15,564,952	$11,517,531	$11,287,914
Battery sets, value	$1,249,214	$1,176,656	$1,320,649
Auto sets, value	$11,942,960	$8,088,701	$7,340,214

RECEIVING TUBE SALES

(Source: RTMA)	Nov '50	Oct '51	Nov '51
Receiv. tubes, total units	39,326,641	34,137,519	32,710,369
Receiving tubes, new sets	31,327,152	21,103,669	20,405,712
Rec. tubes, replacement	6,744,892	9,615,159	8,539,275
Receiving tubes gov't	119,600	1,567,190	1,371,886
Receiving tubes, export	1,134,997	1,851,501	2,393,496
Picture tubes, to mfrs.	851,872	455,636	460,566

BROADCAST STATIONS

(Source: FCC)	Jan '51	Dec '51	Jan '52
TV Stations on Air	107	108	108
TV Stns CPs—not on air	2	0	0
TV Stns—Applications	379	475	488
AM Stations on Air	2232	2331-r	2331
AM Stns CPs—not on air	121	77	75
AM Stns—Applications	271	304	311
FM Stations on Air	669	637-r	635
FM Stns CPs—not on air	21	13	13
FM Stns—Applications	11	8	7

NETWORK BILLINGS

(Source: Pub. Info. Bureau)	Dec '50	Nov '51	Dec '51
AM/FM—ABC	$2,898,508	$3,220,760	$3,300,219
AM/FM—CBS	$6,544,490	$5,257,454	$5,278,508
AM/FM—MBS	$1,312,393	$1,583,291	$1,697,014
AM/FM—NBC	$5,077,740	$4,315,646	$4,343,307
TV—ABC	$1,298,616	$1,911,243	$1,980,145
TV—CBS	$2,304,602	$4,605,506	$4,736,368
TV—Dumont	Not avail.	$847,373	$937,875
TV—NBC	$3,274,757	$6,535,907-r	$6,592,673

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago Jan '51	Previous Month Dec '51	Latest Month Jan '52
Sets in Use—total	10,549,500	15,176,200	15,777,000
Sets in Use—netw'k conn.	8,946,100	14,363,700	14,931,100
Sets in Use—New York	2,050,000	2,720,000	2,800,000
Sets in Use—Los Angeles	801,000	1,065,000	1,090,000
Sets in Use—Chicago	830,000	1,060,000	1,090,000

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Dec '50	Nov '51	Dec '51
Aeronautical	29,048	31,415	30,370
Marine	28,237	33,700	33,914
Police, fire, etc.	8,400	9,969	10,161
Industrial	7,841	11,233	11,449
Land Transportation	4,060	5,362	4,653
Amateur	90,599	99,292	100,922
Citizens Radio	412	674	749
Disaster	0	28	26
Experimental	484	452	452
Common carrier	834	835	835

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Nov '50	Oct '51	Nov '51
Prod. workers, electronic	278,400	257,200-r	266,200-p
Prod. wkrs., radio, etc.	192,000	159,400-r	165,900-p
Av. wkly. earnings, elect.	$58.83	$63.38-r	$64.23-p
Av. wkly. earnings, radio	$56.32	$60.39	$60.96-p
Av. weekly hours, elect.	41.2	41.1	41.6-p
Av. weekly hours, radio	40.9	41.0	41.5-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Jan '51	Dec '51	Jan '52
Radio—TV & Electronics	211.2	265.6	270.9
Radio Broadcasters	193.3	252.6	261.4

INDUSTRIAL EQUIPMENT ORDERS

	Quarterly Figures		
(Source: NEMA)	Year Ago 3rd '50	Previous Quarter 2nd '51	Latest Quarter 3rd '51
Dielectric Heating	$300,000	$600,000	$210,000
Induction Heating	$1,100,000	$2,300,000	$1,900,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	3rd '50	2nd '51	3rd '51
Vacuum (non-receiving)	$3,370,000	$7,750,000	$8,420,000
Gas or vapor	$1,660,000	$2,700,000	$2,620,000
Phototubes	$230,000	$360,000	$275,000
Magnetrons and velocity modulation tubes	$2,050,000	$4,130,000	$3,750,000

p—provisional; r—revised; e—estimated

INDUSTRY REPORT

electronics—MARCH • 1952

Defense Department Stretches Out Production

Some arms orders cut back for 1952, but not electronics

STRETCHING out rather than peaking of the mobilization program, now planned by Washington, will apply to the production of electronic equipment as well as other items made for the armed forces. There'll be, however, more stretching out than slowing down of actual production in our specific field.

Reshuffling of the mobilization program that has been going on is due largely to a shift in future plans. Instead of turning out weapons at an 'all-out' pace this year and next, defense and mobilization officials have decided to spread the program over a longer period . . . through all of 1954 and part of '55.

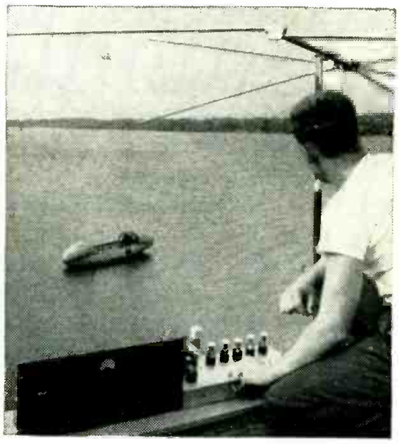
This means industry will produce such arms as airplanes, tanks, ships and guns a little more slowly—at about thirty percent below the rate expected late this year or early 1953.

▶ **Little Change Seen**—Military and other mobilization officials predict that scaling back won't have much effect on overall electronic production. Electronic components and accessories for aircraft are only a fraction of the industry's total output for the armed services, say these officials. Such programs as guided missiles, modernization of all types of weapons and equipment will not be affected. They will go right ahead at present rates—or faster.

The experts say ordering of electronic equipment may level off somewhat this year, however. Military orders were going out at a rate of over $300 million a month at the first of the year, and were scheduled to continue upward through July. Now you can expect military awards of contracts to remain somewhere near present levels for the rest of this year.

▶ **Civilians Gain**—Slowdown in military production eventually will mean more metal for makers of civilian items. Mobilization authorities think they now can promise that military requirements for materials are at a peak.

By the end of the year there probably will be more aluminum, as well as steel, for consumer goods. Key materials for electronics production—nickel and copper—will continue to be scarce, however, probably throughout this year and next.



CONTROLLED LIFEBOAT

Dropped by the Air Force, this lifeboat is unerringly guided by a radio signal from the plane and Westinghouse electronic controls to crash or shipwreck survivors

TV Expansion Considered Within Bounds of Present Material Allocations

RTMA report examines prospect for new stations and increased demand for receivers

THE TV INDUSTRY went a long way February 7th toward answering a big question mark in video's future: *Can the defreeze take place without running smack into serious shortages of materials?* On that date RTMA released a report on "The Impact of TV Expansion" which said, with minor qualifications, *"No big trouble anticipated"*.

This optimistic conclusion was reached by a four-man task force appointed by the Television Committee, headed by W. H. Chaffee of Philco, to look into the rate at which stations might be built, using scarce materials in the building, and thereafter take the air, creating new demand for receivers.

Handed a clouded crystal ball, the task group adopted three bases for the calculations ("optimistic, realistic and pessimistic"), hoping that at least one answer would stand the test of time.

▶ **Transmitter Market**—First question was the rate at which FCC would authorize the construction of new stations. Most optimistic thinking was that the Commission might issue 70 construction permits per quarter, half to vhf and half to uhf, beginning with second quarter of 1952. That would make 490 new permits by the end of 1953. With 70 additional power amplifiers thrown in for power increases at existing stations, this adds up to a total of 560. The pessimists divided this total figure by nearly 3, for a total of 200. Most realistic estimate was that 280 permits for new stations and 50 for power increases would be handed down by the end of 1953.

Second question, how long to get these stations on the air, was estimated "realistically" at 164 new stations and 30 power increases on the air by the end of 1953, leaving 116 new stations and 20 power increases "still building" at that time.

▶ **Equipment On Hand**—A survey of transmitting equipment on hand showed 28 vhf jobs already sold to prospective broadcasters, another 20 in stock, and materials on hand for another 149. No uhf transmitters are ready, but materials are available for five units. A detailed breakdown on the requirements for carbon, alloy and stainless steel, copper, brass and aluminum disclosed that the additional transmitting equipment could be readily built within existing allocations, even on the most optimistic estimate of new station construction.

Towers are not so easy. Under the "optimistic" schedule, taking a 400-foot steel tower as a basis, the 3rd and 4th quarter 1952 requirements would aggregate 5,775 tons of structural steel and 38.5 tons of copper. No prospect of these amounts is in sight. So, even on the realistic estimate, improvised towers will probably be necessary. But all anticipated stations can still get on the air within material limitations now in effect.

▶ **Receivers Market**—Estimate of new receiver demand, based on markets opened up and extensions of old markets, runs much smaller than previous industry findings.

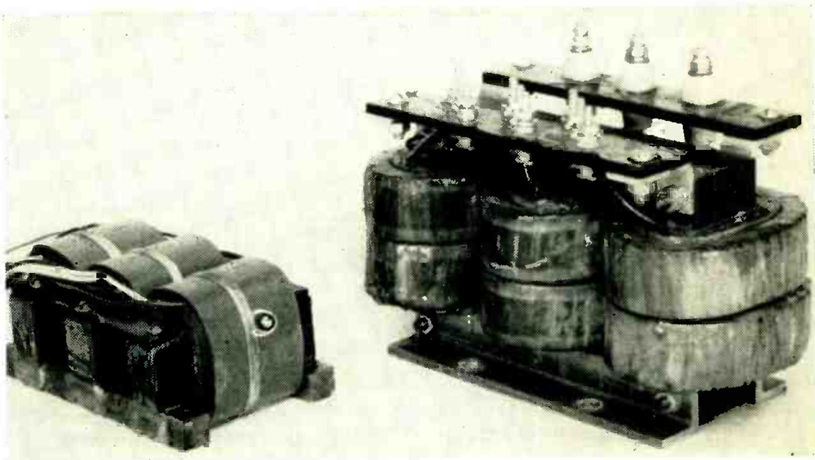
The optimists think that receiver demand in newly covered areas may run from 50,000 in the third quarter of 1952 to nearly 900,000 in the second quarter of 1953, making 1.6 million sets for the year over and above existing levels. The realistic estimate is about half this level, running from 23,000 to 434,000, or 810,000 for the year from mid-1952 to mid-1953. This figure is about one fifth the estimated tv receiver production for 1952. Consequently, new markets can readily be served by set manufacturers, if the present level of consumer demand in the established markets does not increase.

Fair Trade Rules Near Ready for FTC

ADVERTISING, promotion and other business rules coming under the general heading of 'Fair Trade Practice' for the radio-tv industry have been whipped into shape by the Radio and Television Manufacturers Association.

There are some 34 separate and distinct rules in the latest draft, awaiting final touches before presentation to the Federal Trade Commission.

LESS HEAT, LESS WEIGHT, LESS SPACE



Aircraft designers and operators got a lift from a report that Raytheon's Leonhard Katz has reduced overall weight of electronic gear to half normal. The trick is done by blowing turbulent air through ducts rather than over the outside of standard components. Typical reduction is exemplified by direct-cooled three-phase, 1,100-va transformer at left weighing 8 pounds, with a volume of 59 cu in. It is interchangeable with conventional model at right weighing 18 pounds and requiring 200 cu in.

Business Plans for New Plant and Equipment

Expansion this year will be greatest in history; it will continue even after the peak

AMERICAN INDUSTRY has huge plans for new plant and equipment. That's the main conclusion of a survey by McGraw-Hill to which ELECTRONICS contributed. From the mass of material gathered by our Department of Economics two things stand out:

The year ahead will set a record. *Companies plan to lay out 13 percent more for capital goods than ever before in history.*

After 1952, investment will still be big. *Although mobilization expansion may have passed its peak, business intends to keep spending at a level well above pre-Korea.*

This year will be the high-water mark in what has been the greatest all-time wave of expansion in the U. S. Industries whose capital expenditures are now rising most sharply are those with defense contracts or defense-supporting priorities.

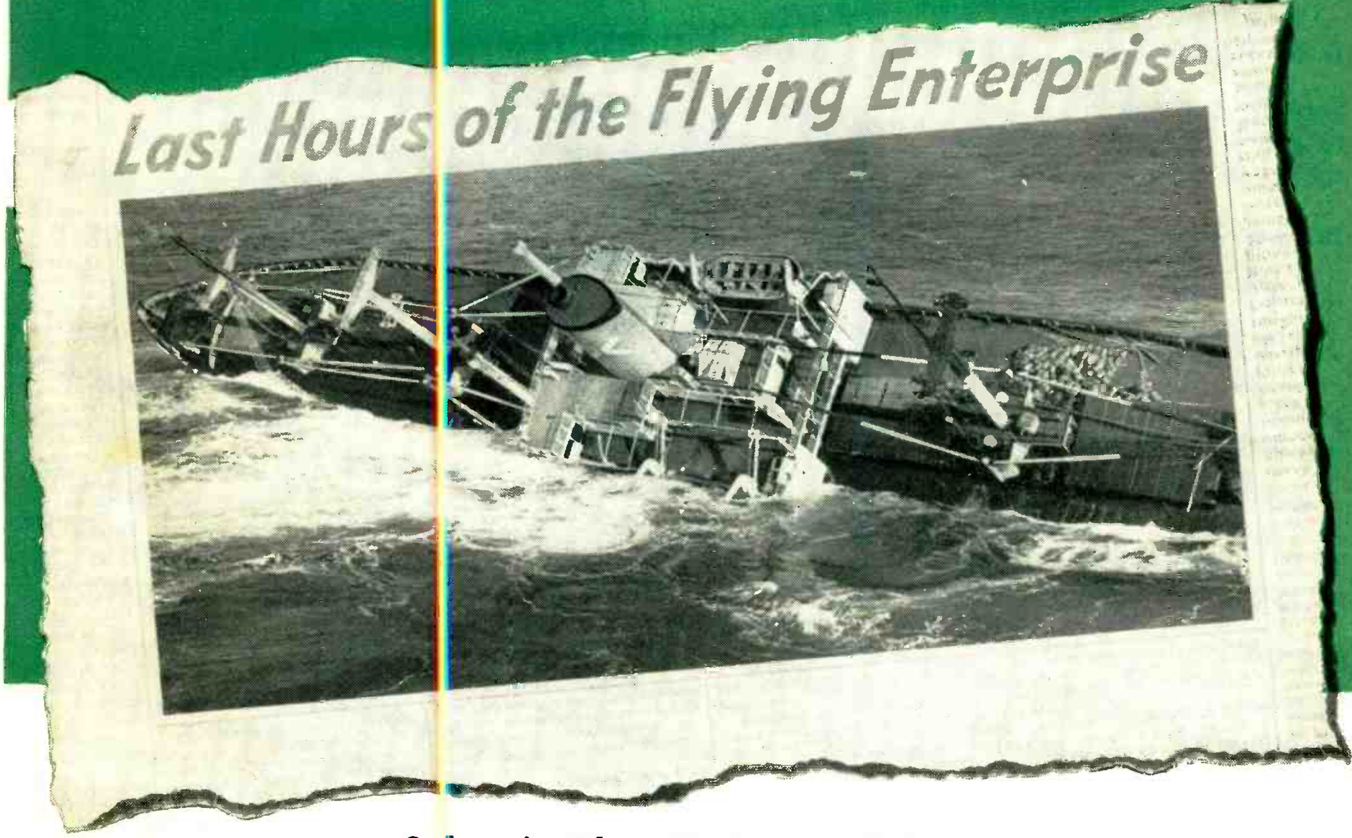
▶ **Post-Peak Prospects**—Industry spending, adding up to $21.2 billion planned for 1952, may drop in 1953. But the idea that after mobilization capital will dry up, as it did in the 1940's, can now be written off.

All signs point to a total of $16.7 billion in capital expenditures in 1953, $15.1 billion in 1954, and $14.1 billion in 1955. The actual drop from 1952 to 1955 may amount to no more than 20 percent. That would still leave investment within 10 percent of 1951, and well above pre-Korea.

▶ **Electronics Up Front**—The 13-percent jump that will take capital

(Continued on page 8)

WHY THE EYES OF THE WORLD WERE ON THIS SHIP!



Sylvania Glow Modulator Tubes help bring dramatic on-the-spot photos to your newspapers

Never in history had a disaster at sea been witnessed by so many people. Millions watched the battle of the Flying Enterprise . . . vividly shown, practically blow for blow, on front pages everywhere.

The pictures of this struggle were made possible by the Sylvania Glow Modulator Tube, which forms the heart of radiophoto and wirephoto receivers.

The unique ability of this tube to vary its light output intensity at a 15 kc rate also makes it valuable for oscillograph timing markers, seismograph recorders, and psychological-eye-response equipment.

For complete information about the Sylvania Glow Modulator Tube write Sylvania Electric Products Inc., Department E-2603, Emporium, Pennsylvania.

Here's How the Glow Modulator Helps Bring You the Pictures

Pictures were taken from airplanes and flown to England. Here they were scanned by a facsimile transmitter which translated the tiny black and white picture elements into a series of electronic impulses which were sent over the Atlantic. At receiving stations Sylvania Glow Modulator Tubes responded to these impulses and "painted" on sensitized paper a faithful reproduction of the original.

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS spending to its record $21.2 billion in 1952 is by no means uniform throughout industry. Increases will range from 100 percent in some fields to 8 in others.

Electronics is up near the top of the list, companies having military contracts and subcontracts leading the parade and others lagging. Considering our industry overall, the opportunity for the sale of equipment and services contributing to plant expansion and modernization is great.

March IRE Show Sets Stage for Big Business Year

Services pull exhibits to conserve funds but manufacturers snap up space

INSTITUTE OF RADIO ENGINEERS' 1952 National Convention and Show coming up March 3–6 at New York's Waldorf Astoria and Grand Central Palace represents very big business indeed and will have widespread influence upon the design, production and purchase of electronic gear in the year ahead.

Registration of engineers, military brass and top industry management men is expected to exceed 25,000 during the four-day shindig publicizing the almost overwhelming total of 220 technical papers, to be presented at 43 separate sessions split between hotel and two-block-distant exhibit hall. Exhibitors signed up for the Palace (including ELECTRONICS and *Nucleonics*) total 350 and will occupy all four instead of last year's three floors, filling the big building from foundation to roof. Products to be shown are valued at $10,000,000.

IRE banquet-keynoter Charles E. Wilson, U. S. Director of Defense Mobilization and former president of General Electric. He will be at the head table, coincidentally, when GE's W.R.G. Baker receives the Institute's Medal of Honor

▶ **Much Manpower Involved**—Some idea of how much manpower and money is directly or indirectly wrapped up in the convention and show may be gleaned from the following facts relative to last year's electronic-industry affairs:

IRE's 1951 National Convention in New York registered 22,919 people, had 292 speakers and 277 exhibits. Western Electronic Show in San Francisco pulled 8,745 people, had 45 speakers and 151 exhibits, Electronic Parts Show in Chicago 8,498, 20 and 204. Audio Fair in New York hit 8,400 and 22 and 93—people, papers and exhibits; Instrument Society of America in Houston 6,166 and 82 and 147; American Institute of Electrical Engineers in New York 3,334 and 320 (no exhibits); Association of American Railroads Communications Section in Quebec 604 and 18 and 21; IRE Radio Fall Meeting in Toronto 550 and 24 (no exhibits) and Society of Motion Picture and Television Engineers in Hollywood 500 and 65 (no exhibits).

▶ **Last-Minute Switch**—Six weeks before IRE showtime, the Department of Defense pulled all Service exhibits out of the Palace floor plan despite the usual 'no-charge' donation of space, regretfully informing the Institute that the cost of preparing, shipping and manning displays could not be borne in view of slashed appropriations.

Military electronic equipment of an unclassified nature will be displayed by manufacturers in the space originally reserved for the Army, Navy and Air Force, in a special Institute-coordinated exhibit.

Color TV Field Test Underway in Philadelphia; New York Next

NTSC program uses WPTZ and WNBT. Tests go to Syracuse soon

LAST PHASE in the development of a satisfactory system of compatible color television appeared to be at hand as the National Television System Committee began field tests in Philadelphia February 12th.

According to RTMA, under whose auspices the NTSC has been examining compatible systems since 1950, FCC staff members were invited to view the images on February 16th, with facilities provided by the Philco Corporation. The Philadelphia tests are being conducted with the transmitter of WPTZ, on channel 3.

On February 25th the tests move to New York, where NBC-RCA, DuMont and Hazeltine will provide tests signals to be radiated by WNBT, channel 4, and by the DuMont uhf experimental transmitter. After a period of about two weeks, the test locale will shift to Syracuse, where a General Electric transmitter at Electronics Park will carry the signals in the vhf band.

▶ **Time, Participants**—The tests on WPTZ and WNBT will occur for the most part in the early morning hours, after midnight, since FCC regulations prohibit the experimental use of commercial stations during regularly scheduled program hours. The DuMont and General Electric stations, being experimental, do not fall under this ruling.

All manufacturers of tv receivers, whether or not they are members of RTMA, have been invited to take part in the tests. Although no list of those participating thus far has

(Continued on page 10)

NEW!

SPRAGUE *Blue Jacket*☆ wire-wound RESISTORS

WITHSTAND SEVERE HUMIDITY!

MEET JAN-R-26A!

Designed to withstand the rigid Characteristic G humidity tests of the most stringent specification of them all—JAN-R-26A—Sprague's new Blue Jacket Wire-Wound Resistors give trouble-free service in military electronic and electrical equipment exposed to extremely damp climates!

These outstanding new members of the Sprague resistor family are now available in tab terminal styles RW29 through RW39 in wattage ratings up to 166 watts.

You'll find the complete Blue Jacket Story with performance specifications in Engineering Bulletin 110, just off the press. Get your copy without delay.

YOU'LL KNOW THESE REMARKABLE RESISTORS BY THEIR VITREOUS ENAMEL BRIGHT BLUE JACKETS

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

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been officially released, it is understood that experimental receivers built by Crosley, General Electric, Hazeltine, Motorola, Philco and RCA are scheduled for the Philadelphia tests, and at least four other companies were expected to test their receivers later.

▶ **How the System Works**—A full technical description of the color signal used in the tests has appeared in ELECTRONICS (February, 1952, cover and p 88 and 96). Reduced to the simplest terms, the NTSC color system employs two signals, both broadcast within the standard 6-megacycle channel occupied by commercial tv stations. One of these signals is identical to the standard black-and-white signal now used in public broadcasts. The other is a 'color carrier' signal which carries the color information.

Black-and-white receivers respond only to the first signal and hence reproduce the color program in monochrome, as if they were tuned to a black-and-white transmission. Color receivers respond to both signals, producing a black-and-white image on which are superimposed the color values transmitted by the color carrier.

All of the color receivers thus far tested use tricolor picture tubes of the type developed by RCA (ELECTRONICS, p 86 May 1951). This tube has a viewing screen consisting of 600,000 color dots, 200,000 for each of the three primary colors. Three electron beams within the tube excite dots of the corresponding color, producing three superimposed images. The primary colors combine to reproduce the full gamut of colors in much the same manner as the three superimposed dye images in Kodachrome and Technicolor film.

▶ **End Point**—The NTSC field tests will subject the color signal to 16 specific tests outlined by the FCC, and others formulated by NTSC.

Following a satisfactory conclusion of the tests, the system will be referred to FCC.

Extra Materials For Color TV Out, Says NPA

One group asks easing of order M-90 for theatre-tv

No additional allocations of critical materials for color tv equipment can be expected at this time, NPA officials told tv manufacturers at a second industry-government conference February 8th.

Objectors to the M-90 order contend it prohibits production of a specific item and is unnecessarily restrictive on competitive development. NPA's view is that color tv is an adaptation of an existing product and therefore must come under the general allotments for radio and television receivers.

▶ **Labor Drain Discussed**—Industry estimates of the drain on labor which color television would impose varied considerably. At an October meeting, one company reported that 4 percent of its engineers were engaged in color development work. Today the same firm estimates that if commercial color equipment were permitted it would assign 16 percent of its engineers to it.

Industry's recommendations about what to do with order M-90 range from outright revocation to retention in its present form. A number of representatives propose a middle course . . . amending the order to prohibit production of home color tv receivers only. This would open the way for color television in theatres and other commercial uses.

UHF TV Transmitters Ready in Fall

ON FEBRUARY 14, at a Washington conference of broadcast consultants, it was announced that RCA is ready for the tv freeze-end with a complete line of uhf transmitters and receiving equipment.

Available in the Fall, a one-kilowatt transmitter at $65,700 is the basic unit. To this, an amplifier to increase station power to 10 kilowatts can be added for $85,000. Purchasers of the one-kilowatt job may establish priority for the high-power amplifier. Bought together, cost is $135,000.

An antenna that provides an effective radiated power of 200 kilowatts will be available in September. Cost, $17,900.

▶ **For Present Receivers**—A series of uhf converter units will be available to fit conditions in different cities. A single-station unit costs about $10, a two-station adapter $25, and an all-uhf-channel unit $50. A combined vhf-uhf tuner for 16 channels that fits certain models of present set production is available.

Consultants attending the seminar at the Statler Hotel were told that RCA facilities will be made available to them at cost for making uhf field-strength measurements.

Boomlet in Marine Radio Business

Acceptance of Safety Convention to change FCC requirements

A FLURRY of new equipment business in the maritime radio field is forecast now that fifteen nations have finally accepted the International Convention for the Safety of Life at Sea, proposed in London in 1948. Biggest item of new business will be lifeboat radiotelegraph sets. Next are radiotelephones for cargo ships between 500 and 1,600 gross tons with no radio at present.

Ships of United States registry, working under Federal Communications Commission rules, are already better equipped than most.

▶ **Many After Business**—The 'Big Two', Mackay Radio and Telegraph Co., IT&T affiliate, and Radiomarine Corporation of America, branch of RCA, hope to whack up the lion's share of the lifeboat market, despite stiff competition from five or six other companies. A feature of the required lifeboat rig will be a precision automatic keyer to set off the auto-alarm of any ship within range.

More competition is expected in

(Continued on page 14)

REDUCING DIET

for electronic equipment

Centralab shows you
a complete line of Controls,
Switches, Capacitors and Printed Electronic Circuits
in the *smallest* sizes and in the ratings
needed to help you MINIATURIZE nearly all
types of Electronic Equipment

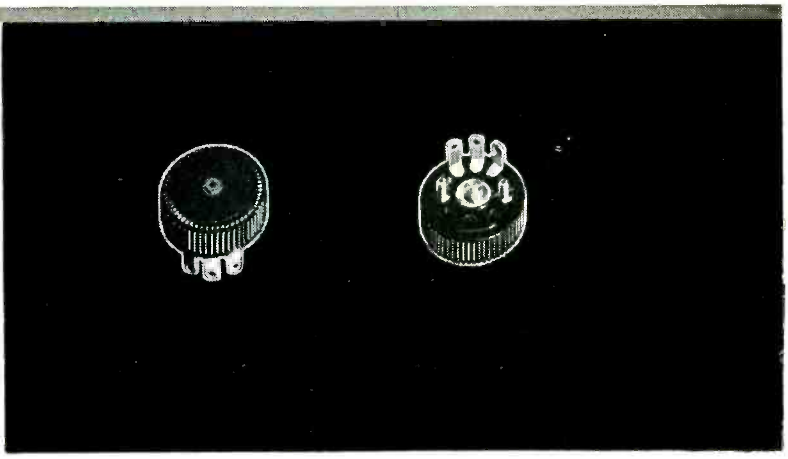
For more information on how Centralab Printed Electronic Circuits can offer you big savings . . .

see next two pages

CENTRALAB PARTS CUT DOWN

OF TV-AM-FM AND

Whatever your need in modern miniature size controls, switches, ceramic capacitors or printed electronic circuits — you'll find Centralab your best source of supply . . . for standard components or special adaptations. For technical bulletins — check corresponding numbers in coupon below. For engineering assistance write factory direct — state your problem.



Model 1 variable resistor — a truly miniature unit . . . no bigger than a dime! Available in standard or new Hi-Torque types . . . either type with or without off-on switch. Also available with slot—front or rear—for screw-driver adjustment. New high torque units will hold settings under conditions of vibration or shock. Check No. 42-158 on coupon.

MINIATURE CONTROLS

You can rely on Centralab for the smallest in controls. The Model 1, illustrated here is literally the standard for the hearing aid industry — where small size and smooth, noiseless, reliable performance is of paramount importance. What's more, Model 1 controls now are being used widely for miniaturization of several types of military electronic equipment.

Combination Series 30 miniature switch unit with dual concentric shaft — permits independent operation of switch, off-on switch, and Model 2 variable resistor.

Same combination unit as shown at left, *except* that Model 2 variable resistor is mounted at rear of miniature switch. Position of resistor provides convenience of wiring.

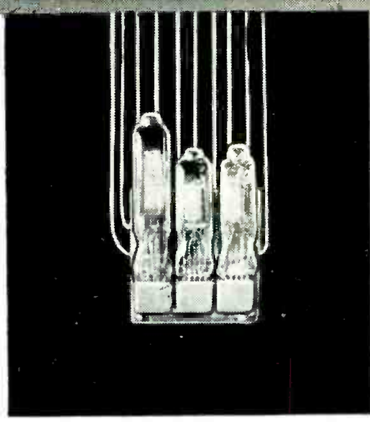
Also available with dual switches operated independently with dual concentric shafts.

MINIATURE CAPACITORS

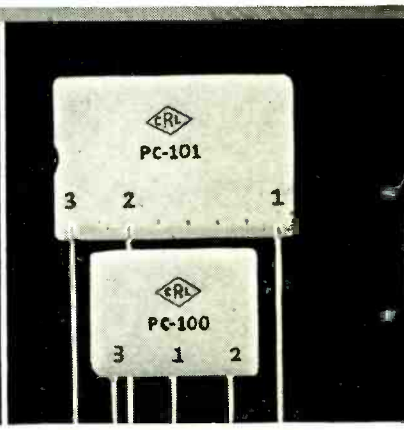
Centralab ceramic capacitors make possible tremendous savings in space; many of them are 1/7th the size of ordinary capacitors. This is particularly important where new design requirements call for less bulk. What's more, they provide a permanence never before achieved with old-fashioned paper or mica condensers. The ceramic body provides imperviousness to moisture, plus unmatched ability to withstand temperatures generally encountered in electrical apparatus. You can rely on Centralab ceramic capacitors for close tolerance, high accuracy, low power factors, and temperature compensating qualities as required.

PRINTED ELECTRONIC CIRCUITS

Printed Electronic Circuits are complete or partial circuits (including all integral circuit connections) consisting of pure metallic silver and resistance materials fired to CRL's famous Steatite or Ceramic-X and brought out to convenient, permanently anchored external leads. They provide miniature units of widely diversified circuits—from single resistor plates to complete speech amplifiers. No other modern electronic development offers such tremendous time and cost saving advantages in low-power applications. *Important to note:* All PEC's illustrated are developed for standard applications. Numerous other circuit complements can be furnished for volume requirements.



New Model 3 Ampec — a sub miniature 3 stage speech amplifier . . . dimensions: 1-1/32" x 15/16" x 11/32". Check coupon for Technical Bulletin 42-130.



82% less soldered connections with Vertical Integrator . . . in assembly of TV vertical integrator networks . . . reduces 16 soldered connections to 3! Technical Bulletin 42-126.

SIZE-SPACE-WEIGHT- AND COST

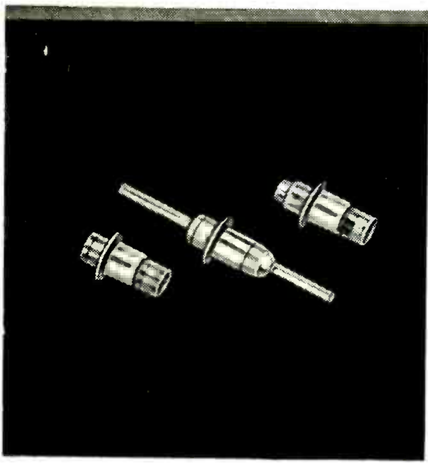
MILITARY ELECTRONIC GEAR

MINIATURE SWITCHES

Centralab's new miniature Series 20 and Series 30 switches have been specifically designed to meet the modern trend toward greatly reduced size for high-frequency, low-current applications. Extremely compact design and small size, plus availability of separate sections and index assemblies, provide an adaptability that is invaluable to design engineers and manufacturers. For complete information on the new Centralab Miniature Series 20 and Series 30 Switch line . . . multi-pole, multi-position, multi-section models or combinations with attached line switches and variable resistors, mail the coupon ay. *Manufacturer's samples promptly.* Bulletins 4 .63 and 42-164.

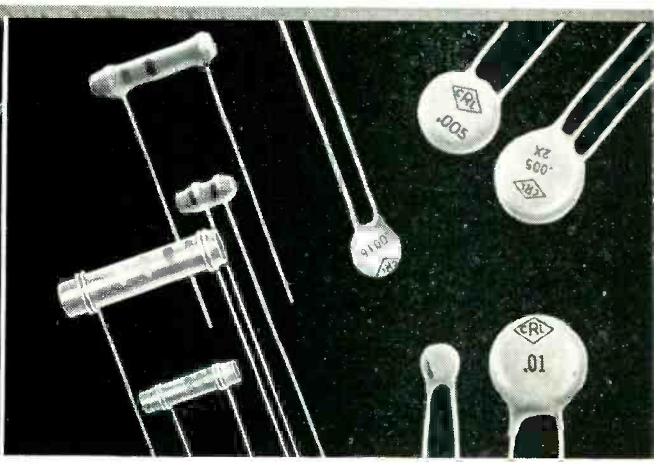
New Centralab Series 20 miniature switch, single steatite section. Available in 2 to 11 positions with stops, or 12 position continuous rotation—and with multiple sections.

Here's standard Series 20 miniature switch with standard shaft and phenolic section with off-on switch added. Also available with multiple sections.

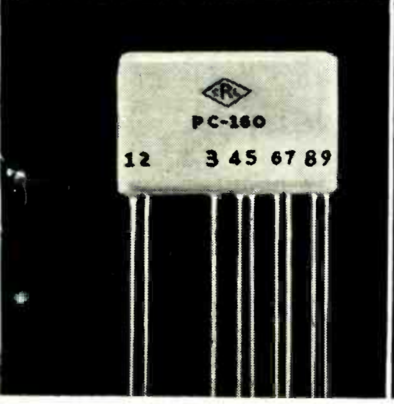


NEW Eyelet-Mounted Feed-through Ceramic Capacitors are exceptionally small. Capacities range from 25 to 3000 mmf., Voltage rating. 500 V. D. C. W. Check No. EP-15 in coupon.

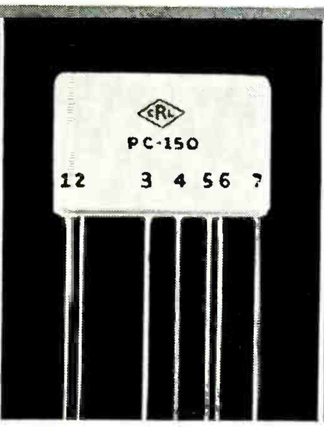
Centralab's Type 850 high voltage ceramic capacitors are especially designed for high voltage, high frequency circuits. Centralab's Type 950 high accuracy ceramic capacitors are especially developed for exacting electronic applications. Bulletins: 42-102 and 42-123.



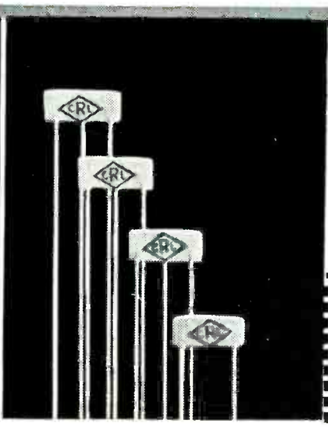
Ceramic Disc Hi-Kap Capacitors have very high capacity in extremely small size. Bulletin No. 42-4R. TC Tubulars (Temperature Compensating) — TCZ units show no capacity change over wide range of temperature; TCN's vary capacitance according to temperature. Bulletin No. 42-18. BC (By-pass Coupling) Tubulars . . . well suited to general circuit use. Bulletin No. 42-3.



50% less soldered connections with Centralab's new Pendet... 5 capacitors and 4 resistors in a single plate... couples diode-triode and pentode tubes in output stage of AC-DC sets. Technical Bulletin 42-149.



50% less soldered connections with Centralab's Audet . . . furnishes all values of all components generally found in the output stage of AC-DC radio receivers. Technical Bulletin 42-129.



Tiny plate capacitor, resistor, and resistor-capacitor units. Readily fit all types of miniature and portable electronic equipment. Technical Bulletin 42-24.

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☐ 42-4R	☐ 42-123	☐ 42-149	☐ EP-15
☐ 42-18	☐ 42-126	☐ 42-158	
☐ 42-24	☐ 42-129	☐ 42-163	

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the radiotelephone field, where a large number of manufacturers are already supplying equipment for small-craft operations around two megacycles (off the high-frequency end of the broadcast band).

RMCA and Mackay spokesmen point out that while the provisions of the international agreement are known, the FCC, which calls the tune for U. S. manufacturers, has not yet issued rules or set specifications. Even though the Convention comes into force in November, it may take another couple of years to run the gamut of design, type approval and manufacture-during-shortages.

Government Relations Unit Set Up By RTMA

ESTABLISHMENT of a government-relations division to deal with the problems of electronics manufacturers handling government contracts is announced by the reorganized Transmitter Division of the Radio-Television Manufacturers Association. The new division, headed by Ben Edelman, Western Electric, will also aid companies from other fields now turning to electronics manufacturing.

Navy Electronics No Bottleneck

INDUSTRY was turning out electronic equipment for the Navy at the rate of $1.5 billion annually at the end of 1951. By July 1, 1952 (beginning of the 1953 military fiscal year) production is expected to double, according to Captain W. I. Bull, Chief of the Electronics Division, Office of Naval Materiel.

Production of electronic equipment for the Navy is 27 percent behind schedule. This constitutes no bottleneck, however, since new ships, airplanes and shore installations are not yet ready to receive their full complement of equipment.

JTAC Surveys Crowded Radio Spectrum, Recommends Conservation Measures

Report by 25 experts compares present allocations with ideal

SOON to be issued by the Joint Technical Advisory Committee (RTMA-IRE) is a 250-page magnum opus titled "Conservation of the Radio Spectrum", which spells out the status quo of the multi-billion-dollar radio-tv industry. It predicts a stagnant future if present allocation practices are continued.

The six-part report was compiled by a three-man subcommittee assisted by five consultants and 17 additional contributors, each of whom rates as an expert in some part of the field. Written in layman's language, the report traces the history of radio regulation since the turn of the century, and defines the facts of nature (propagation characteristics) which must be recognized in assigning spectrum space.

▶ **Action Urged**—JTAC brashly sets out an ideal allocation which would make best use of available facilities, on the assumption that the existing channels could be reassigned without reference to the past. The existing allocation is then compared with the ideal and the less-than-ideal practices of the present are subjected to rational criticism.

A specific program for amelioration of present difficulties is presented under the title "Dynamic Conservation". The proposed program notes the unavoidable handicaps imposed by concentrations of population and propagation vagaries, but lists specific technical and economic measures which should, in JTAC's view, be adopted at once by the FCC and similar agencies throughout the world.

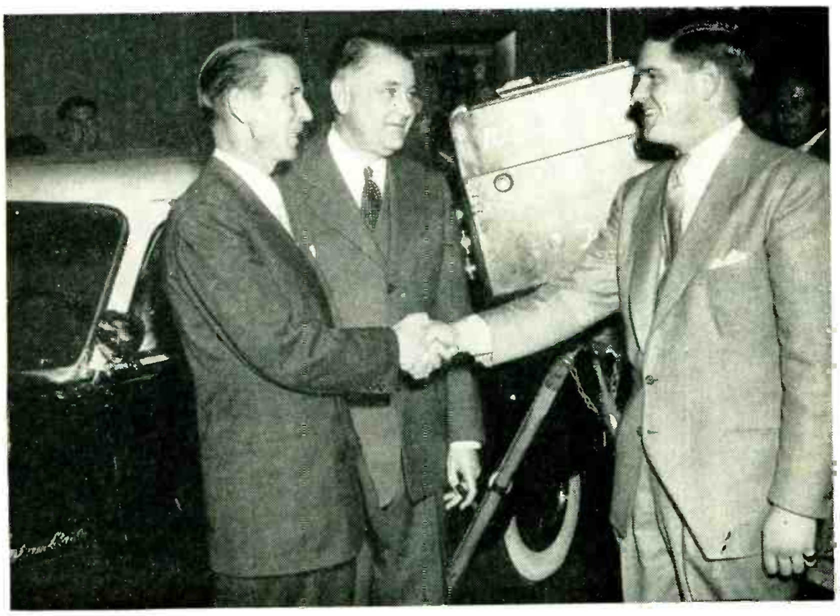
Plans for reproducing the report for worldwide distribution, possibly in book form, were discussed at the February 15th meeting of JTAC.

▶ **Men Behind Report** — Among those contributing to the report were Haraden Pratt, now Telecommunications Adviser to President Truman, Philip Siling, RCA Frequency Bureau head, and Donald G. Fink, ELECTRONICS editor, who headed the JTAC subcommittee.

Consultants appointed to JTAC for the project included J. H. Del-

(Continued on page 16)

INDUSTRIAL TELEVISION HELPS SELL NEW CARS



Dealers and salesmen in the jampacked 1,200-seat ballroom of Atlantic City's Hotel Traymore saw their 1952 line for the first time on a 15-by-20-foot theatre-tv screen. The cars were televised over a closed circuit from a nearby garage by (left to right) Ford's Johnston and Beacham, RCA-Victor's Doug Deakins

(Advertisement)

New BARRY Products on Display at I. R. E. Show Booths 284-285

Watertown, Mass., Feb. 1, 1952 — New equipment for isolating vibration, controlling shock, and performance-testing vibration isolators and shock mounts themselves, will be shown in operation at the Barry exhibit on the second floor of the exhibition hall, during all of the 1952 I. R. E. show.

All-Metl Barrymounts.

A complete line of All-Metl unit isolators, and of equipment mounting bases incorporating these isolators for all JAN-standard sizes of electronic equipment, will also be exhibited. Data on the performance characteristics of these mounts, which are specifically designed to withstand extremes of high and low temperature, will be available to those interested.

Ruggedized Mounts and Bases.

Ruggedized versions of Barrymounts and bases, in the All-Metl and Air-Damped types, will be shown. These units meet the latest military specifications for protection against shock. They are designed to hold mounted equipment securely through the most severe shocks encountered in the operation of carrier-based aircraft, and even in crash landings.

Miniaturized Vibration Isolators.

In line with the current trend toward smaller and smaller airborne equipment, Barry engineers have developed a line of miniature isolators. These are available in both the All-Metl and the Air-Damped types, and combine maximum performance with minimum loss of space. They will be on display, together with special bases available to incorporate them.

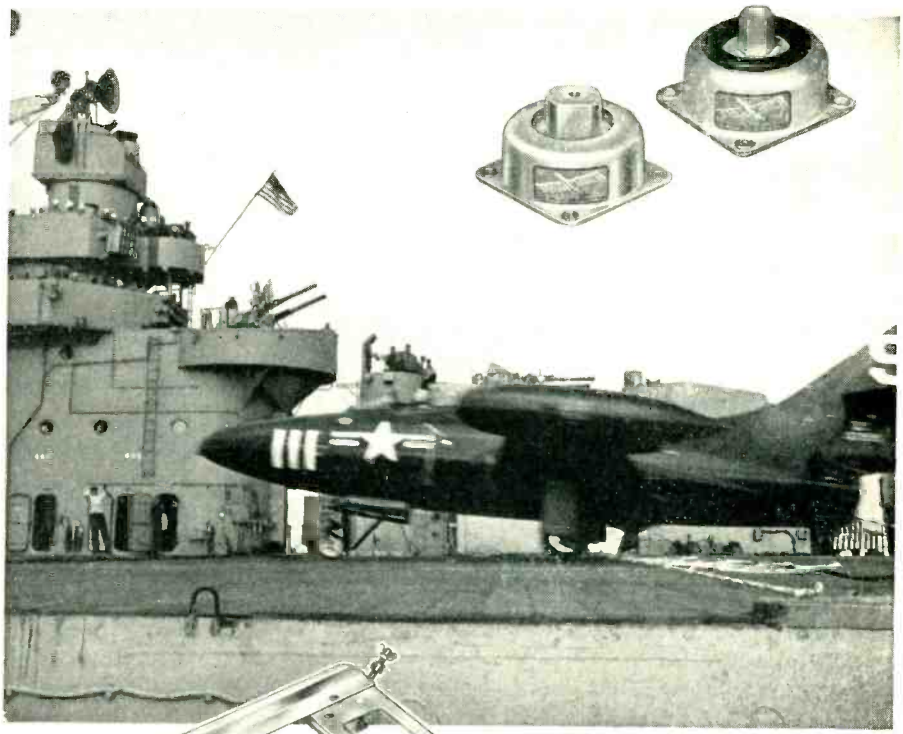
Shock Test Machine.

A working demonstration of the new Model 20-VI Impact-shock Testing Machine will be conducted at frequent intervals. This will enable visitors to see for themselves what is involved in laboratory tests of vibration isolators, shock mounts, and mounted equipment. Experienced Barry Personnel will be on hand at all times to demonstrate and discuss the apparatus, and to answer questions about the control of shock and vibration.

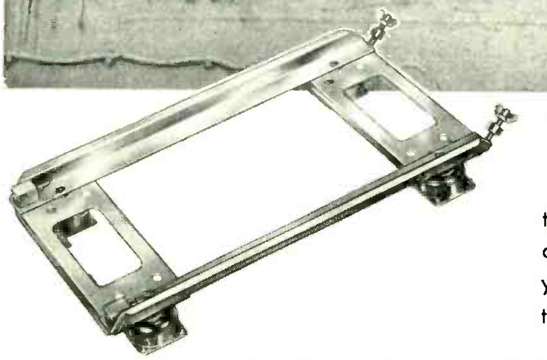
SHOCK and VIBRATION NEWS

BARRYMOUNTS FOR ASSURED CONTROL OF SHOCK AND VIBRATION

*can **YOUR** equipment stand the shock of carrier landings? **Barrymounts can!***



Official United States Navy Photograph



New military specifications for all services require ruggedization of your equipments with their mountings.

Ruggedized Air-damped and All-Metl Barrymounts and mounting bases are now available to meet the shock test requirements of specifications MIL-T-5422 (Aer), MIL-E-5272 (USAF), and ANE-19. These mountings hold your equipment securely and maintain uniform performance characteristics even after the repeated shock of many aircraft carrier landings.

For full information about Barrymounts and bases, write today for your free copy of each of these Barry catalogs:

Catalog #524—Ruggedized Barrymounts and ruggedized mounting bases.
Catalog #523—Air-damped Barrymounts and mounting bases.
Catalog #509—All-Metl Barrymounts and mounting bases.

THE BARRY CORP.

707 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

Atlanta Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington linger, generally regarded as dean of propagation specialists here and abroad, G. C. Southworth of the Bell Labs, A. F. Van Dyck of RCA and former IRE President, Trevor H. Clark, now of Southwestern Research Institute, and James P. Veatch, former FCC engineer now manager of the RCA Frequency Bureau in Washington.

The roster of JTAC members, who approved the report unanimously included I. J. Kaar, chairman, Ralph Bown, vice-chairman, A. V. Loughren, T. T. Goldsmith, Jr., D. B. Smith, J. V. L. Hogan, D. G. Fink and P. F. Siling.

Italian TV Approved

ITALIAN authorities have approved a television broadcasting license for the RAI (Radio Audizioni Italiane), a private company, on condition it come under direct state control.

RAI expects to set up television service within eighteen months in Turin, Milan and Rome. TV service by 1957 is expected to cover an area of 56,000 square miles with a population of 26 million.

The standards for television broadcasting in Italy will be 625-lines, 25 pictures per second.

TV Picture-Tube Trade-In Plans Stir Industry

Price of glass envelopes appears to be the motivating force behind the move

SYLVANIA late last month startled the tv industry by quietly offering its dealers a trade-in allowance, ranging from $2.25 to $5.25, on used picture tubes. First move by a major tube maker along these lines, the announcement came in for close scrutiny by other leading manufacturers, many of whom had been toying with the idea. National Union immediately followed suit. Others appear to be on the verge of doing so.

The story behind the news is this:

Independent firms scattered around the country have profitably salvaged many picture tubes for distributors, dealers and consumers by (1) reactivating tired electron-emitting cathodes, electrically 'flashing' them from the outside base pins, (2) removing gas by breaking the vacuum seal and re-pumping, and reactivating cathodes by electro-chemical means, or (3) removing everything from the glass envelope, cleaning it, and putting in a new electron gun and phosphor screen.

▶ **Rebuilts Compete**—There is considerable technical doubt as to the efficacy of the first-mentioned method of extending tube life and a widespread difference of opinion among engineers even regarding the second. But the third method really disturbs tube makers.

Glass envelopes represent a substantial part of the cost of picture tubes, and suppliers have been slow to reduce it. Most manufacturers have for some time reworked the good envelopes of tubes rejected during production for internal faults, saving the consumer up to 25 percent by so doing. Where the glass itself is not damaged a rebuilt tube may conceivably be as good or better than a new one, depending upon the skill of the builder; and some shops are now selling rebuilts as low as $1 per tube inch, about 50 percent of the prevailing new-tube lists, largely because they buy their glass cheap.

Rebuilt picture tubes are thus competing with new ones in the replacement market.

▶ **Tube-Makers Fight Back**—Whether or not major manufacturers establishing a picture-tube trade-in policy will actually re-use many of the glass envelopes so obtained remains to be seen. There is no shortage of new envelopes, so their price will probably be the determining factor.

The apparent reason for buying up used tubes is to remove them from the reach of firms that do not obliterate the original maker's name when rebuilding, a common practice currently under investigation by a battery of corporation and Association lawyers.

Except insofar as the acceptance of trade-ins implies a cut price, there does not appear to be any desire on the part of major manufacturers to start a tv picture-tube price war among themselves.

What Happens To Drafted Engineers?

INDUSTRY has asked "what happens to drafted engineers" and raised another question—"will my engineer use his talents in military service?" ELECTRONICS can supply management with an answer to these questions after talking to Colonel Thomas A. Pitcher, Commanding Officer, Fort Monmouth, Officer Candidate School.

Army's reopening of Signal Corps OCS provides the opportunity for drafted technical men to become engineering officers and receive assignments in line with their civilian occupations.

Officer Candidate William Foland, formerly with the Bell System in Missouri and a graduate of University of Missouri, is one of the engineers graduating as 2nd lieutenant this month at Fort Monmouth Signal Corps Officer Candidate School. Foland is shown here tuning an SCR 499 as part of his communications center training

Of the 140 candidates graduating this month, 5 percent hold college engineering degrees; 16 percent have had two or more years of college but did not receive a degree, and 26 percent have had electronic experience or training in private industry.

▶ **Training Provided**—Taking 22 weeks of rigid training, one por-

(Continued on p 18)

NEW a-c operated megohmmeter

½ to 2,000,000 megohms *with Constant 500 Volts Across Unknown*

RUGGED ☆ PORTABLE ☆ ACCURATE ☆ SIMPLE TO USE

SIMPLE TO USE — *Minimum of panel controls for inexperienced personnel . . . value of unknown is product of meter reading and multiplier switch setting*

SAFE TO USE — *In the DISCHARGE position of panel switch all voltage is removed from terminals, allowing connections to be made or broken with complete safety*

CONSTANT 500-VOLTS APPLIED TO UNKNOWN — *the standardized voltage level for these measurements — balanced vacuum-tube voltmeter indicating circuit with glow-discharge type of voltage regulator tube and stabilized 500-volt supply — voltage on unknown is held at 500 to within ± 2% over a 105- to 125-volt supply line range*

RAPID MEASUREMENTS OF CAPACITOR LEAKAGE — *in the DISCHARGE switch position a shunt resistor is automatically connected across the UNKNOWN terminals, removing any residual charge in capacitive component of the unknown . . . this feature is especially useful when measuring leakage resistance of capacitors*

NOT NECESSARY TO CHARGE UNKNOWN *before starting measurements, as circuit resistance is so small that it has negligible effect on charging time of even largest capacitors*

VERY CONVENIENT IN OBSERVING APPARENT LEAKAGE RESISTANCE *after one and ten minutes of charging time, as is done commonly as routine checks on large electrical machines*

"CHECK" SWITCH POSITION PROVIDED *for checking calibration . . . controls provided for readjustment, normally required only when tubes are changed*

GUARD AND GROUNDING TERMINALS *provided, in addition to the two unknown binding posts, for making three-terminal resistance measurements . . . ground terminal can be connected either to guard terminal or to one of the UNKNOWN terminals*

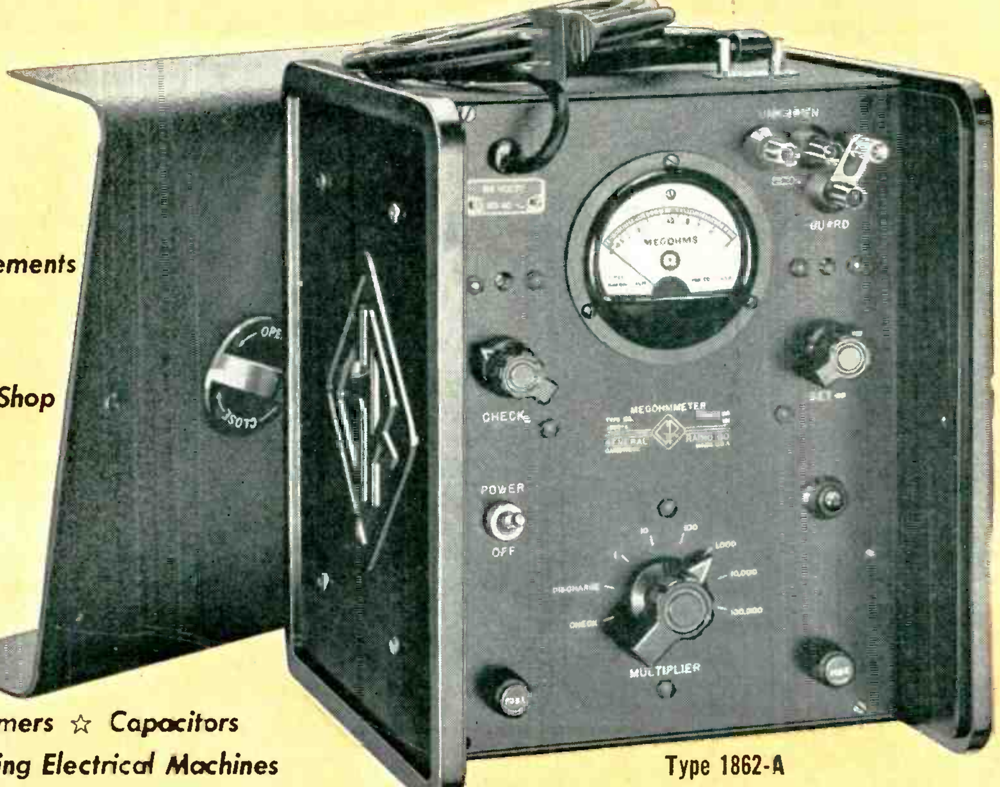
ACCESSORIES SUPPLIED — *Two color-coded test leads with phone tips, two insulated probes, two alligator clips and a G-R Type 274-MB Plug*

For General-Purpose Resistance Measurements

☆ in Production

☆ in the Repair Shop

☆ in the Field



For Insulation Resistance Tests

on Transformers ☆ Capacitors
Cables ☆ Rotating Electrical Machines
☆ Household Appliances

Type 1862-A
Megohmmeter: $225.

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass.

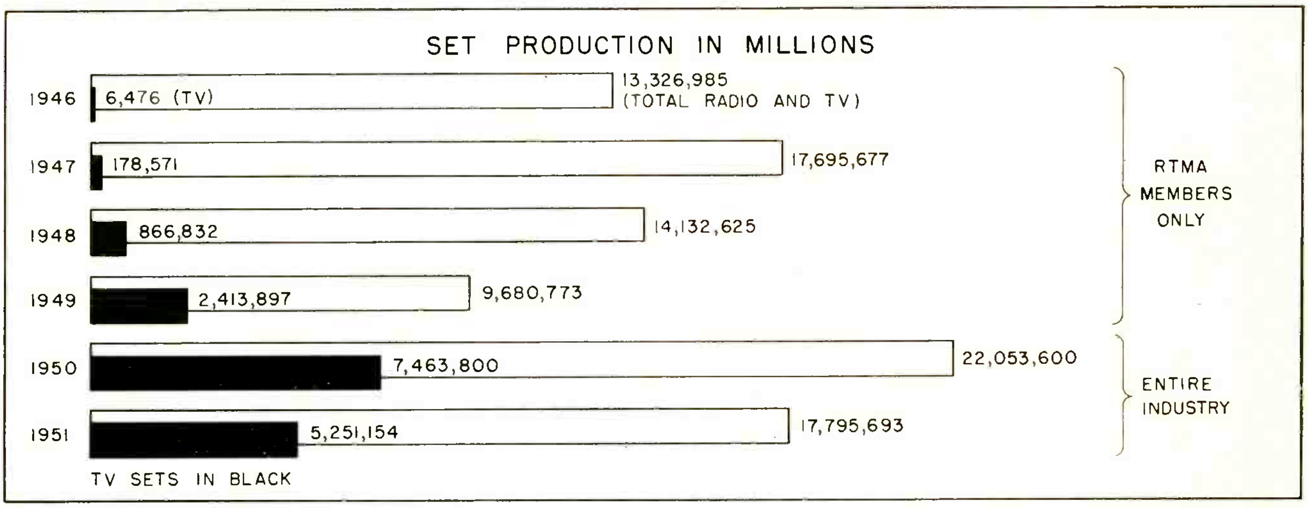
90 West Street NEW YORK 6 *920 S. Michigan Ave.* CHICAGO 5 *1000 N. Seward St.* LOS ANGELES 38 tion of instruction entails 345 hours of Signal Subjects. Then 49 hours are spent in learning the complete operation of a communications center; 44 hours cover radio theory; 30 hours are given in ac-dc theory, while the remaining 222 hours are given over to allied subjects in the electronics fields. Upon completion of the academic courses, the candidate spends a week in the field under simulated 'official assignment.'

▶ **Tip To Industry**—If you have an engineer or technician about to be drafted into the Army he should complete basic training (13 weeks) and then apply for admittance to Officer Candidate School (specifying the Signal Corps) if he meets these requirements: 18½—28 years of age, at least a completed high school education (college will count more toward admittance), and a good moral character and mental ability.

U. S. Radio Set Exports Up 103 Percent

REPORT just released by the Foreign Section, Electronics Division, NPA, reveals that exports of radio sets to foreign countries, in 1951, increased 103 percent over the previous year.

Of 57 countries supplying information for the report, twenty-eight indicate their principal source of supply of radio sets is the U. S.



What's Behind the Figures—RTMA Monthly Radio-TV Set Production

First of a series of fuller explanations of ELECTRONICS' statistics

INQUIRIES from readers indicate a desire to know the basis of the statistics reported monthly on the "Figures of the Month" page (p 4). Accordingly, following the statement last month describing the *Electronics Output Index* graph, the editors have prepared a series of brief explanations of the various other entries on that page.

First of the eleven divisions on the page beneath the graph is "Radio Set Production", which lists the monthly production reports of the Radio-Television Manufacturers Association. The RTMA release is broken into four categories: tv sets of all types including combinations; home radio sets; battery portable sets; and auto sets. The figures are compiled under the direction of W. F. Long, RTMA Director of Statistics in the Washington office of the Association. They comprise production reports of RTMA member companies for the month in question, and are today adjusted to include the production of the entire industry, including manufacturers not members of RTMA. Prior to January 1950, the figures represent production of RTMA member companies only.

The figures represent production over four- or five-week periods, depending on the length of the month. Consequently, production for the current month cannot always be compared directly with that of the previous month or the same month a year ago. (The same caution applies to comparisons between set production for a given month and set sales, listed immediately beneath, in the same or a later month. There is normally a lag between production and sales of the order of several weeks to several months even when sales are brisk. Moreover, differences between production and sales result when sets are put into or taken out of inventory in manufacturer's or distributor's warehouses.

▶ **Detailed Breakdown**—Plotted in the accompanying diagrams are production figures reported by RTMA in past years. The post-war period 1946-1951 is charted in the bar diagram. Tv production started in 1946 with a mere 6,000 sets, rose in 1950 to over 7 million, and fell back as consumer demand slackened to about 5.25 million last year. Radio set production (home, portable and auto sets combined) was highest immediately following the war, has since fallen off to about two thirds

(Continued on page 20)

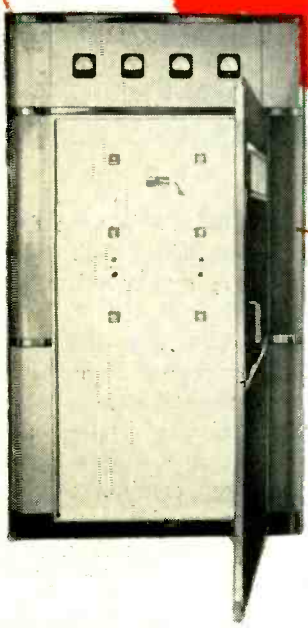
Go on the Air to Stay

with JOHNSON

ANTENNA PHASING EQUIPMENT

ANTENNA AND TRANSMITTER

COMPONENTS



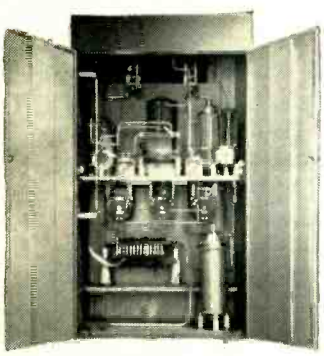
Typical Johnson Antenna Phasing Equipment

Hundreds of Johnson phasing installations are on the air — to stay — for you can depend on JOHNSON for the best! Designed especially for your station, and incorporating the recommendations of your consulting engineers, JOHNSON phasing equipment offers a host of advantages. It has optimum circuit design, heavier components, automatic switching from directional to non-directional operation, and others.

OTHER JOHNSON BROADCAST EQUIPMENT

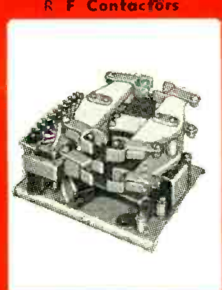
- Adjustable Phase Sampling Loops
- Isolation Filters
- Sampling Lines
- FM and AM Concentric Lines
- Fixed Capacitors
- Variable Capacitors
- Standing Wave Indicators
- R F Contactors
- Tower Lighting Filters
- Transmission Line Supports
- Pressurized Capacitors
- Neutralizing Capacitors
- Fixed Inductors
- Variable Inductors
- Feed-Thru Bowl Assemblies
- Make Before Break Switches

Write for specific information directly or through your consulting engineer

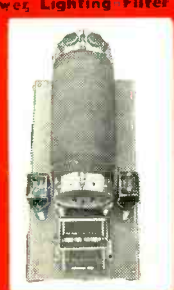


Interior view of Phasing Equipment

R F Contactors

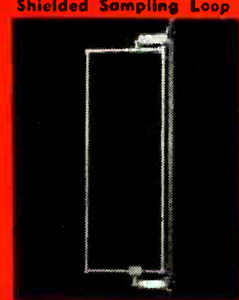


Tower Lighting Filter



Johnson Coupling Unit

Johnson Adjustable Shielded Sampling Loop



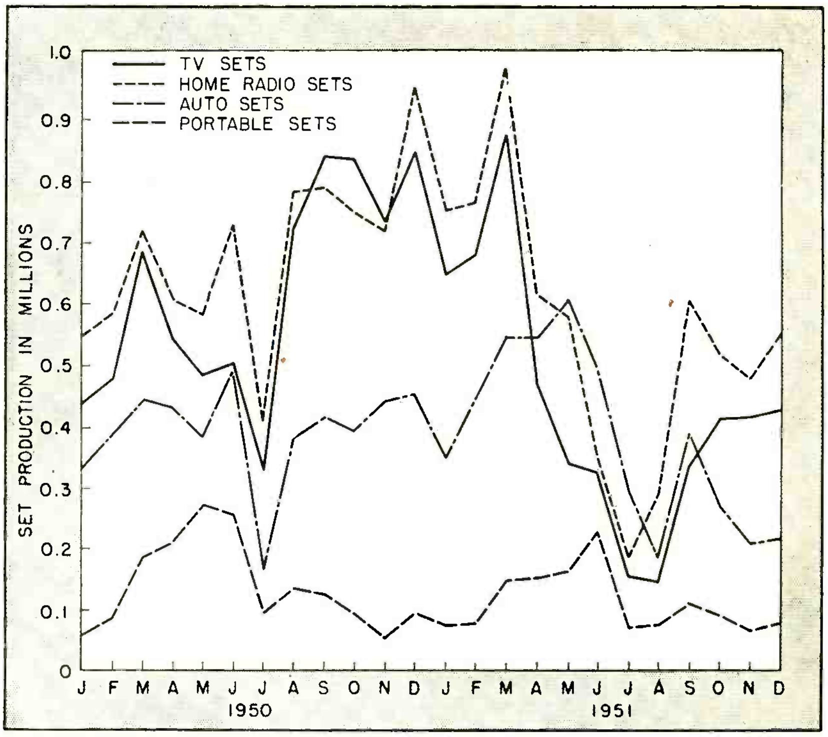
JOHNSON *a famous name in radio*

E. F. JOHNSON CO., WASECA, MINNESOTA

its peak level. The total production of radio and tv sets combined, noted at the right of each bar, fell to a low of 9.6 million in 1949, reached a peak of 22 million in 1950, and dropped to 18 million in 1951.

The trend chart for the period 1950-51 shows the production of tv, home, auto and portable sets by months. It is generally believed that the slump of the spring and summer in 1951 applied primarily to tv sets, but the chart shows that production of all classes of sets suffered in about the same proportion during that period. The production records of tv and home radio sets follow almost identical patterns during this two-year period.

The trend chart also shows the interesting fact that industry production levels at the start of 1952 were very closely the same, in all classes of sets, as at the start of 1950.



Surplus Business Booming Says ISD, Dealers

First Surplus Show sees $$$$$ and goods change hands

SURPLUS BUSINESS is here to stay, says Morris Cohen, vice-president of the Institute of Surplus Dealers. Backing his statement were thousands of people who roamed through the first cooperative exhibit the dealers have held, in New York.

Value of products shown amounted to over $100 million, according to the Institute. Some military equipment was offered at as low as 1 percent of its initial cost.

With all the bustle and appearance of big deals in the making, few of the businessmen on hand at the show were willing to discuss, for publication, how business was going. Not satisfied with this impasse, your reporter visited "Radio Row" in downtown New York and talked with some of the surplus dealers at their stores. All preferred not to be mentioned by name, nor would any of them say what was a 'hot item' now, in fear that it might raise the price among the others. However, each of them expressed an opinion on business conditions since 1945 and it boiled down to this:

Surplus business boomed immediately following the second world war. From 1947 to 49 business dropped because of the return to mass factory production of civilian goods. Many dealers went bust speculating too heavily. Big outfits bought up smaller ones to have "goods on hand." The year 1950 saw the rise again of surplus dealers with the start of the Korean war. Factories went back to military production, patronizing surplus dealers with needed critical stock on hand.

ISD says surplus business should hit its peak, since 1946, this year and stay that way for at least 5 years.

Millions for Conelrad, More FCC Staff?

INTERESTING budget item asked by Federal Communications Commission for Conelrad, control of all electromagnetic radiation (communications, broadcasting and tv) by Presidential order, forecasts expenditure of $3,627,035 in next fiscal year as contrasted with $2,484,994 for similar types of activity for the current period.

Additional monitoring stations, more personnel to man both old and new stations on a 24-hour basis, enforcement activities such as searching out illegal radio stations and investigating complaints of violations are among the less spectacular items FCC will talk about now as recipients of the $1.1 million asked.

Engineer Shortage Still Acute

A STUDY of classified newspaper advertisements seeking the services of electronic engineers indicates that the manpower problem is still acute in the field of electronics.

West Coast manufacturers are running the greatest number of ads, with 34 appearing in one Los Angeles Sunday newspaper alone. This is attributed to the number of aircraft plants located in California, and the extreme importance currently placed on the electronics side of aviation.

Second heaviest advertising area

(Continued on page 22)

Consider these

Brown Electronic Components

Brown Converters are precision, vibrator-type converters for use with any system requiring the conversion of low power direct voltage signals of the order of 100 microvolts to 60 or 400 cycle alternating voltages.

The Brown 60 Cycle Balancing Motor combines reversibility and low inertia . . . is designed to have a tapered curve of speed versus voltage and, at the same time, to maintain high torque at low speeds.

*The **ElectroniK** Amplifier is a precise, rugged and reliable "continuous balance" system which is rapidly becoming the heart of a host of devices and apparatus requiring automatic zeroing or standardizing.*

. . . in research, testing and other applications

Great numbers of these special Brown Electronic Components are daily playing a vital role in the efficient and effective performance of a variety of servos. Just like the thousands of modifications of the *ElectroniK* Potentiometer which are serving in extensive programs of scientific research and development . . . the qualities of these components are recognized and valued not only in the laboratory but also by a growing list of manufacturers of highly sensitive research equipment.

Your own development program may benefit from such specialized instrumentation and tools for research. Our local engineering representative is qualified to discuss your requirements . . . and he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

H HONEYWELL

First in Controls

● *Important Reference Data*

Write for Data Sheets No. 10.20-1, 10.20-2, and 10.20.3 . . . and for Bulletin 15-14, "Instruments Accelerate Research."

is the East Coast, with Boston Sunday papers having 19 ads, Baltimore 12 and Hartford 4.

A surprising statistic appeared in the study of Chicago papers. This city had only 3 advertisements for electronic engineers.

The Market for TV Components

Breakdown of parts in typical model is projected by ELECTRONICS

BEST GUESSTIMATE is that 4 million television sets will be made this year.

ELECTRONICS selected a new 17-inch table model considered typical in design, took it apart down to the last nut and bolt and counted every item. Multiplying items by 4 million gives a good working picture.

Parts strictly electronic or electrical in nature, suitable primarily for tv and radio, will total nearly 1.4 billion pieces. Over 432 million feet of hookup wire, and more than 1.2 million pounds of solder, will be needed. Mechanical parts will exceed 1.6 billion in number.

► **In Detail**—Breaking down the telephone-number totals, these parts will be required for 1952 tv receiver production:

Tubes	84,000,000
Resistors	520,000,000
Capacitors	436,000,000
Controls	28,000,000
Coils (r-f, i-f, etc.)	160,000,000
Cores (coil-tuning)	64,000,000
Transformers (reactors, yokes etc.)	28,000,000
Rectifiers (metallic)	8,000,000
Knobs	32,000,000
Bolts, eyelets, nuts, rivets, staples, washers	1,184,000,000
Braces, brackets, clamps, clips, mounting plates, straps, supports	128,000,000
Hubs, pins, pulleys, shafts, sleeves, spacers, sprints, stops	64,000,000
Shields	20,000,000
Terminal boards, lugs, strips	148,000,000
Cushions, grommets, insulators	80,000,000

MEETINGS

MARCH 3–6: IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y.

MARCH 11: Fifth National Plastics Exposition, Convention Hall, Philadelphia, Pa.

MARCH 20–21: First Conference on Cooling of Airborne Electronic Equipment, Ohio State University, Columbus, Ohio.

MARCH 30: Sixth Annual NARTB Broadcast Engineering Conference, and 30th Annual Convention of NARTB, Stevens Hotel, Chicago, Ill.

APRIL 7–9: Radio Component Show, Grosvenor House, Park Lane, London, W1, England.

APRIL 16–18: Audio-to-Microwaves Symposium, Engineering Societies Building, 33 West 39th St., N. Y., N. Y.

APRIL 21–24: National Committee of URSI-IRE, National Bureau of Standards, Washington, D. C.

MAY 2–3: Association for Computing Machinery, Pittsburgh, Pa.

MAY 5–7: Second Government-Industry Conference, sponsored by RTMA, NEMA, AIEE, at National Bureau of Standards, Washington, D. C.

MAY 5–16: British Industries Fair, Earls Court and Olympia, London, England, and Castle Bromwich, Birmingham, England.

MAY 12–14: National Conference on Airborne Electronics, Biltmore Hotel, Dayton, Ohio.

MAY 13: RADIO CLUB of America, Room 502, Engineering Societies Building, New York, N. Y.

MAY 16–17: Fourth Southwest IRE Conference and Radio Engineering Show, Rice Hotel, Houston, Tex.

MAY 19–22: 1952 Electronics Parts Shows, Exhibition Hall, Stevens Hotel, Chicago, Ill.

MAY 22–24: Electronics Section, Quality Control Convention, Syracuse, N. Y.

MAY 23–24: 1952 Audio Fair, Conrad Hilton Hotel, Chicago.

JUNE 8–12: National Association Electrical Distributors, Ambassador Hotel, Atlantic City, N. J.

JUNE 23–27: AIEE Summer General Meeting, Hotel Nicole, Minneapolis, Minn.

AUG. 12–15: 1952 APCO Conference, Hotel Whitcomb, San Francisco, Calif.

AUG. 27–29: Western Electronic Show and Conference, Municipal Auditorium, Long Beach, Calif.

SEPT. 8–12: National Instrument Conference and Exhibit, Cleveland, Ohio.

OCT. 20–22: Radio Fall Meeting, RTMA Engineering Department, Hotel Syracuse, Syracuse, N. Y.

NOV. 10–30: International Radio and Electronics Exhibition, Bombay, India.

Business Briefs

► **A Ceramic** permanent magnet has been developed in the Netherlands by Philips Research Laboratories. This chinaware-like product needs no cobalt or nickel, contains barium.

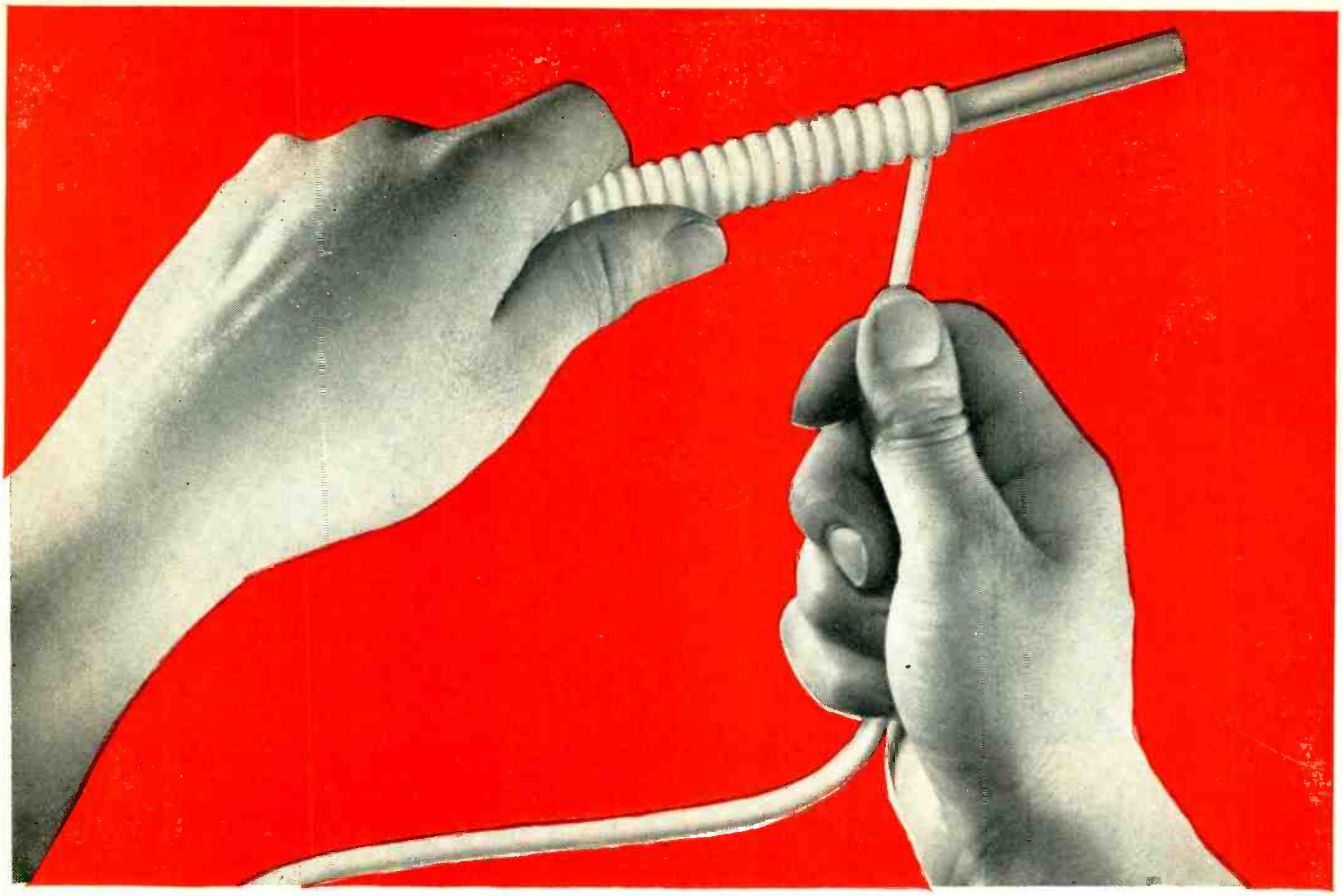
► **TV Sales** by areas are tabulated and distributed by RTMA. Statistical Committee chairman Frank Mansfield says that the breakdown by areas will soon be extended to cover radio sets. First breakdown will cover all of 1951.

► **Australia** has started stockpiling electronic equipment. The Aussies are placing orders abroad for recording and insulation-measuring equipment because local production cannot produce enough for anticipated needs. The government is encouraging big world firms to come 'down under' to manufacture much-needed radar equipment.

► **Airplane Makers** are spending more money on electronic equipment these days than on airframes and power plants combined, according to H. Leslie Hoffman of Hoffman Radio.

► **Major League** baseball clubs received, in dollars and cents, over $4 million for radio-tv rights in 1951, reports the Radio-Television Manufacturers Association.

► **Cross-Channel** microwave tv link may be set up between France and England if plans for celebration of the French national holiday on July 14 go through. Temporary or permanent, a link would provide a fillip to tv equipment business.



Now . . . an extremely flexible high-temperature tubing . . .
IRVINGTON Silicone Rubber-Coated Fiberglas*

If you need a *flexible* insulating tubing that meets Class "H" specifications—and particularly if you need it *now*—look into this new Irvington product!

With the introduction of Silicone *Rubber*-Coated Fiberglas Tubing, Irvington offers to the electrical industry a product that, like the resin-coated type, meets all NEMA Class "H" requirements. In addition, this new tubing has the advantage of extreme flexibility. Its white color is a plus wherever appearance is a factor.

AND . . . Irvington Silicone Rubber-Coated Fiberglas Tubing is available for immediate delivery!

Get the full story—just mail the coupon for technical data sheet.

Look to
IRVINGTON
for Insulation Leadership
INSULATING VARNISHES
VARNISHED CAMBRIC
VARNISHED PAPER
VARNISHED FIBERGLAS
INSULATING TUBING
CLASS "H" INSULATION

*T.M. Reg. U. S. Pat. Off. by Owens-Corning Fiberglas Corp.

Send this convenient coupon now

Irvington
VARNISH & INSULATOR COMPANY
Irvington 11, New Jersey
Plants: Irvington, N. J.; El Monte, Calif.; Hamilton, Ontario, Canada

EL 3/52

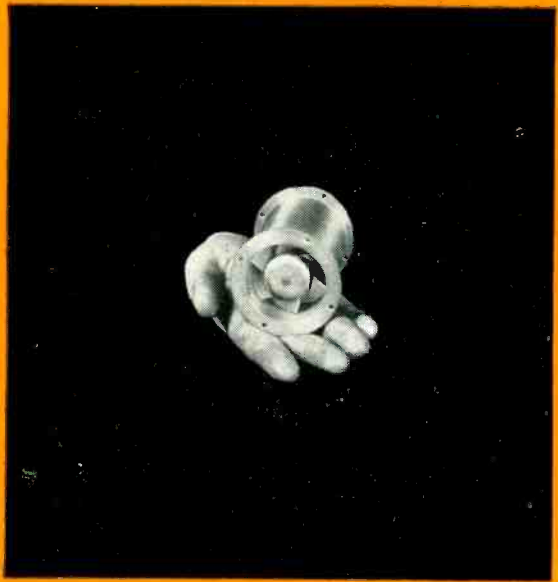
Irvington Varnish & Insulator Co.
Argyle Terrace, Irvington 11, N. J.

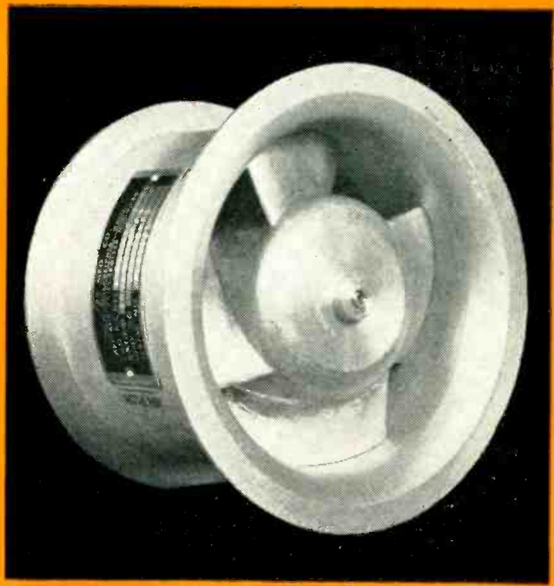
Gentlemen:
Please send me technical data sheet on Irvington Silicone Rubber-Coated Fiberglas Insulating Tubing.

Name.................................Title.................
Company...
Street..
City......................Zone..........State...............

For Further Information, Consult pages 92-93 in the 1951-1952 Electronics Buyers' Guide

From VERY SMALL ... to LARGE CAPACITY





JOY AXIVANE® FANS

are available to meet any ELECTRONIC COOLING NEED

Joy AXIVANE Electronic Cooling Fans are expressly designed to meet the needs of this exacting field of service. They are built in a complete range to suit any requirements, such as: spot cooling of ventilated units where local high-temperature conditions arise; heat removal from pressurized or hermetically-sealed units; or heat removal where space is so restricted that natural ventilation through the unit or over its surface is insufficient. Important operating advantages of these fans are their strength, high resistance to shock and vibration, and efficiency in low or high-pressure service. Aluminum and magnesium construction keeps weight at a minimum.

Available in sizes from 2" I.D. up, these Joy Fans are built to meet all present Air Force and Naval electronic specifications. They can be furnished with totally enclosed or explosion-proof motors, if desired.

In general, keep these facts in mind: that the light, compact design, low power consumption and high overall efficiency of Joy AXIVANE Fans provide more satisfactory cooling for electronic equipment in either air-borne or surface units. ● If you have a problem in heat dissipation from electronic units, let us place at your disposal JOY's experience as the world's largest manufacturer of vaneaxial-type fans.

Consult a Joy Engineer

Over 100 Years of Engineering Leadership

W&D I 4064

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

Announcing and introducing the new Airpax MIDGET Chopper
On display for first time at IRE Show, Booth 477. Don't Miss It!

NOW AIRPAX BRINGS YOU THE NEWEST, MOST REVOLUTIONARY DEVELOPMENT IN CHOPPERS!

the AIRPAX MIDGET

MODEL NO. C747

Here's the biggest, most important news in choppers the industry has ever seen. It's the new Airpax MIDGET . . . being introduced now for the first time after three years of intensive engineering development work. Compare the exclusive features of the MIDGET with choppers you're now using. You'll specify Airpax MIDGETS from now on.

DIMENSIONS Weight—33.6 grams (.074 lbs.) Size—Fits 7 pin miniature socket Length 1.812 Maximum diameter .791	**SPECIFICATIONS** Meets An-E-19 specifications. See Airpax specification 156 for details of operation.	**CONTACTS** Single pole double throw only, break before make. Rated at 100 volts, 2 ma.	**VIBRATION** Operates well under vibration of 10G, 10 to 55 cycles.
DRIVE At present available only at 400 cycles, 6.3 volts, with maximum coil voltage of 6.3. (Usual frequency range is 380 to 420 cycles.)	**PHASE ANGLE** Contacts lag 65° behind a driving sine wave. Dwell time approximately 135° per side.	**TEMPERATURE** Operates successfully between −70C to 100°C. Will not be damaged by temperatures varying over those limits.	**ACCELERATION** Will operate under greater than 50G, any plane. Will take over 500G, in certain planes.
RESIDUAL NOISE At 1 megohm impedance, residual noise is less than 400 microvolts peak, measured from any contact to ground.	**HERMETIC SEALING** May be operated at full rating at any altitude or humidity. Will not be damaged by prolonged exposure to either humidity or salt spray.		**LIFE** Repeated life tests by some of nation's major electronic and aircraft concerns show a life expectancy in excess of 1,000 hours.

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

FIRST... with the finest in CHOPPERS, VIBRATORS, INVERTERS, TRANSFORMERS & POWER SUPPLIES

CHATHAM ELECTRONIC TUBES

Hydrogen Thyratrons

—for Pulse Voltage Generation

Type	VC-1258	5949/1907	5948/1754	VC-1257
Maximum Peak Forward Anode Potential	1000 volts	25000 volts	25000 volts	38000 volts
Maximum Peak Anode Current	20 amps	500 amps	1000 amps	2000 amps
Maximum Average Anode Current	0.05 amps	0.50 amps	1.0 amps	2.0 amps
Maximum Heating Factor (epy x prr x ib)	1.0×10^8	6.25×10^9	9.0×10^9	—
Nominal Filament Power	12.6 watts	95 watts	190 watts	230 watts
Hydrogen Reservoir	No	Yes	Yes	Yes

ELECTRICAL DATA*

*More detailed information on electrical and mechanical data will be supplied on request.

TYPE VC-1257
Hydrogen filled, zero bias thyratron with hydrogen generator for generation of pulse power up to 40 megawatts.

TYPE 5948/1754
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

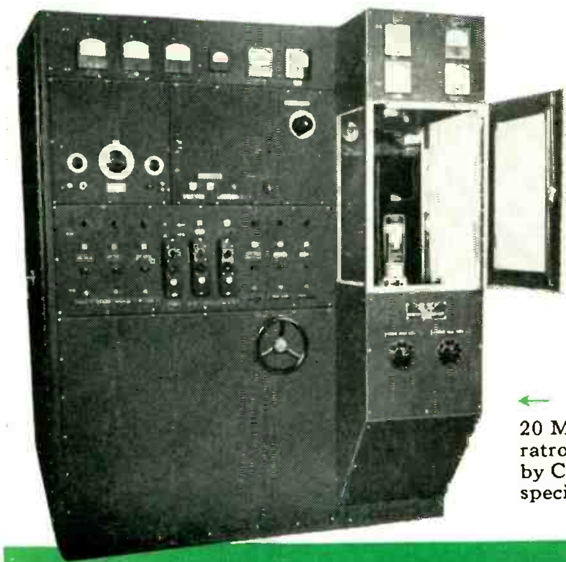
TYPE 5949/1907
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

TYPE VC-1258
Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW.

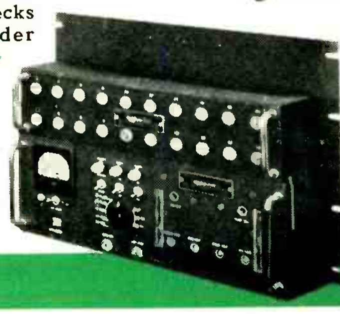
• A NEW CONCEPT OF HYDROGEN THYRATRON DESIGN! The tubes illustrated represent a departure from conventional hydrogen thyratron designs and are a result of several years of concentrated development work. They are primarily employed in the generation of peak voltages with durations in the order of microseconds.

Custom-built Electronic Equipment

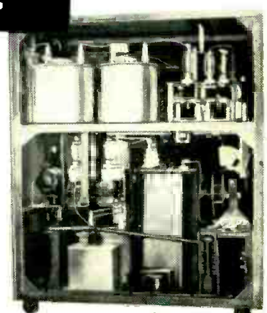
• CHATHAM specializes in the development, design, and construction of custom-built electronic equipment to exactly meet customers' requirements. Our capable staff of engineers will furnish prompt estimates or, if desired, will call to discuss your problem personally. Call or write today.



← 20 Megawatt Hydrogen Thyratron Test Equipment built by CHATHAM to customers' specifications.



Pulse life test equipment built by CHATHAM checks receiver type tubes under pulse conditions. →



↑ 5 Megawatt radar modulator built by CHATHAM to rigid government standards.

ELECTRONICS AND EQUIPMENT

Electronic Tubes

Ruggedized Type Tubes

• The following tubes are JAN approved and can be supplied promptly, usually direct from stock:

5R4WGY	2D21W
6AL5W	OC3W
6H6WGT	OD3W
25Z6WGT	2050W

TYPE 719-A HIGH VACUUM CLIPPER DIODE

This tube is used primarily for clipper diode service in hard tube modulator circuits. Filament 7 volts, 7 amps . . . Inverse peak anode voltage 25 kv, Max., peak anode current 10 amps, Max., anode dissipation 75 watts.

TYPE 1Z2 RECTIFIER

A small bulb high voltage vacuum rectifier. Low cathode heating power and low dielectric losses make tube suitable for radio frequency supply circuits. Filament 1.5 volts, .290 amps . . . Inverse peak anode voltage 20,000, average plate current 2 ma. . . . peak plate current 10 ma.

TYPE 1B46 REGULATOR

A cold cathode glow discharge tube designed for voltage stability. DC operating voltage 82 volts, operating current range 1 ma minimum, 2 ma maximum. Regulation 3 volts.

TYPE 395-A COLD CATHODE GAS TRIODE

Requires no filament supply and is used in many grid controlled rectifier and relay applications. Maximum D.C. anode current—10 ma. Maximum D.C. anode voltage—150 volts

TYPE 4B32 RECTIFIER

A rugged half-wave Xenon filled rectifier. Operates in any position throughout an ambient temperature range of −75°C to +90°C. Filament 5 volts, 7.5 amp . . . Inverse peak anode voltage 10,000, average anode current 1.25 amp.

TYPE 394-A THYRATRON

A Mercury vapor and Argon filled thyratron for grid controlled rectifier service. Operates over wide ambient temperature range. Heater 2.5 volts, 3.2 amps . . . Inverse peak anode voltage 1250, average anode current 640 ma.

TYPE 3B28 RECTIFIER

This rugged half-wave Xenon filled rectifier will operate in any position and throughout an ambient temperature range of −75°C to +90°C. Filament 2.5 volts, 5.0 amps . . . Inverse peak plate voltage 10,000, average anode current .25 amp.

Chatham Vacuum Switches

TYPE 1S22 (illustrated) is a mechanically actuated, single-pole, double-throw, glass vacuum switch. This and other types can be supplied.

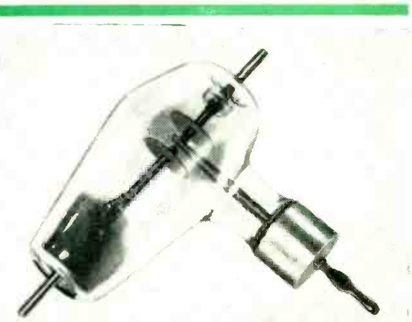
SPECIFICATIONS

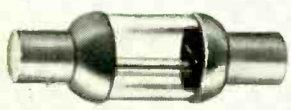
HOLD OFF VOLTAGE: Internal—10,000 volts rms; External* (at 27,000 feet altitude)—10,000 volts rms; External* (at 40,000 feet altitude)—7,500 volts rms.

INTERRUPTING RATING, RESISTIVE LOAD: 1,000 operations life at 10,000 v, ac, rms—10 amp, ac, rms; 1,000,000 operations life at 10,000 v, ac, rms — 2 amp, ac, rms; 500,000,000 operations life at 10,000 v, ac, rms—0.1 amp, ac, rms.

NET WEIGHT (approx.)	2 ozs.	MAXIMUM WIDTH (overall)	4 1/16 ins.
MAXIMUM LENGTH (overall)	3 5/8 ins.	MAXIMUM THICK. (overall)	1 9/16 ins.

*at 50% humidity





HIGH VOLTAGE VACUUM FUSES

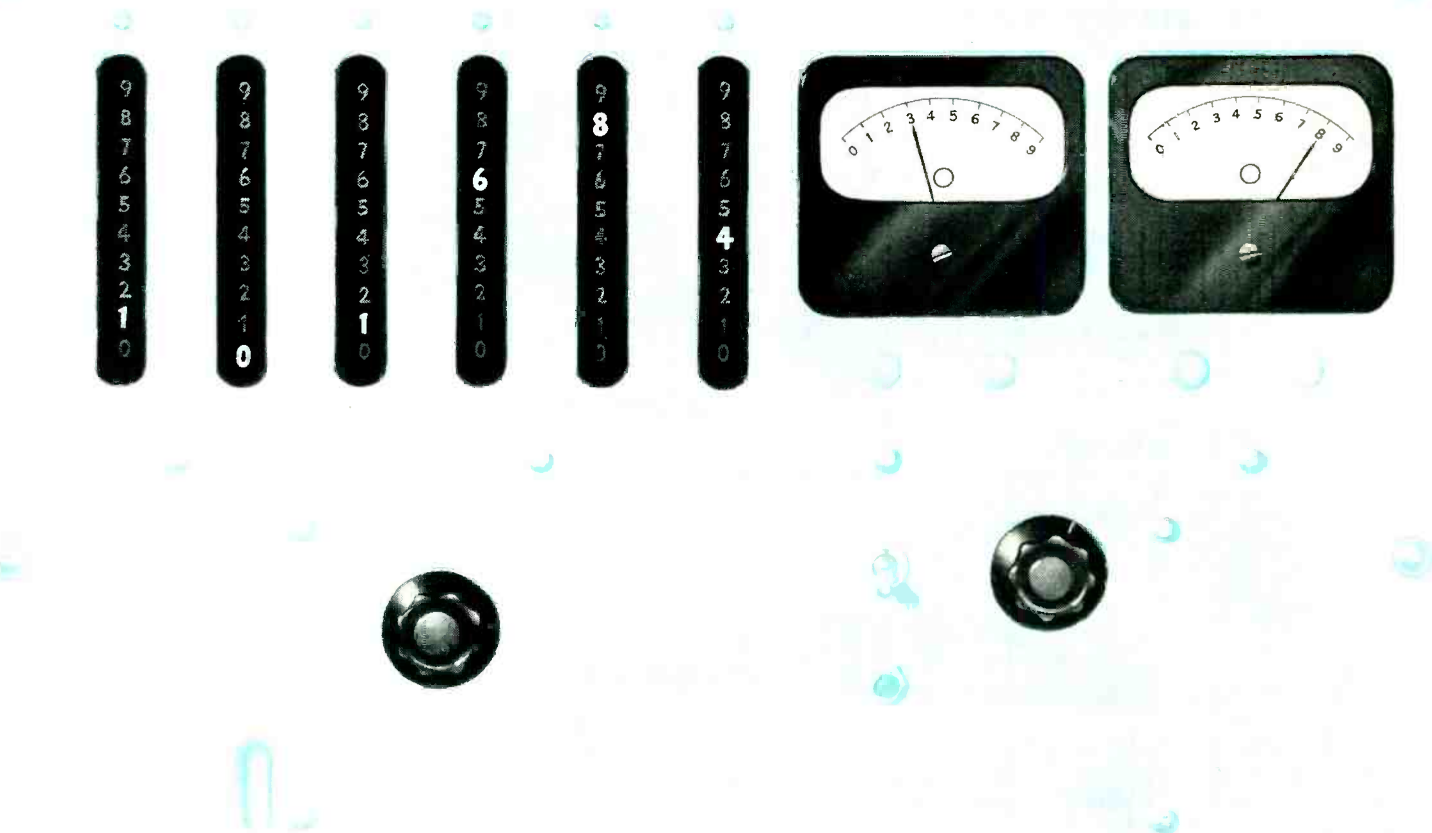
Can be supplied by Chatham to exact customers' specifications if ordered in adequate quantity. Call or write for full particulars and quotes.

CHATHAM ELECTRONICS • INC.

475 WASHINGTON STREET • NEWARK 2, NEW JERSEY

With this one *NEW* instrument read frequency directly, automatically, without calculation—*in 1 second or less!*

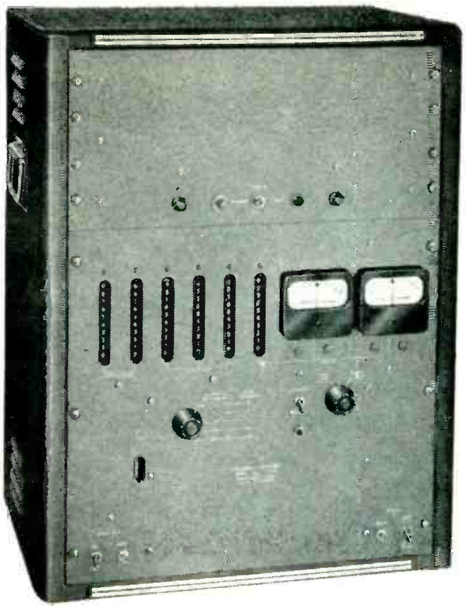
Any frequency to 10,000,000 cps displayed here the split-second unknown is connected! No other equipment needed, no interpolation. (Frequency counted below, 10,168,438 cps.)



A daily work-saver for laboratory or production line!
Here are just a few time-saving uses!

- Measure exact frequency of transmitters and crystal oscillators
- Calibrate sub-audio, audio and supersonic test oscillators
- Measure rpm electronically up to 600,000,000 rpm
- Establish frequencies for filter characteristic determination
- Monitor frequency drift with precise accuracy
- Make rapid checks of crystal frequency
- Read total random events per unit time
- Use as precision frequency standard

HEWLETT-PACKARD hp INSTRUMENTS



REVOLUTIONARY NEW -hp- 524A FREQUENCY COUNTER

- **No figures to add, no calculations!**
- **No complex equipment set-up!**
- **Easily used by non-technical personnel!**
- **Production-line speed, instantaneous readings!**
- **Laboratory accuracy, 1/1,000,000 ±1 count!**
- **Broad coverage, .01 to 10,000,000 cps!**

-hp- 524A Frequency Counter sets new standards for accurate, high-speed frequency measurement in the laboratory or on the production line. It counts frequency instantly, automatically, without effort on your part. It performs all functions of a frequency standard, interpolating system, and detector. For frequency determination it eliminates expensive, hard-to-maintain harmonic amplifiers, transfer oscillators, multi-vibrators, and oscilloscopes.

Two Types of Measurement

1. Direct Counting for High Frequencies • The equipment counts and displays—*directly*—unknown frequencies over exact time intervals of 10, 1, 0.1, 0.01, and 0.001 seconds. Counting and display periods are equal and automatically cycled. The count is displayed repetitively; or, by merely pressing the "manual" button, can be "held" any length of time.

2. Period Measurement for Low Frequencies • The equipment measures the duration of one low frequency cycle in microseconds. A 10 cps sample is taken to determine this period. Periods may be displayed repetitively or "held" as in frequency counting.

Circuit Description

-hp- 524A operates on pulse counting techniques. The unknown is applied through a wide-band squaring amplifier to a fast gate controlled by a time base generator. When the gate is open, unknown is applied to counting circuits. When gate is closed, counting circuits remember and display the counted frequency in cps, or the period in microseconds. Time base circuits are controlled by a highly stable crystal oscillator with instantaneous stability of 1/1,000,000; accuracy of 2/1,000,000 per week.

BRIEF SPECIFICATIONS

-hp- 524A Frequency Counter

COUNTING RATE: 10 mc maximum.

PRESENTATION: 8 places, direct reading.

COUNT PERIOD: 0.001, 0.01, 0.1, 1, 10 secs.

LOW FREQUENCIES: Permits low frequencies to operate as time base. Duration of one cycle is displayed in microseconds.

ACCURACY: ± 1 count ± 2/1,000,000 per week. (Higher accuracy external standard may be employed.)

PERIOD MEASUREMENT: Within 0.03% up to 300 cps: within 1 μsec between 300 cps and 10 kc.

EXTERNAL 100 KC TIMING CIRCUIT: For higher accuracy. Requires 1 v across 50,000 ohms shunted by 30 μμfd.

INPUT VOLTAGE: 1 v peak minimum.

INPUT IMPEDANCE: Approx. 100,000 ohms, 30 μμfd shunt.

CONNECTORS: Standard BNC type.

POWER SOURCE: 115 v, 50/60 cps, 400 watts.

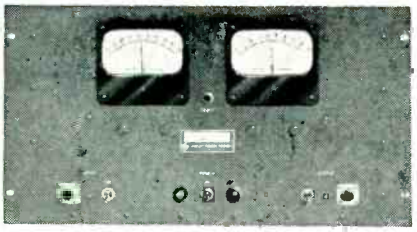
SIZE: Approx. 28" high, 21¾" wide, 14" deep. Weight 115 lbs. Shipping weight 175 lbs.

PRICE: $2,000.00 f.o.b. factory.

Data Subject to Change Without Notice

New -hp- 520A High-Speed Scaler

This new *-hp-* equipment is an aperiodic 10 mc scaler offering precise accuracy and high-speed operation for easy measurement of "fast" circuits and nuclear parameters. This equipment is built into *-hp-* 524A Frequency Counter, and is also available as a separate instrument.



-hp- 520A Scaler will count period pulses from 0 cps to 10 mc. Double-pulse resolving time is 0.1 μsec. Triple-pulse resolving time is 0.2 μsec. Scaler delivers 1 output pulse per 100 received, and displays residual count on two panel meters. Instrument may be used with conventional 10^5 pps scalers to increase count capacity. $600.00 f.o.b. factory.

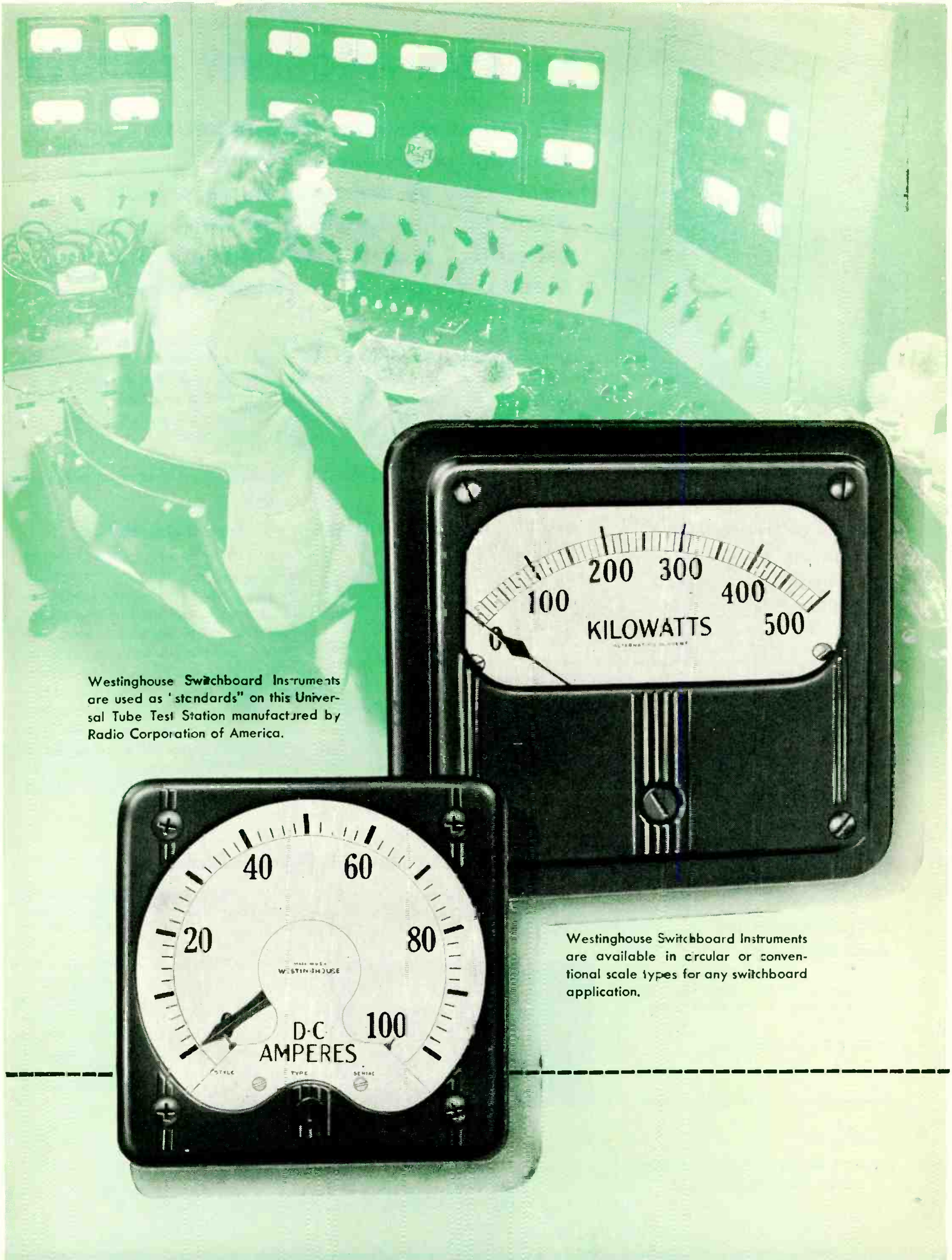
See your -hp- field engineer or write direct for complete details.

HEWLETT-PACKARD COMPANY

2322A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

Export: Frazar & Hansen, Ltd., San Francisco, Los Angeles, New York

THE COMPLETE COVERAGE LINE



Westinghouse Switchboard Instruments are used as "standards" on this Universal Tube Test Station manufactured by Radio Corporation of America.

Westinghouse Switchboard Instruments are available in circular or conventional scale types for any switchboard application.

Where instrument accuracy is a "Must"... specify Westinghouse

The use of Westinghouse instruments as "standards" on RCA's Master Tube Test Stations demonstrates how they measure up to *your* need for accurate measurement of any electrical quantity.

In order to reliably measure the quality of all types of electronic tubes the instruments have to consistently maintain precise accuracy. Westinghouse Switchboard Instruments not only fulfill this requirement but provide important plus benefits as well: Easier readability—to simplify the operator's job . . . and co-ordinated space-saving design—to contribute to the functional compactness of the unit.

Here's further assurance of quality: all Westinghouse switchboard panel, portable and recording instruments are built to meet the rigid performance requirements of the American Standards Association. Moreover, you can select from . . .

The most complete line in the industry!

You get a wider selection for every need whether it be a-c or d-c current and voltage, single or polyphase circuits, watts or vars, frequency, power factor, synchroscopes, temperature indicators, ground detectors or synchrotie (position indicators). And you get . . .

Competent application assistance!

Westinghouse Instrument Application Engineers are available to consult with and serve you in selecting and applying the proper instruments for your application. Simply call your nearest Westinghouse office.

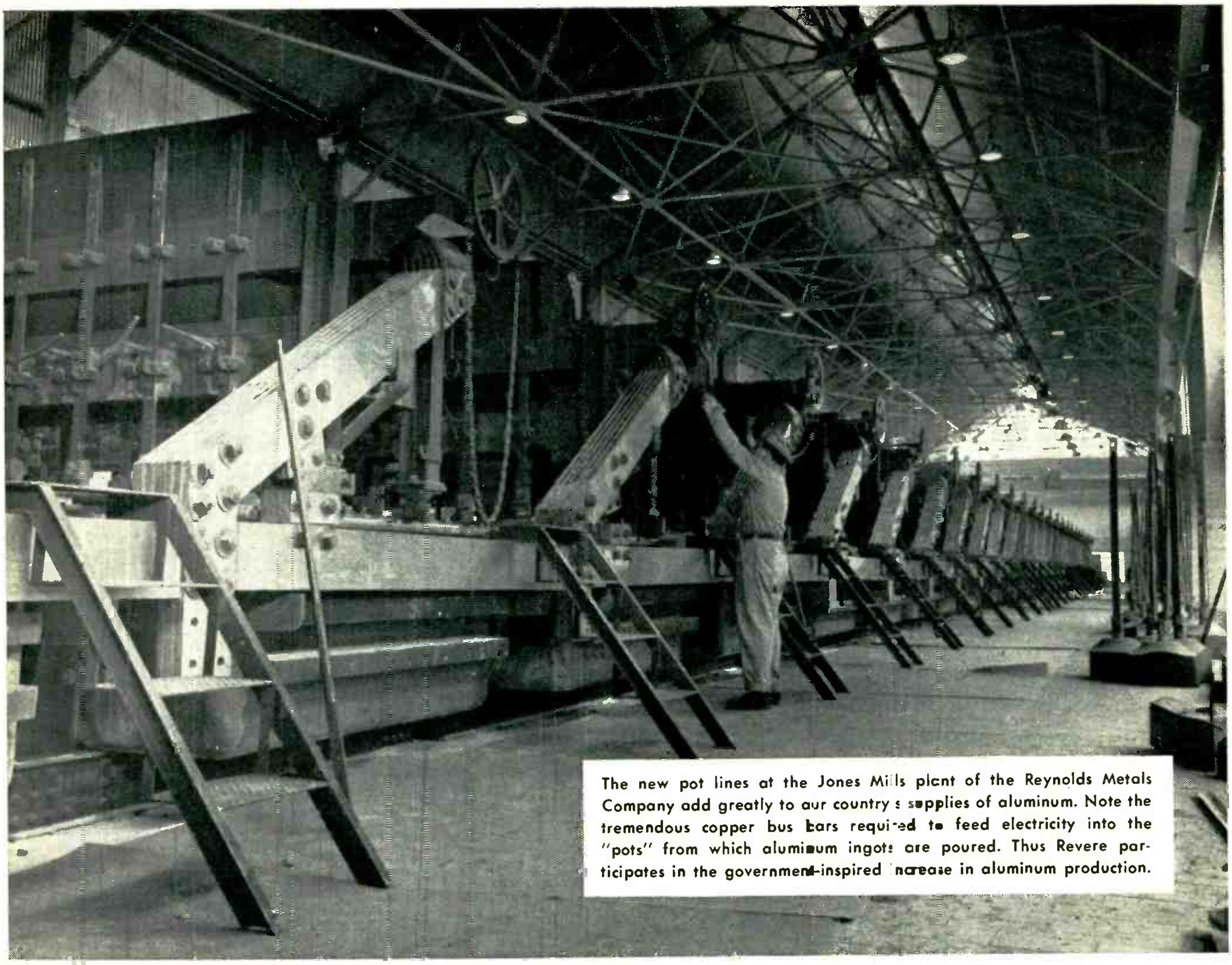
For complete information about Westinghouse Instruments write for Booklet B-4696. Address: Westinghouse Electric Corporation, P.O. Box No. 868, Pittsburgh 30, Pennsylvania.

J-40400

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

Westinghouse

INSTRUMENTS



The new pot lines at the Jones Mills plant of the Reynolds Metals Company add greatly to our country's supplies of aluminum. Note the tremendous copper bus bars required to feed electricity into the "pots" from which aluminum ingots are poured. Thus Revere participates in the government-inspired increase in aluminum production.

It takes a lot of REVERE COPPER BUS BAR to increase aluminum production

● The Government has directed Revere to produce millions of pounds of copper bus bar for the new aluminum plants being put into operation in order to increase the output of this light metal that is so essential to defense. Copper is the ideal metal to carry the heavy currents required for the "pots" that produce aluminum from the ore. Thus aluminum and copper are intimately linked together. Aluminum is used in planes, ships, weapons, missiles, ammunition, and in many other defense applications. Copper, best of all the commercial metals in electrical conductivity, likewise has many vital tasks to perform for our armed forces, afloat, ashore, and in the air.

Revere is glad that its large capacity for the production of bus bar is so valuable in these times; in our long history of over 150 years of service we have always given everything possible in times of our country's need. However, we are regretful that today's government requirements materially limit our ability to fill civilian orders. We look ahead, eagerly and hopefully, to the time when the present urgent demands are met to such an extent that orders for bus bar and other Revere products can be filled more promptly.

REVERE

COPPER AND BRASS INCORPORATED

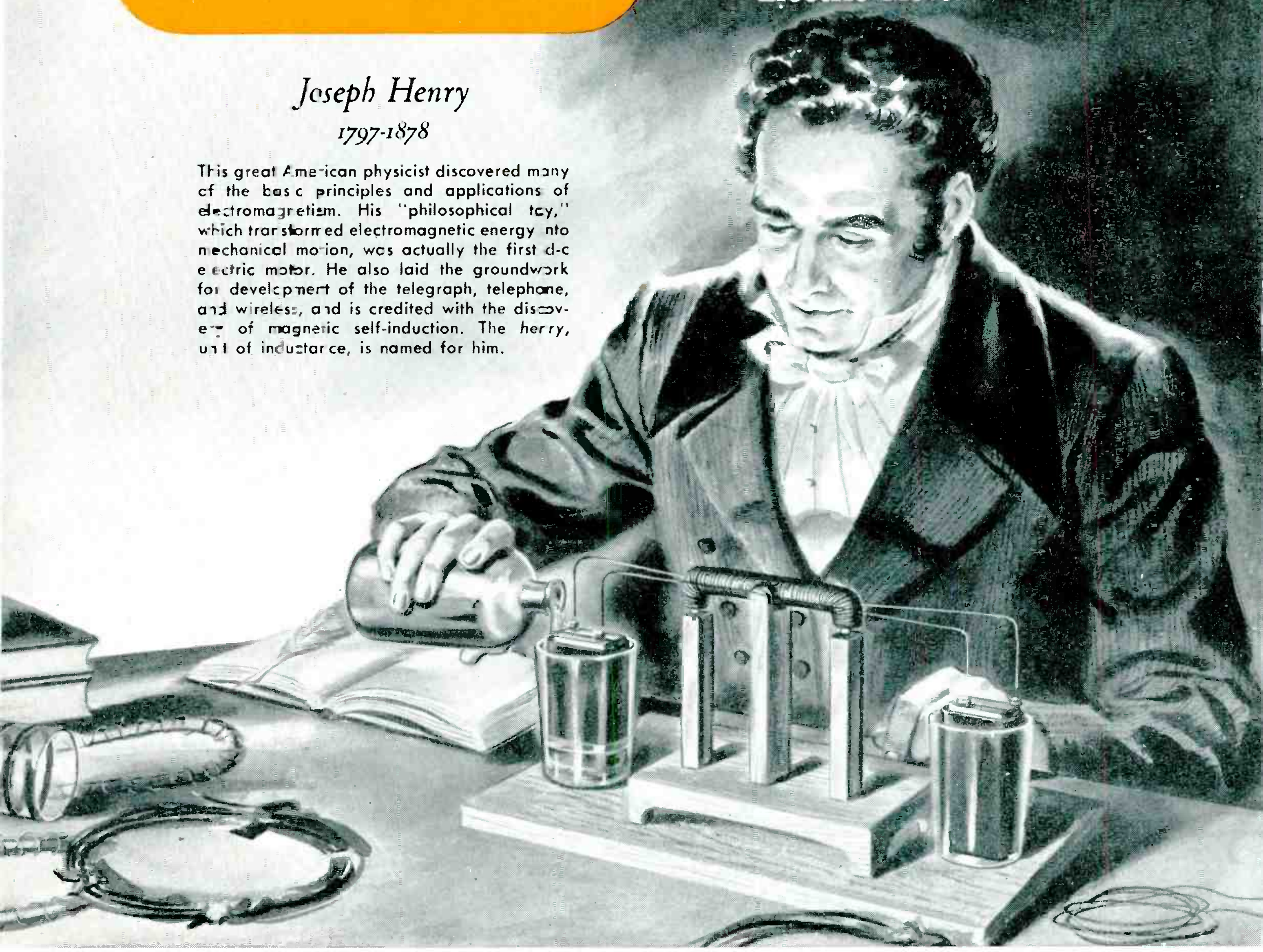
Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

HENRY ...FIRST to produce an Electric Motor



Joseph Henry
1797-1878

This great American physicist discovered many of the basic principles and applications of electromagnetism. His "philosophical toy," which transformed electromagnetic energy into mechanical motion, was actually the first d-c electric motor. He also laid the groundwork for development of the telegraph, telephone, and wireless, and is credited with the discovery of magnetic self-induction. The *henry*, unit of inductance, is named for him.

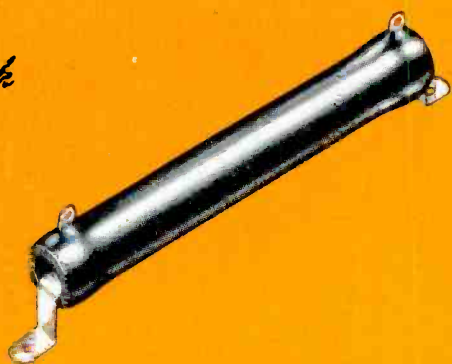
From an original drawing made for OHMITE

OHMITE® ...FIRST in Resistors ...today

Be Right with

OHMITE

RHEOSTATS
RESISTORS
TAP SWITCHES



Ohmite wire-wound resistors are recognized and preferred all over the world for their *dependability*—their ability to provide long life and reliable performance under the most adverse operating conditions. Furthermore, Ohmite offers the most complete line of wire-wound resistors on the market today, with types and sizes for every need. Where *extra* dependability counts, specify Ohmite resistors—overwhelmingly industry's first choice.

OHMITE JAN-TYPE WIRE-WOUND RESISTORS

MEET REQUIREMENTS OF JOINT ARMY-NAVY SPECIFICATION JAN-R-26A

STYLES AND SIZES

TAB-TERMINAL TYPE

Characteristics G and J

Style	Overall length	Diameter	*Watts
RW-29	-3/4"	1/2"	8
RW-30	1"	19/32"	8
RW-31	[illegible]-1/2"	19/32"	10
RW-32	2"	19/32"	12
RW-33	3"	19/32"	18
RW-34	3"	29/32"	30
RW-35	[illegible]	29/32"	38
RW-36	[illegible]	1-5/16"	60
RW-37	[illegible]	1-5/16"	78
RW-38	[illegible]	1-5/16"	[illegible]
RW-39	[illegible]	1-5/16"	[illegible]

TAB-TERMINAL TYPE with terminal hole to clear No. 8 screw

Characteristics G and J

Style	Overall length	Diameter	*Watts
RW-40	3"	29/32"	24
RW-41	4"	29/32"	32
RW-42	4"	1-5/16"	49
RW-43	6"	1-5/16"	74
RW-44	8"	1-5/16"	100
RW-45	12"	1-5/16"	160
RW-46	10-1/2"	1-5/16"	135
RW-47	10-1/2"	1-9/16"	145

FERRULE-TERMINAL TYPE

Characteristics G and J

Style	Overall length	Diameter	*Watts
RW-10	11-7/16"	1-5/16"	140
RW-11	9-5/8"	1-5/16"	116
RW-12	7-[illegible]/16"	1-5/16"	86
RW-13	5 1/8"	1-1/16"	50
RW-14	4-[illegible]/16"	1-1/16"	40
RW-15	2-[illegible]5/16"	3/4"	20
RW-16	2-3/8"	3/4"	14

FLAT (Stack Mounting) TAB-TERMINAL TYPE

Characteristics G and J

Style	Overall Length	Width of Core	Thickness of Core	*Watts
RW-20	2-1/2"	1-3/16"	1/4"	15
RW-21	3-1/4"	1-3/16"	1/4"	22
RW-22	4-3/4"	1-3/16"	1/4"	37
RW-23	6"	1-3/16"	1/4"	47
RW-24	7-1/4"	1-3/16"	1/4"	63

AXIAL-TERMINAL TYPE

Characteristics G and J

Style	Length of Core**	Diameter	*Watts
RW-55	1-3/8"	5/8"	5
RW-56	2"	5/8"	[illegible]0

**2-1/2" wire leads

*Watts free air JAN Characteristic "G"

Ohmite offers an unusually complete line of resistors that meet the most rigid requirements (Characteristics "G" and "J") of Joint Army-Navy Specification JAN-R-26A. To meet these requirements, resistors must pass severe moisture resistance and thermal shock tests. They are required to withstand strenuous vibration applied for five continuous hours. And, they must satisfy the requirements of many other tests, including momentary overload, mechanical strength and terminal strength.

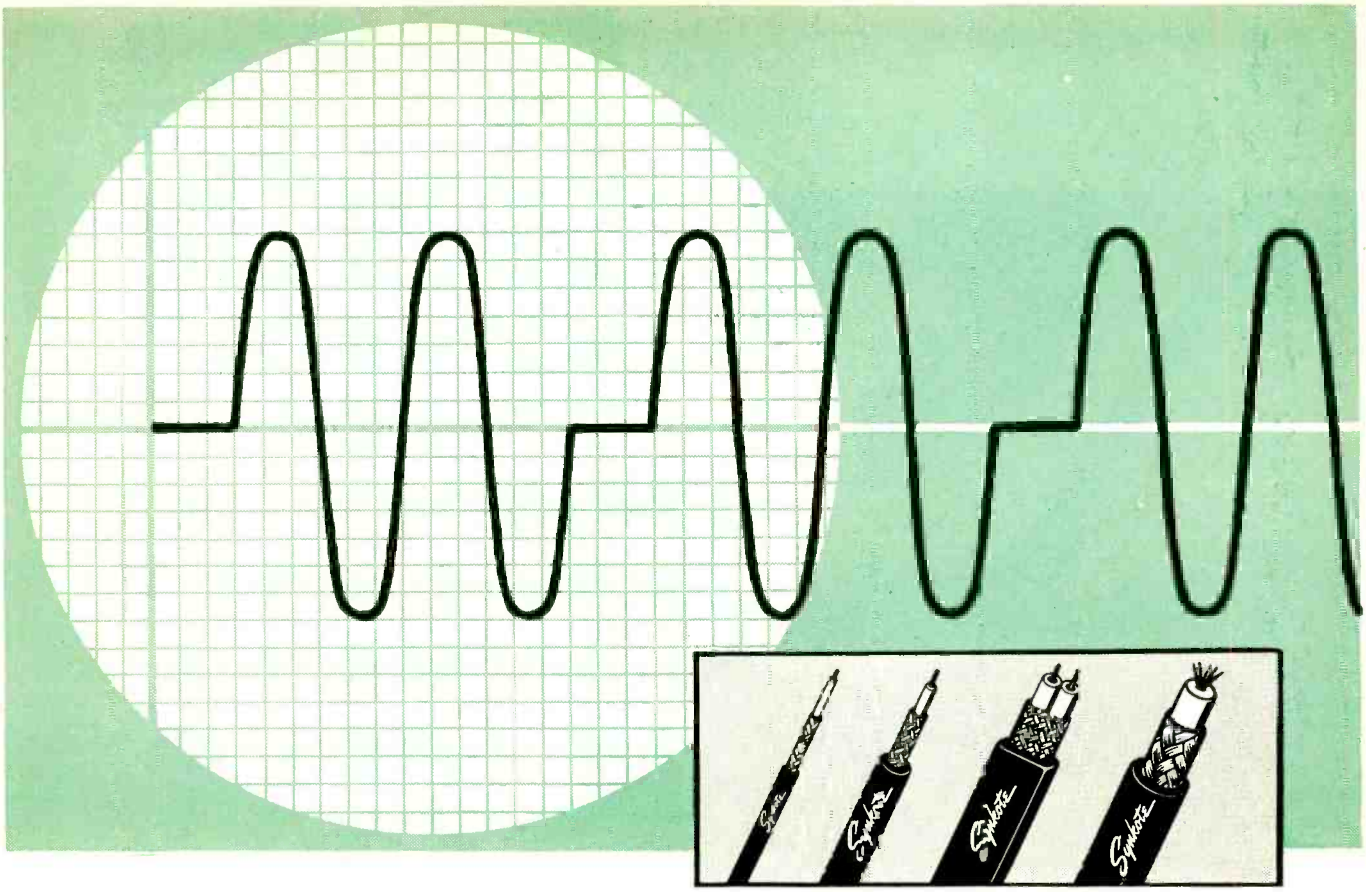
Of the 38 different resistor styles listed in JAN-R-26A, Ohmite offers 33 styles that meet these specifications. These styles represent the most popular resistors, and are available in a complete range of resistance values, in the types and sizes listed.

OHMITE MANUFACTURING COMPANY
4817 Flournoy St., Chicago 44, Ill.

Be Right with...

OHMITE®

RHEOSTATS • RESISTORS • TAP SWITCHES



Several Things Less to Worry About...
When You Specify Synkote Coax Cable

Attenuation, impedance, shielding, insulation, velocity of propagation, *all* the worrisome wire factors affecting your final signal are *dependably constant* in SYNKOTE Coaxial Cables.

Manufactured to 10 standard specifications, SYNKOTE Coax Cables are available in impedances from 50 to 300 ohms . . . insure minimum attenuation and maximum dependability at all frequencies and under most conditions.

For specifications other than standard, our engineering service department will be glad to work with you. Write today — your inquiry will be given prompt attention.

Synkote

DEPENDABLE
Coaxial Cable
"Made by the mile — tested by the inch"

● *You are cordially invited to visit us at BOOTH #451 (Lexington Avenue and 46th St. corner), Grand Central Palace, March 3, 4, 5, 6*

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42-61 24th STREET, LONG ISLAND CITY 1, NEW YORK

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Electronics puts real sting in modern ground defenses

Today's high-level, high-speed aerial attack imposes ever-increasing burdens on ground defenses. Only electronics can supply the split-second action now demanded for effective antiaircraft gunnery. During thirty-three years of collaboration with our Armed Forces, Arma has developed the matchless research and engineering skills required to design, improve and produce many of the complex instruments that keep our naval, military and aerial weapons abreast of constantly changing target problems.

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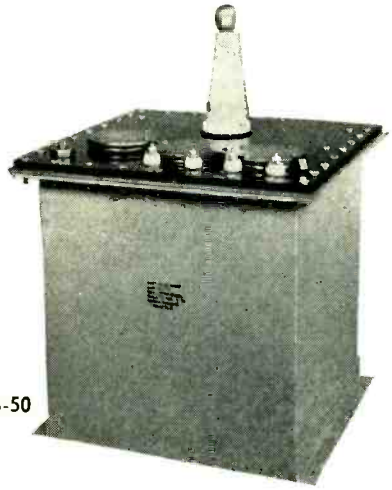
QUALITY ARMA INSTRUMENT PRECISION

HIVOLT POWER SUPPLIES—

deliver high voltage at low currents . . .


PS-50

HIVOLT POWER SUPPLIES are hermetically sealed, self-contained units. Their small size, ease of operation and flexibility are ideal for the operation of display tubes, radiation counters, photoflash devices, electrostatic precipitators, insulation testers, spectrographic analyzers and other equipment.

400 CYCLE POWER SUPPLIES

Power supplies using a primary source voltage with frequencies of 400 or more are also available or can be made to suit your requirements.

The following standard power supplies are designed for 60 cycle, 117 volt operation:

PS-50*—50 KV; 2 ma output; size of case: 12½" x 12½" x 12½" high

PS-30*—30 KV; 1 ma output; size of case: 7" x 7" x 8"

PS-15*—15 KV; 1 ma output; size of case: 3¾" x 4-9/16" x 9"

PS-10*—10 KV; 1.5 ma output; size of case: 3¾" x 4-9/16" x 8"

PS-5 —5 KV; 3 ma output; size of case: 3¾" x 4-9/16" x 6"

PS-2 —2 KV; 2 ma output; size of case: 3¾" x 3-3/16" x 5½"

* Can be used with a primary voltage control device for adjustment to output voltage values from 0 to rated voltage.

We invite your inquiries.

• • •

Our specialty is engineering capacitors to exacting requirements.

MANUFACTURERS
Glassmike Capacitors
Plasticon Capacitors
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Pulse Forming Networks

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Condenser Products Company

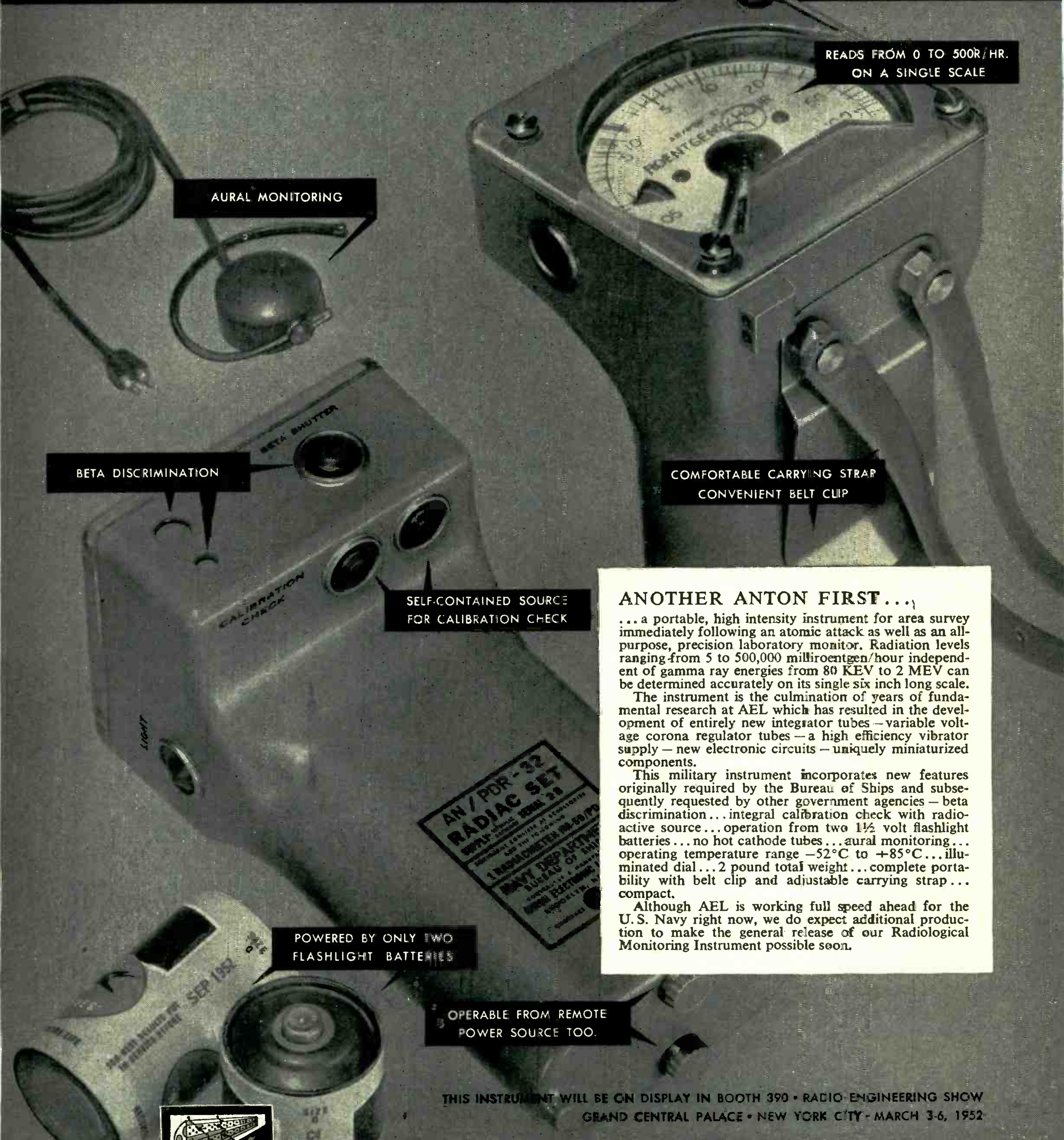
CP

7517 North Clark Street • Chicago 26, Illinois

The HIGH INTENSITY RADIOLOGICAL MONITORING INSTRUMENT

conceived and developed by

ANTON ELECTRONIC LABORATORIES for the U.S. NAVY



ANOTHER ANTON FIRST . . .

. . . a portable, high intensity instrument for area survey immediately following an atomic attack as well as an all-purpose, precision laboratory monitor. Radiation levels ranging from 5 to 500,000 milliroentgen/hour independent of gamma ray energies from 80 KEV to 2 MEV can be determined accurately on its single six inch long scale.

The instrument is the culmination of years of fundamental research at AEL which has resulted in the development of entirely new integrator tubes – variable voltage corona regulator tubes – a high efficiency vibrator supply – new electronic circuits – uniquely miniaturized components.

This military instrument incorporates new features originally required by the Bureau of Ships and subsequently requested by other government agencies – beta discrimination . . . integral calibration check with radioactive source . . . operation from two 1½ volt flashlight batteries . . . no hot cathode tubes . . . aural monitoring . . . operating temperature range –52°C to +85°C . . . illuminated dial . . . 2 pound total weight . . . complete portability with belt clip and adjustable carrying strap . . . compact.

Although AEL is working full speed ahead for the U. S. Navy right now, we do expect additional production to make the general release of our Radiological Monitoring Instrument possible soon.

THIS INSTRUMENT WILL BE ON DISPLAY IN BOOTH 390 • RADIO ENGINEERING SHOW
GRAND CENTRAL PALACE • NEW YORK CITY • MARCH 3-6, 1952

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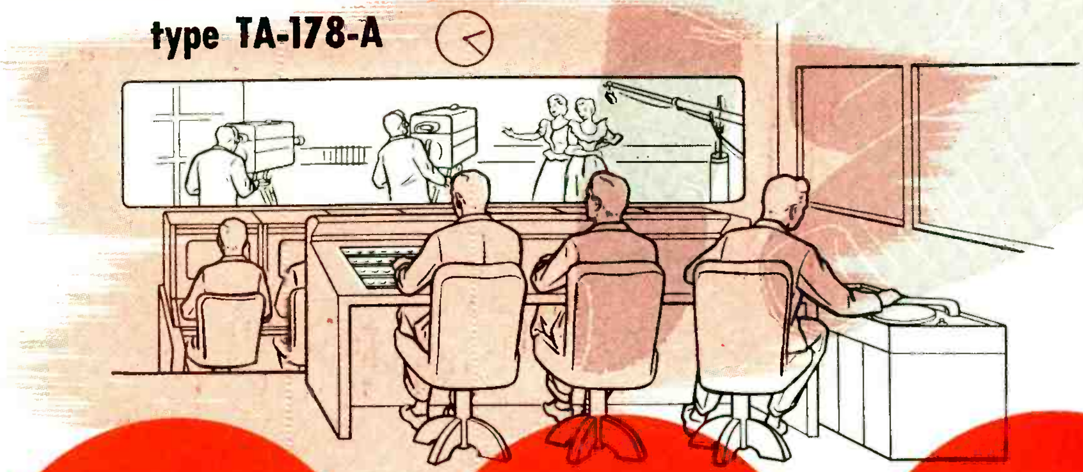
DUMONT

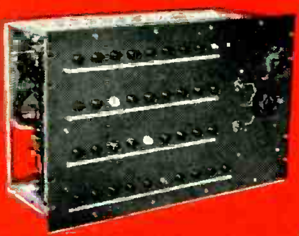
VIDEO SWITCHING

MIXING EQUIPMENT

type TA-178-A



MIXER LINE AMPLIFIER



NINE CHANNEL SWITCH UNIT

SIMPLIFIED FINGER-TIP CONTROL FOR VIDEO SWITCHING

Comprising the Nine-Channel Switch Unit (5262-A), Mixer Line Amplifier (5263-A) and Low Voltage supply (5019-A).

Variety of special effects, achieved quite simply with the provisions in the Mixer Amplifier, can be previewed before being put on the air. Single Mixer Control at Switching unit permits smooth transition from one channel to another. Again, another control at Switch Unit determines bus cutoff voltage cross-over point, so that any degree of fading, lapping or superimposing of two signals an be accomplished. Provision is made available in the Mixer Amplifier for insertion of special blanking to create special effects such as wipes, montages, etc.

While main line is feeding transmitter, the mixer amplifier output can be used to feed, simultaneously, a different mixed studio show to an audition circuit. The Mixer Amplifier has three identical program outputs which may be fed to transmitter, network cable and master line monitor.

First with the Finest in Television

TELEVISION TRANSMITTER DIVISION

ALLEN B. DU MONT LABORATORIES, INC.

1500 Main Avenue, Clifton, N. J.

FEATURES

Switch Unit available for mounting in standard 19" relay rack or in console. Mixer Line Amplifier and its power supply are rack-mounted.

All channels take either local or remote signals.

Lap, fade or super are achieved with single control. Facilities for inserting special blanking (horizontal wipes, montages, etc.). Preview for special effects.

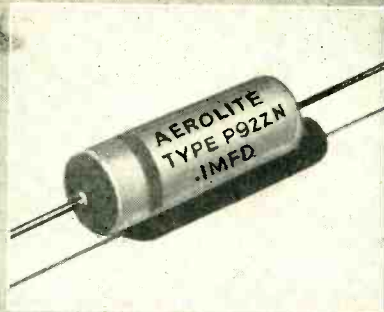
Sync insertion on local signals, controlled by pushbuttons. No switching transients on main-line switching. Automatic pedestal setup incorporated in mixer amplifier.

Frequency response of preview monitor No. 1 amplifier, mixer amplifier and main-line amplifier flat within 0.5 db to 8 MC: less than 6 db down at 10 MC. Preview Monitor No. 2 amplifier flat with in 0.5 db to 6 MC: less than 6 db down at 8 MC.

Lucite pushbuttons lighted internally when button is pressed.

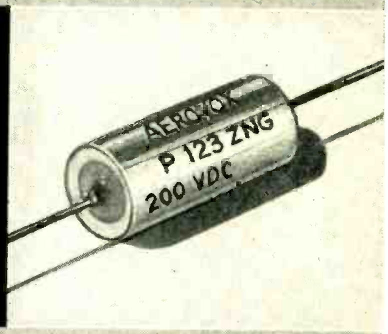
FURTHER DETAILS and QUOTATIONS ON REQUEST

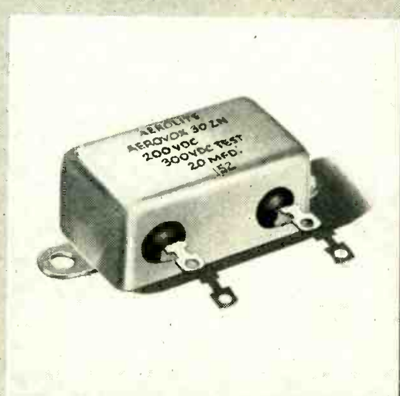
high-temperature metallized-paper capacitors



Series P92ZN Aerolene-impregnated metallized-paper capacitors are modified plastic-tubular duranite-end-sealed units in paper cases. Operating temperatures of −30°C. to +100°C. 200, 400 and 600 V. D. C. 0.01 to 2.0 mfd.

Series P123ZNG Aerolene-impregnated metallized-paper capacitors housed in tubular metal cases with vitrified ceramic terminal seal. Operating temperature range of −55°C. to +100°C. at full rating: to +125°C. at 75% of voltage rating. 200, 400 and 600 V.D.C. .0005 to 2.0 mfd.

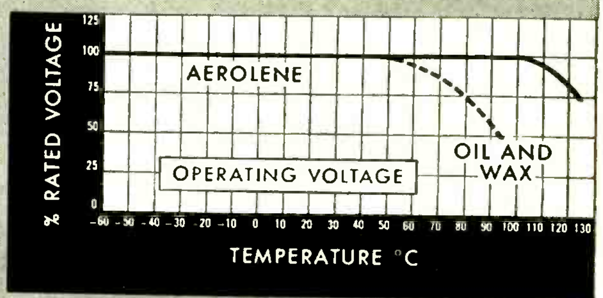




Series P30ZN Aerolene-impregnated metallized-paper capacitors housed in "bathtub" metal cases with vitrified or glass terminal seals. Operating temperature range of −55°C. to +100°C. at full rating; to +125°C. at 75% of voltage rating. Capacitances available from 0.1 mfd. up to 15.0 mfd. at 150 V. D.C., and up to 3.0 mfd. at 600 V. D.C.

Once again, Aerovox is privileged to blaze the capacitor-development trail. For these high-temperature metallized-paper capacitors are definitely Aerovox "firsts" in *conception, production* and *application.*

Their truly phenomenal acceptance is due to (1) The *Space Factor,* especially when *miniaturization* is a prime consideration; (2) *Reliability,* particularly in meeting voltage peaks or surges, by taking advantage of their self-healing characteristics; and (3) *Wide Operating Range,* from sub-zero to elevated temperatures.



Let us quote on your metallized-paper capacitor needs. Or if you are not already familiar with metallized-paper advantages, our engineers will gladly show you how they can fit your functions and circuits.

AEROVOX capacitors

THE HOME OF CAPACITOR CRAFTSMANSHIP

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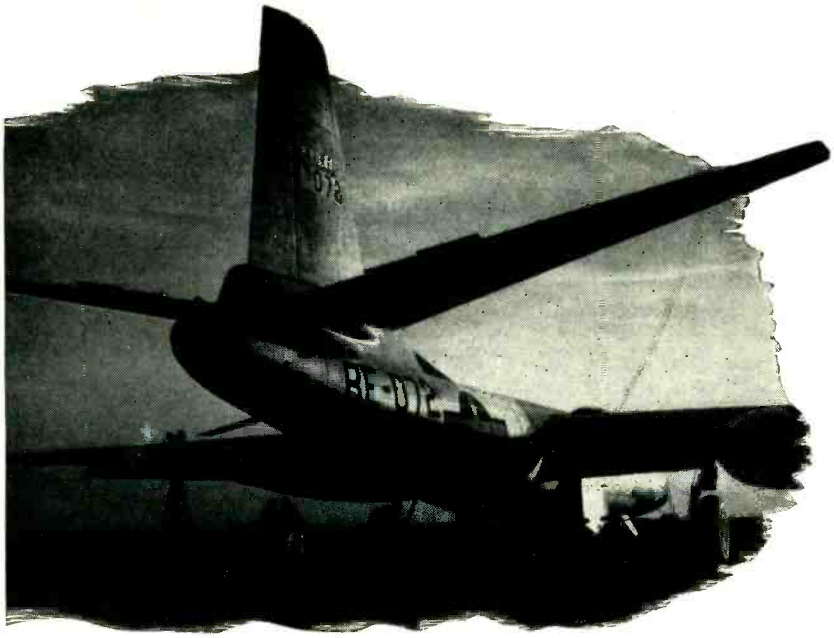


Ears to hear voices. Ears with which to "see" and even identify a plane as friend or foe many miles away. Ears for a "homing" device that tells a pilot how far he is from his base.

The ears are antennae. Some planes have 39 to pick up and transmit signals for a dozen different purposes. Some even more.

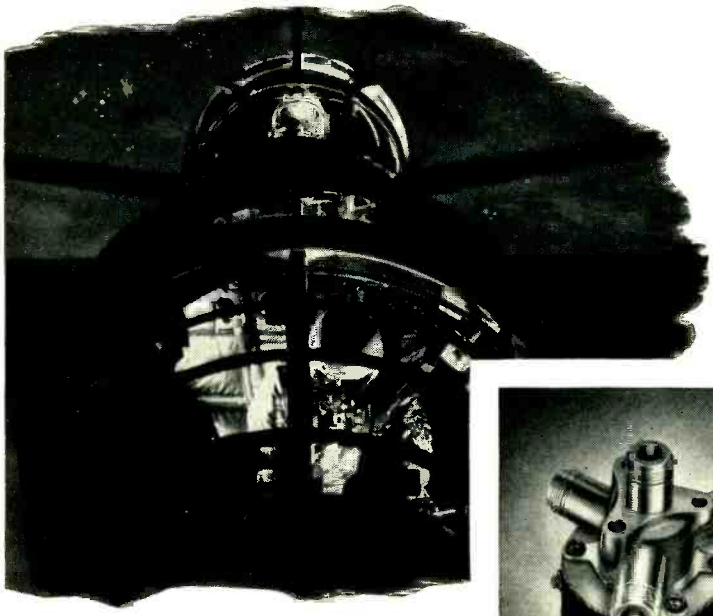
All depend on electronics. Thompson Products, long a leader in transportation progress, entered this field in the '40s by developing an electronic control for jet engines. Now Thompson is knee-deep in electronics, builds such things as coaxial switches and antennae.

The plane with 39 ears...

The Thompson coaxial switch directs electrical currents, without leakage, at the touch of a finger. The only alternative is making slow, hazardous manual connections.

This amazing switch promises new improvements in radio, television, telephone —wherever high frequency current is used.

In the field of electronics as well as automotive and aircraft parts, you can count on Thompson Products, Inc., Electronics Division, 2196 Clarkwood Road, Cleveland 3, Ohio.



This coaxial switch is a high frequency electronics device, product of the *Thompson Products Electronics Division.* Thompson perfected the means of combining two different plastics and several alloys in a mechanism that would operate only if made to extremely close tolerances.

You can count on **Thompson Products**

for Radio Relay Performance

AT ITS BEST—IT'S

PTM MICROWAVE by *Federal*

"FIRST Commercial Radio Relay System in North America"

PTM Provides INDUSTRY with complete, private, high-reliability, weatherproof communications—over any terrain—without costly line construction and maintenance

Federal PTM Microwave offers the most stable basic channels for pipe lines, power utilities, railroads, telephone companies, broadcasting, aviation and others

PROVED performance in all large and small industrial applications! That's why industry can rely on Federal Pulse-Time Modulation Microwave . . . the modern system developed by the world-wide International Telephone and Telegraph Corporation, pioneer in microwave techniques. Tens of thousands of channel-miles of PTM have been installed in 15 countries by IT&T associates.

Federal PTM—providing *all* facilities *simultaneously*—meets *all* communication requirements . . . over long distances and with remarkable reliability, using equipment of highest RF output and simplest design. For details on microwave at its best, write to Wire and Radio Transmission Systems Division, Dept. D-713.

HIGH POINTS of PTM PERFORMANCE

- Unaffected by fog, rain, snow, ice, static or magnetic storm.
- High signal-to-noise ratio.
- Outstanding for high quality of voice and other transmission.
- No inter-channel crosstalk due to non-linearity of common elements.
- Energy beamed by non-critical, directive parabolic reflectors.
- High power allows large fading margin.
- 99.22% reliability achieved without RF stand-by.

"Federal Microwave—The System Backed by 20 Years of Experience"

Federal Telephone and Radio Corporation

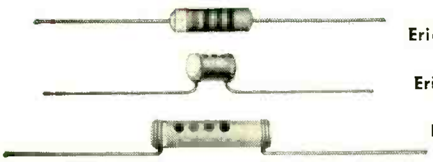
100 KINGSLAND ROAD CLIFTON, NEW JERSEY

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N.Y.

ERIE RESISTOR COMPONENTS

For Easy Assembly — Dependable Performance

ERIE TUBULAR CERAMICONS*



Erie "GP"* Molded Insulated Ceramicons
5 MMF—5,000 MMF

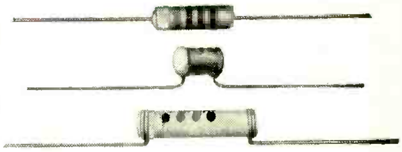
Erie "GP" Dipped Insulated Ceramicons
5 MMF—5,000 MMF

Erie "GP" Non-Insulated Ceramicons
5 MMF—5,000 MMF

Temperature Compensating
Molded Insulated Ceramicons
0.5 MMF—550 MMF

Temperature Compensating
Dipped Insulated Ceramicons
0.5 MMF—1,800 MMF

Temperature Compensating
Non-Insulated Ceramicons
0.5 MMF—1,800 MMF



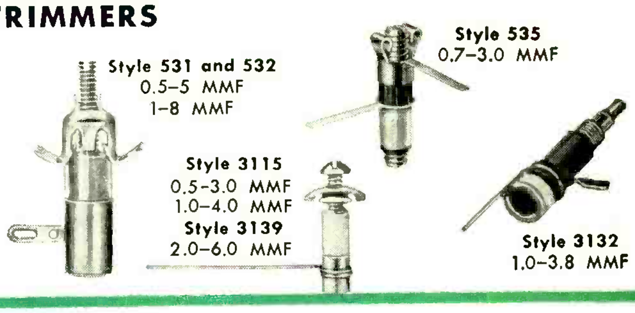
ERIE CERAMICON TRIMMERS

Style 557 — Style 3130

1.5–7 MMF	5–30 MMF
3–12 MMF	8–50 MMF
5–25 MMF	65–95 MMF
	150–190 MMF

Style TS2A

1.5–7 MMF	5–20 MMF
3–12 MMF	4–30 MMF
3–13 MMF	7–45 MMF



Style 531 and 532
0.5–5 MMF
1–8 MMF

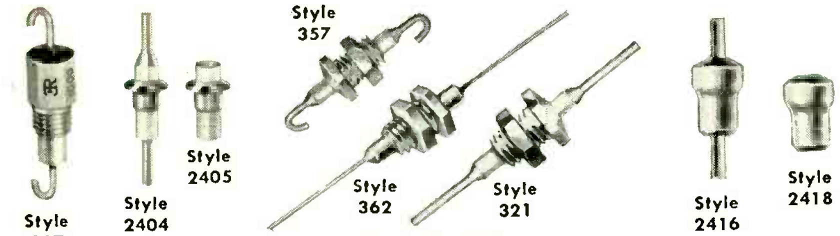
Style 3115
0.5–3.0 MMF
1.0–4.0 MMF

Style 3139
2.0–6.0 MMF

Style 535
0.7–3.0 MMF

Style 3132
1.0–3.8 MMF

ERIE FEED-THRU CERAMICONS

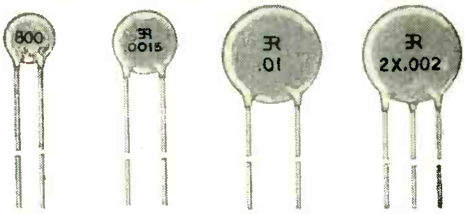


Style 327 — Style 2404 — Style 2405 — Style 357 — Style 362 — Style 321 — Style 2416 — Style 2418

5 MMF—1,000 MMF
5 MMF—1,500 MMF

ERIE DISC CERAMICONS

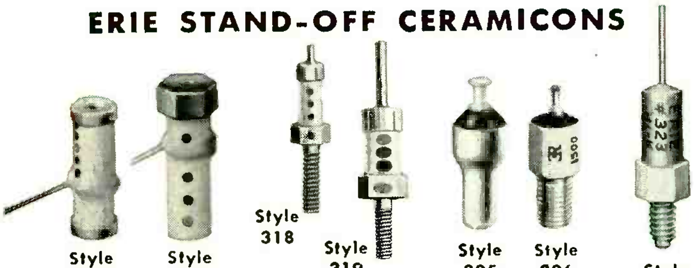
Temperature Compensating and By-Passing



Style 831 — Style 801 — Style 811 — Style 812

Up to .01 MFD

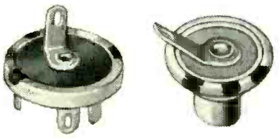
ERIE STAND-OFF CERAMICONS



Style 2322 — Style 2336 — Style 318 — Style 319 — Style 325 — Style 326 — Style 323 and 324

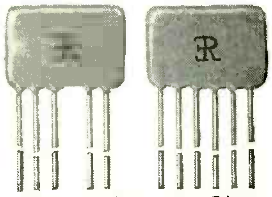
5 MMF—5,000 MMF

ERIE BUTTON MICA CONDENSERS



15 MMF—6,000 MMF

ERIE PRINTED CIRCUITS



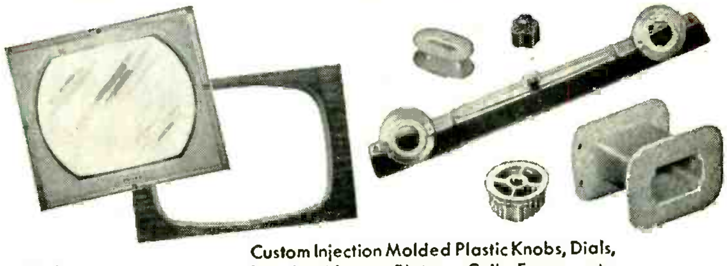
Standard, Integrator, Filter, and Coupling Circuits

ERIE HIGH VOLTAGE CERAMICONS

Style 412 — Style 414

10 and 20 KV.—500 MMF

ERIE CUSTOM MOLDED PLASTICS



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*Ceramicon, Hi-K, GP, and Plexicon are registered trade names of Erie Resistor Corporation.

Electronics Division

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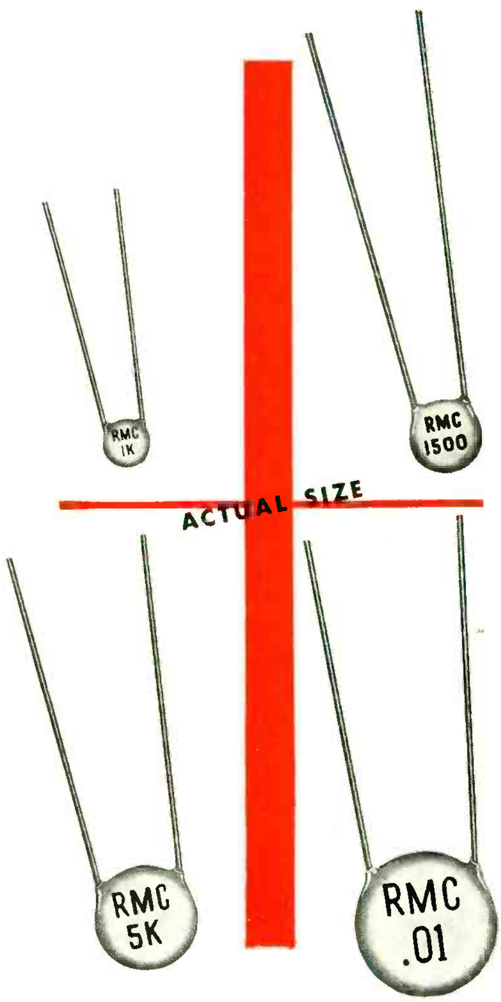
RMC "HEAVY DUTY" By-Pass DISCAPS



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

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

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

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A New Development from the RMC Technical Ceramic Laboratories

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CERAMIC
CONDENSERS

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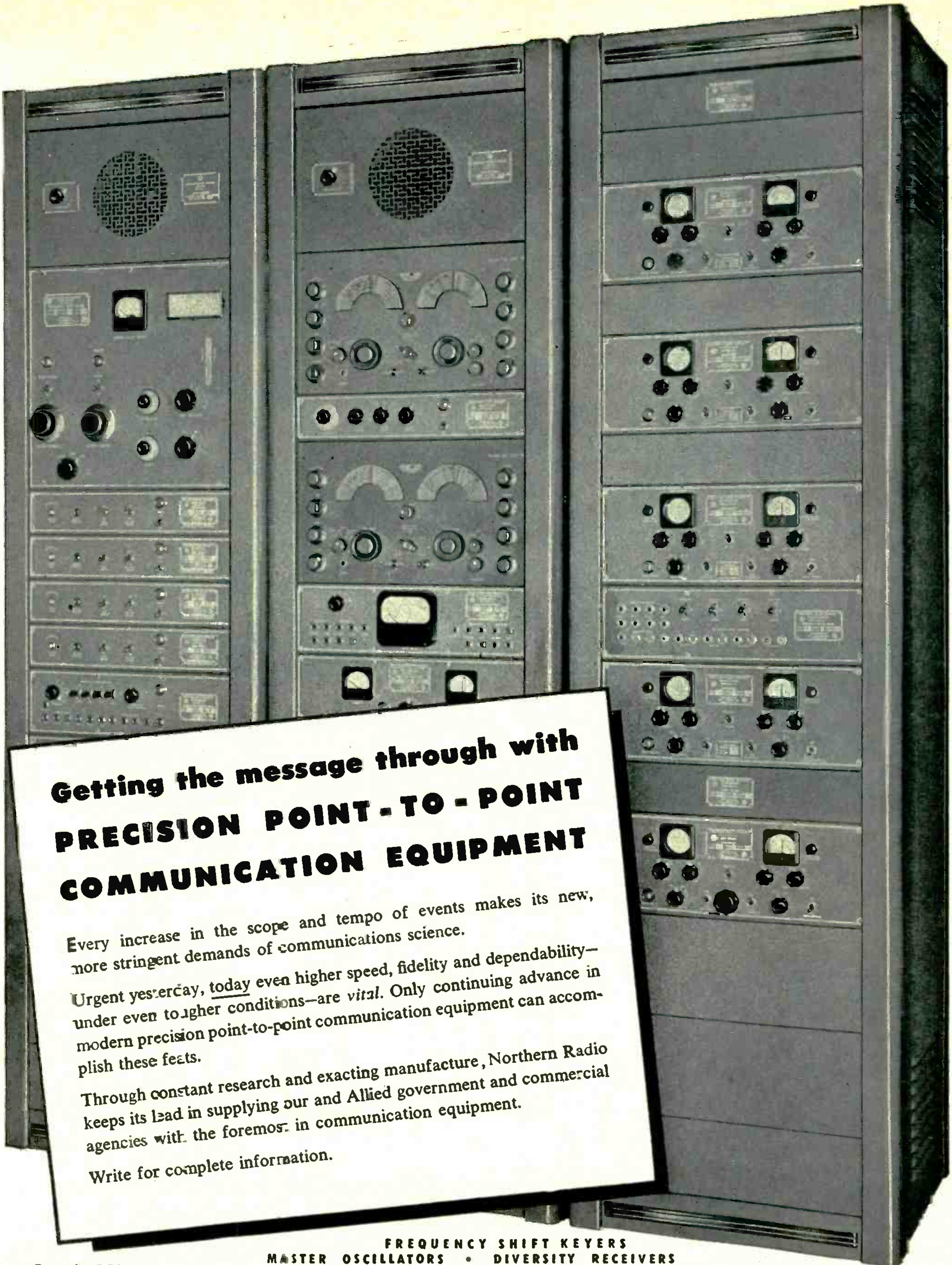
Two RMC Plants Devoted Exclusively to Ceramic Condensers



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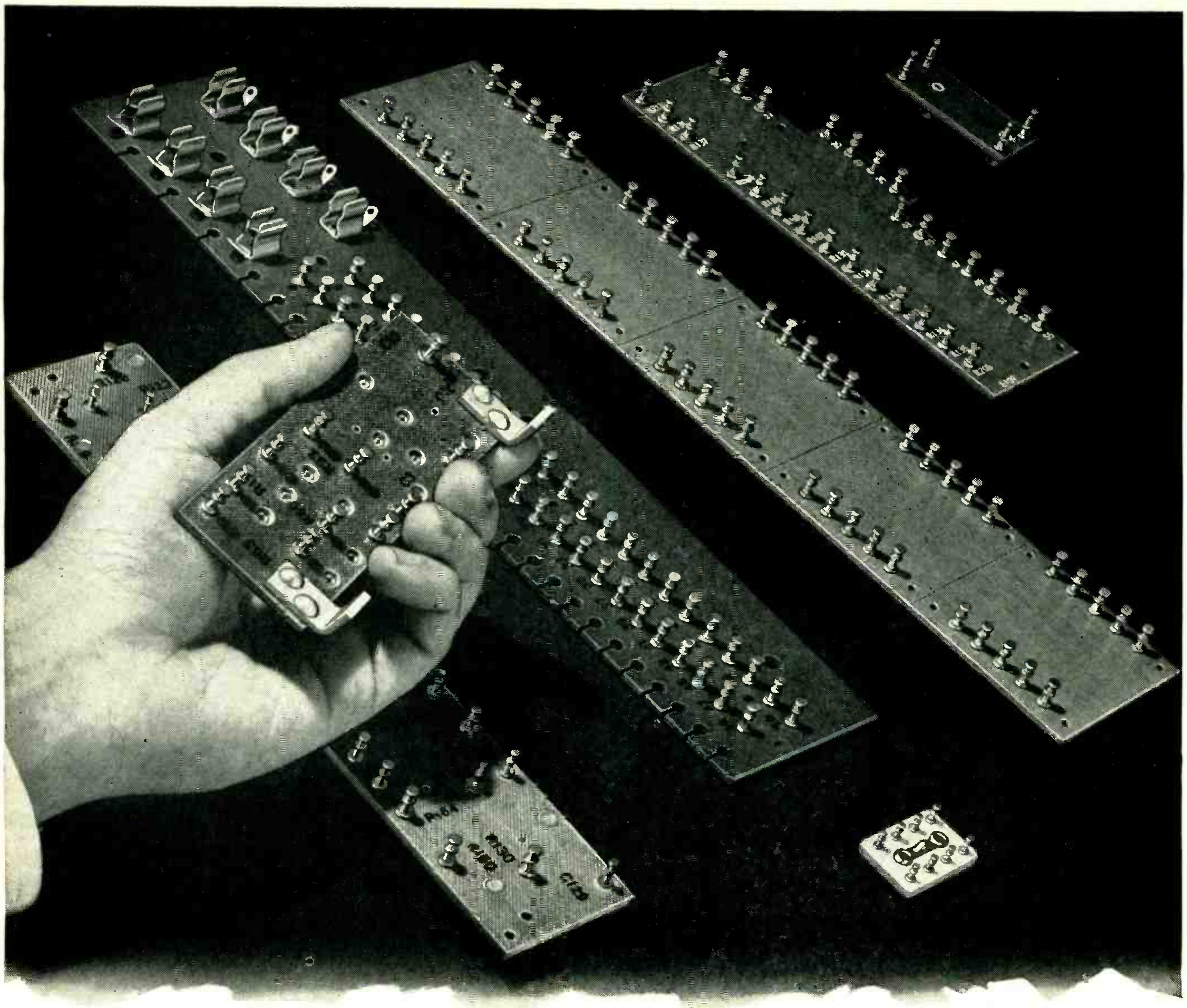

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The rigid specifications of government agencies and the armed forces need pose no problem to you. C.T.C. is in an excellent position to handle government sub-contracts for electronic parts and assemblies.

Our Custom Engineering Service is constantly supplying special terminal boards to the top names in electronics. These boards are built to severe government specifications, are fabricated of certified materials to fit the job. Among the specifications involved are: MIL-P-3115A, MIL-P-15037, MIL-P-15035A, MIL-P-15047, MIL-P-997A.

Boards can be made of cloth, paper, nylon or glass laminates (phenolic, melamine or silicone resin), and can be lacquered or varnished to specifications: JAN-C-173 and JAN-T-152. Lettering and numbering is done by rubber stamping, silk screening, hot stamping, engraving. Inks used in rubber stamping contain anti-fungus and fluorescent additives.

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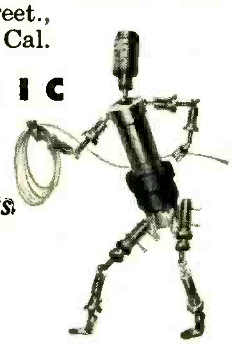

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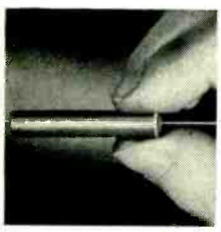
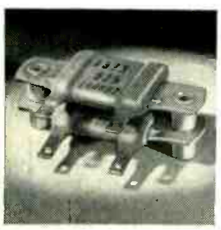
*The green-colored power resistors so conspicuous these days in dependable radio-electronic and electrical assemblies, are GREENOHMS. *No tougher resistors made.* That statement is sustained by laboratory tests. Likewise by countless case histories out in the field.

Unimpaired wire winding firmly imbedded in exclusive cold-setting inorganic cement. Exceptional heat conduction and surface radiation. Heavy overloads handled without damage. Severe heat-shock resistance permits extreme on-off operation without flinching. And Greenohms last and last.

Choice of standard types. Also in virtually unlimited special types. Wide selection of resistance values, wattages, taps, terminals, mountings. And remember, *Greenohms cost less* though they offer you more!



Greenohm Jr. — point-to-point wired power resistor sealed in ceramic tubular casing. 4, 7 and 8 watt.



Flat Greenohms for flat mounting individually, or for stacked arrays. 30 to 75 watt.

In the bantam-weight division — 5 and 10 watt fixed Greenohms.

Standees — convenient above-chassis mounting Greenohms in ceramic casings. 10 to 25 watt.

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RETIRED...

* One Eimac 3X2500A3 . . . after 11,000 hours of FM broadcast service on 94.9 Mc

Before Eimac tubes are put out to pasture, they earn their retirement. Here's a typical story:

GEORGE D. TATE
Chief Engineer
WMRC

TEXTILE BROADCASTING COMPANY
Radio WMRC Station
GREENVILLE, S. C.

Eitel-McCullough, Inc.
San Bruno, California

Dear Sirs:

Thought you may be interested to know that we have just retired one of your 3X2500A3 tubes with a little over 11,000 hours of use.

This tube was used in our FM Station which operates on 94.9 Mc. with an ERP of 79,000 watts; this means an input of 10,5000 watts which in my opinion is pushing any pair of tubes for FM service.

This tube had to operate at a plate current of 1.35 amps. at 3900 volts.

We are highly pleased with this tube.

Very truly yours,

Radio Station WMRC-WMRC-FM

George D. Tate
Chief Engineer

FOLLOW THE LEADERS TO
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THE POWER FOR R-F

* For complete technical data on the 3X2500A3 or 3X2500F3 triodes...or any other Eimac tube, write:

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Unique SPEED NUT Stars on Bendix Television

Product of Bendix Aviation Corporation

How multiple-function SPEED NUT made 40% savings in the assembly of TV transformer

Like the juggling stars on television, this new fastener does several jobs at one time . . . and provides several important cost-savings advantages.

Bendix Television engineers discovered this in their search for a better, simpler way of assembling high voltage transformers. Selected because it was engineered to do this specific job, this unusual Tinnerman fastener: *(1) replaced 4 parts, thereby reducing parts handling; (2) cut material costs 50%; (3) provided a 40% savings in cost of assembling transformer.*

It is through improvements and economies like this that Bendix Television, Baltimore, Md., is able to supply top quality "Front-Row" television receivers for thousands of American homes. You, too, can step up product quality and make production dollars go farther with SPEED NUTS. Your Tinnerman representative can show you how. Call him soon—and write for your edition of "Savings Stories"—actual case histories of leading manufacturers. TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio. In Canada: Dominion Fasteners Ltd., Hamilton. In Great Britain: Simmonds Aerocessories, Ltd., Treforest, Wales.

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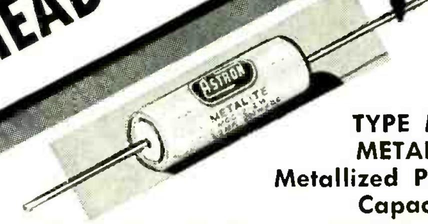

TYPE MQC METALITE* Metallized Paper Capacitors

Type MQC Metalite* Capacitors are encased in tinned, non-ferrous cases with glass-to-metal hermetic terminal seals. They are *ultra-compact*, self-healing—and are ideally suited for military and aircraft applications since they meet the highest exacting requirements for rigorous service. Positively sealed against moisture with glass-to-metal terminal at one end, or both ends (Type MQCF) at slight extra cost. Can be furnished with plastic insulating sleeve when required. Mineral wax impregnated—Type MQM available with mineral oil impregnation. Standard tolerance: −15 + 25%.

Catalog Number	CAP. MF.	Size Diam.		Length	Net Price
200 Volts DC Working					
MQC-2-01	.01	.235	x	¾	$1.20
MQC-2-02	.02	.235	x	¾	1.24
MQC-2-05	.05	.235	x	¾	1.24
MQC-2-1	.1	.312	x	¾	1.27
MQC-2-25	.25	.400	x	¾	1.39
MQC-2-5	.5	.400	x	1-1/16	1.42
MQC-2-1M	1.0	.562	x	1¼	1.56
MQC-2-1.5M	1.5	.562	x	1¾	1.63
MQC-2-2M	2.0	.670	x	1¾	2.33
400 Volts DC Working					
MQC-4-01	.01	.235	x	¾	1.20
MQC-4-02	.02	.235	x	¾	1.24
MQC-4-05	.05	.312	x	1-1/16	1.29
MQC-4-1	.1	.400	x	1-1/16	1.33
MQC-4-25	.25	.562	x	1-1/16	1.45
MQC-4-5	.5	.562	x	1¾	1.62
MQC-4-1M	1.0	.670	x	2¼	1.80
MQC-4-2M	2.0	1	x	2¼	2.74
600 Volts DC Working					
MQC-6-01	.01	.235	x	¾	1.27
MQC-6-05	.05	.312	x	1-1/16	1.33
MQC-6-1	.1	.400	x	1-1/16	1.36
MQC-6-25	.25	.562	x	1¼	1.59
MQC-6-5	.5	.670	x	1¾	1.77
MQC-6-1M	1.0	.750	x	2¼	2.15
MQC-6-2M	2.0	1	x	2¼	3.03

EXTRA DISCOUNTS AVAILABLE TO QUANTITY USERS

* Trade Mark

TYPE ML METALITE*

Cardboard tubulars, vacuum impregnated in a microcrystalline hydrocarbon wax, suitable for service at temperatures up to 65° C. WVDC 200 to 600; capacities .01 to 2.0 mf. Double mineral wax coating for superior moisture-resistance. Soldered metal end-caps assure greater mechanical strength.

TYPE AQ Subminiature Paper Capacitors
For 125° C Operation

Fulfills the demand for extremely reliable subminiature capacitors for operation at ambient temperatures from—65° up to and including 125° C *without derating*. Provides capacitance stability, high insulation resistance, low power factor, high test voltage. Supplied only in extended foil, non-inductive type construction. Glass-to-metal seal terminals. Meets all the stringent and exacting Armed Forces requirements. WVDC from 100 to 600, capacities from .0047 to 1.0 mf, depending on voltages. Sizes range from .235x 11/16" to .750x 2 1/16" in a variety of hermetically sealed metal tubular case and construction styles.

ASTRON ENGINEERING DATA BOOK AVAILABLE

Arrow will be glad to supply an exceptionally well prepared engineering data book and complete listing of all standard ASTRON Capacitors and Filters for Electronic Applications. Vital information on standard types, as well as details on special capacitors for your specific requirements, is contained. Request Astron Book EC on your firm letterhead, and it will be forwarded at once, gratis.

ASTRON Electrolytics for TV & Radio

Popular acceptance of ASTRON Type EY Twist Prong Dry Electrolytics has been proven by its ever increasing use by leading TV and radio manufacturers.

ASTRON Minimite (Type MM) Tubular Dry Electrolytics are compact, high quality capacitors ideal for use where long life and limited space are essential factors.

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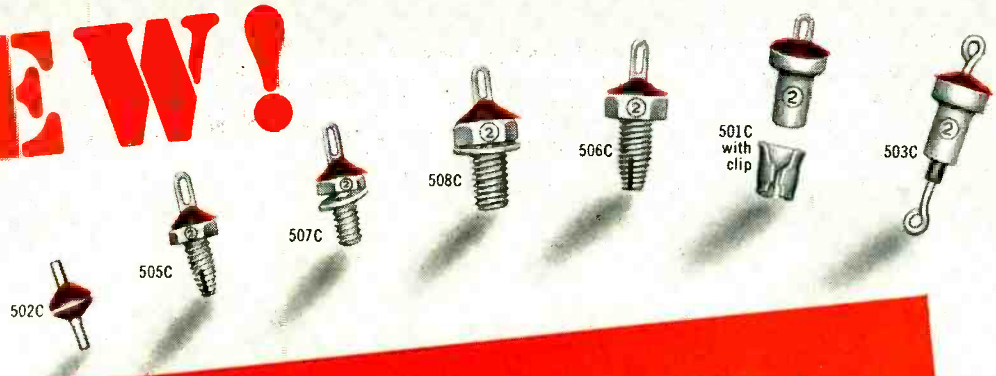


BUTTON CERAMIC CAPACITORS

...FOR TV AND U-H-F DESIGN

Design of electronic equipment and TV receivers for the higher frequencies is simplified by a new series of button ceramic capacitors developed by Sprague. A completely new construction using a disc capacitor element instead of the conventional dielectric tube results in higher self-resonant frequencies and improved circuit efficiency.

For bypass applications, Types 505C, 506C, 507C, and 508C are unique. The dielectric button is housed in a recess in the top of a hex-head machine screw and is sealed against moisture by a plastic resin. This shielded construction minimizes ground inductance and keeps it at a fixed value while providing a short bypass path to ground, which is radially uniform over the capacitor element. The lug terminals are essentially at tube socket terminal height to help maintain short, uniform lead lengths.

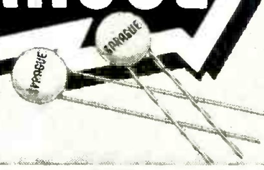
Type 501C is a ferrule shank bypass capacitor for push-clip mounting in TV receivers while type 503C is its feed-thru counterpart. The disc capacitor element is resin-sealed in a recess in the top of the metal shell.

Type 502C "shirt-stud" capacitors are ¼" diameter buttons intended for coupling in u-h-f TV set front ends.

All units are rated at 500 volts d-c and are available in both characteristic SL and GA general application bodies.

Engineering Bulletin 605 gives complete details on these new and different capacitors. Request it today on your company letterhead from Sprague Electric Company, North Adams, Mass.

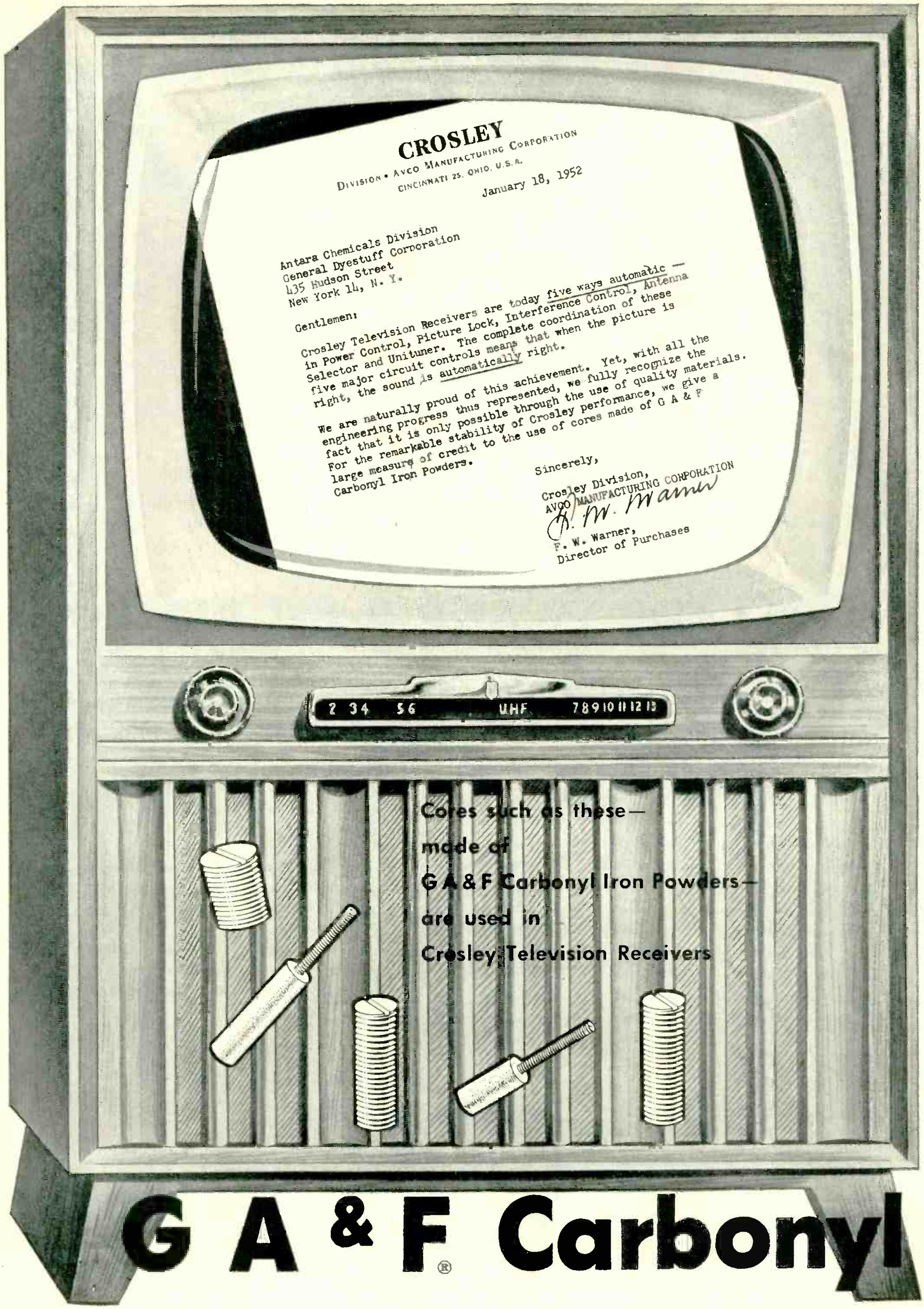
PIONEERS IN ELECTRIC **SPRAGUE** AND ELECTRONIC DEVELOPMENT



NEW HIGH-VOLTAGE CERAMIC DISCS

Sprague Cera-mite Capacitors are now available in 1000 and 1500 volt ratings as well as in the usual 500 volt ratings. Write on letterhead for Bulletin 601C.

See Us at the I.R.E. Show—Booths 27-28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January 18, 1952
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We are naturally proud of this achievement. Yet, with all the engineering progress thus represented, we fully recognize the fact that it is only possible through the use of quality materials. For the remarkable stability of Crosley performance, we give a large measure of credit to the use of cores made of G A & F Carbonyl Iron Powders.
Sincerely,
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AVCO MANUFACTURING CORPORATION
F. W. Warner,
Director of Purchases
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Cores such as these—
made of
G A & F Carbonyl Iron Powders—
are used in
Crosley Television Receivers
G A & F® Carbonyl

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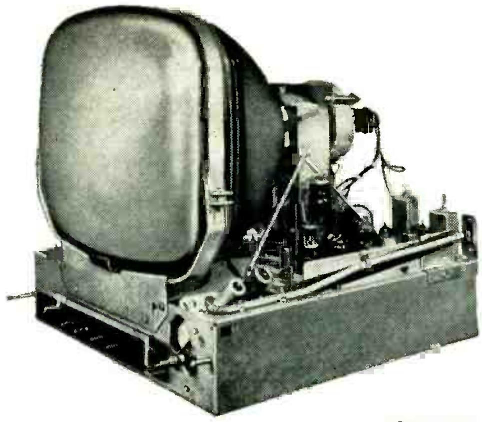


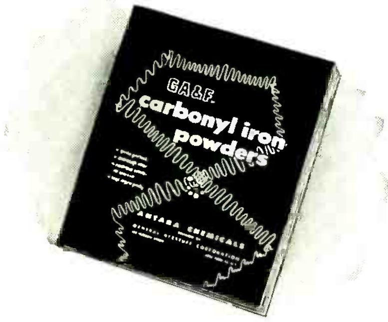
CROSLEY *Automatic* TELEVISION

there are *Quality-Engineered Components*

Superior performance in a television receiver bespeaks a measure of quality that carries through to the last detail. In Crosley Automatic Television this means a combination of the finest engineering with materials and component parts that are likewise quality-engineered. The high-frequency, permeability-tuned circuits use cores made from G A & F Carbonyl Iron Powders. Stability of performance—under all conditions of temperature, humidity and magnetic shock—is one of the major results.

Crosley Television Receivers and G A & F Carbonyl Iron Powders are both made under the most exacting standards of Quality Control—to insure characteristics and uniformity on which the user can always rely. . . . We urge you to ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can increase the efficiency and performance of the equipment you make, while reducing both the cost and the weight. Let us send you the book described below.

THIS WHOLLY NEW 32-PAGE BOOK *offers you the most comprehensive treatment yet given to the characteristics and applications of G A & F Carbonyl Iron Powders. 80% of the story is told with photomicrographs, diagrams, performance charts and tables. For your copy —without obligation—kindly address Department 17.*



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MEMBER mpa METAL POWDER ASSOCIATION

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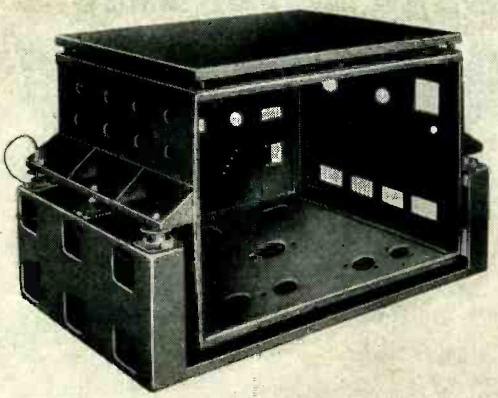
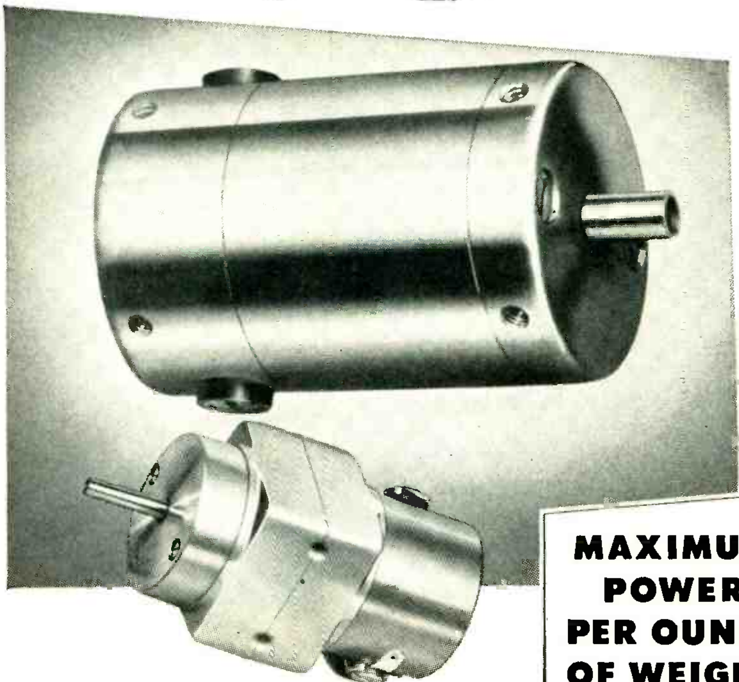


Precision Built

MOTORS *and* DYNAMOTORS



EICOR D. C. MOTORS have been developed to a high degree of efficiency. They are remarkably light in weight for power output — thoroughly reliable — and are used to actuate instruments, turrets, fire control and other critical equipment. From design to production, every detail of construction is a series of precise operations. This specialized skill is reflected in quiet, vibrationless, long-lived performance. It also means better motors at lower cost in the widest range of types and sizes.

MAXIMUM POWER PER OUNCE OF WEIGHT

EICOR DYNAMOTORS furnish the necessary high voltage power for communications,* direction finding, radio compass and other controls. Engineered and built by specialists, they have earned their fine reputation through years of exacting service in aircraft. That's why Eicor Dynamotors are so frequently specified for critical applications.

Eicor produces a Dynamotor for *every* need — from the smallest in size to the largest in output. Our complete line of frames makes possible the widest available range of dynamotor output ratings, in the most compact sizes and weights.

MOTORS AND DYNAMOTORS *Specially Designed* For INDIVIDUAL APPLICATIONS

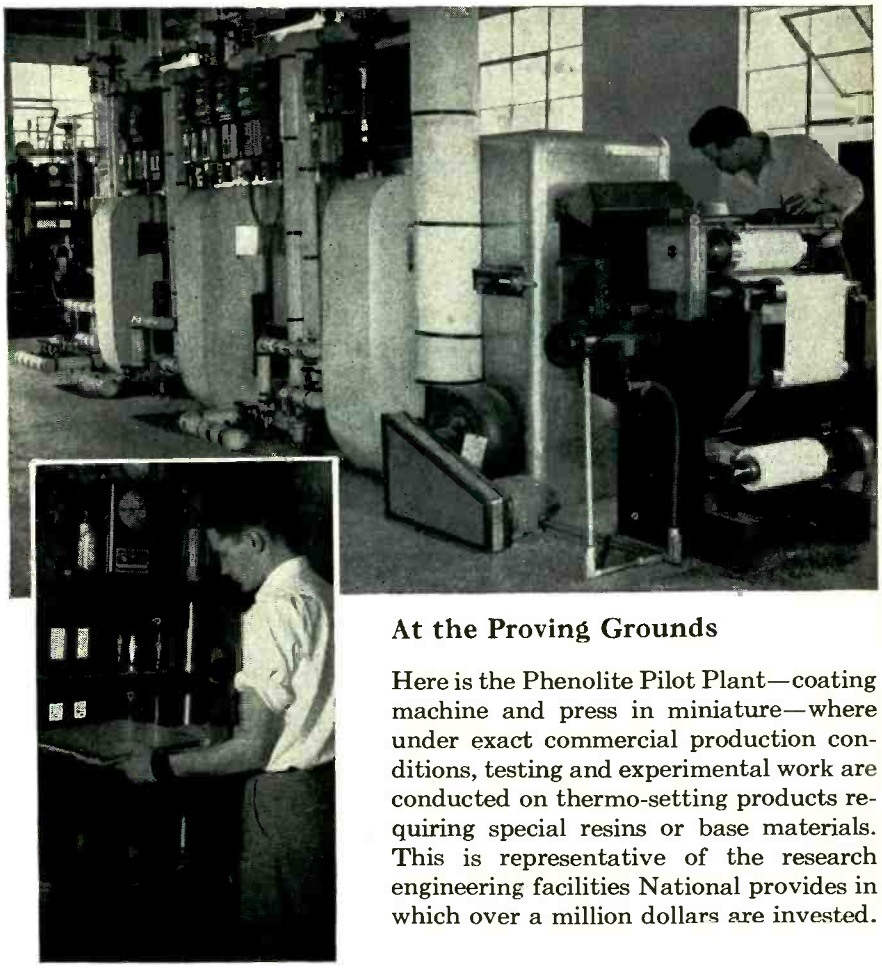
Eicor, Inc. 1501 W. Congress St., Chicago 7, Illinois

DYNAMOTORS · INVERTERS · ELECTRONIC CONTROLS · ALTERNATORS · MOTORS

Men who design, engineer and buy America's products rely on..and use..National Laminated Plastics because..

"At National, engineering research is of prime importance. We believe only through it and by large investment in it are we able to: *first*, provide industry with dependable laminated plastics for the efficient production of today's products which were developed yesterday; *second*, give practical assistance to the design engineer who is creating today, new, better products for tomorrow."

J. Warren Marshall, **President**
National Vulcanized Fibre Co.



At the Proving Grounds

Here is the Phenolite Pilot Plant—coating machine and press in miniature—where under exact commercial production conditions, testing and experimental work are conducted on thermo-setting products requiring special resins or base materials. This is representative of the research engineering facilities National provides in which over a million dollars are invested.

Stiegler's Fungus House

Frederick L. Stiegler directed the pioneering research that came up with a fungus-resistant vulcanized fibre, satisfactory for extended exposure to moist, warm air. This new grade of National Vulcanized Fibre has important use in refrigerators and products that must perform in fungus-generating climates.

National Laminated Plastics nationally known — nationally accepted

NATIONAL VULCANIZED FIBRE

A tough horn-like material with high dielectric and mechanical strength. Excellent machinability and forming qualities, great resistance to wear and abrasion, long life, lightweight. Sheets, Rods, Tubes, Special Shapes.

PHENOLITE Laminated PLASTIC

Phenolite possesses an unusual combination of properties—a good electrical insulator, great mechanical strength, high resistance to moisture; ready machinability, lightweight. Sheets, Rods, Tubes, Special Shapes.

Just published! National Laminated Plastics Handbook. Write for copy. Your company letterhead please.

National Vulcanized Fibre Co.

Wilmington Delaware
Offices in Principal Cities

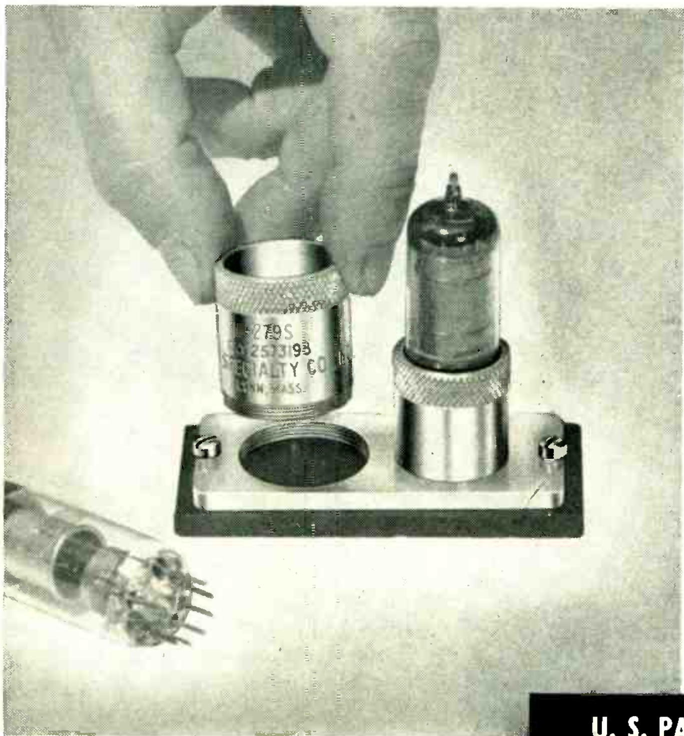
Since 1873

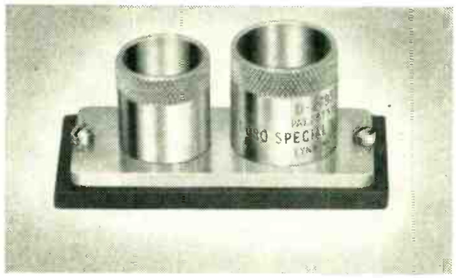
MINIATURE ELECTRON TUBE

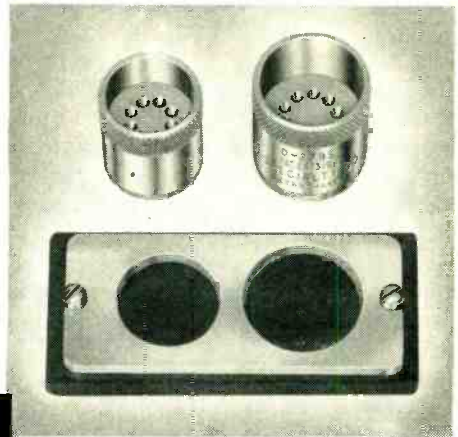
DURO Pin Straightening Tools

TYPE NO. D-279 S

Dual Unit for Straightening 7-Pin and 9-Pin Tubes — For use in Test Equipment, Radio and Radar.







U. S. PATENT NO. 2573198

(ILLUSTRATED ABOVE)

D-279 S ASSEMBLED, illustrating compact design and simple 2-screw mounting.

D-279 S DISASSEMBLED, showing 7-pin and 9-pin straightening dies in removable guides.

A quality pin straightening tool of precision accuracy. Ruggedly constructed with stainless steel straightening dies fitted into removable, knurled and threaded aluminum guides. Rectangular aluminum base plate. New design prevents jamming — broken pins easily removed without disturbing base plate mounting. Tested and approved by U. S. Army Signal Corps for use by the Armed Services. Now finished per U. S. Army Specification 72-53, if desired. Individual 7-pin and 9-pin units also available. Prompt delivery on defense orders.

Write for quantity price list and further information.

TYPE NO. D-200

Precision, double-ended hand tool with knurled aluminum handle and stainless steel 7-pin and 9-pin straightening dies. Designed for positive ejection of broken pins. Approved for use by the Armed Services.

DURO SPECIALTY COMPANY, Inc.

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COSMALITE*
LAMINATED PHENOLIC TUBING.
THESE Ten Grades of Laminated Phenolic Tubing are being used in the Electronic and Electrical industries with astonishing success!
Note how varied are their properties . . . how endless in variety are the diameters, lengths, and wall thicknesses in which this tubing is produced by us.
A GRADE FOR EVERY NEED!
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Grade E.....Improved post cure fabrication and stapling.
Grade EX....Special grade for TV deflection yoke sleeve.
Grade EE....Improved general purpose.
Grade EEX...Superior electrical and moisture absorption properties.
Grade EEE...Critical electrical and high voltage applications.
Grade XAX..Special grade for government phenolic specifications.
COSMALITE
Grade SP....Post cure fabrication and stapling.
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Tell us your needs. We are known for our dependable service and prompt deliveries.
The CLEVELAND CONTAINER Co.
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PLANTS AND SALES OFFICES at Plymouth, Wisc., Chicago, Detroit, Ogdensburg, N.Y., Jamesburg, N.J.
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CHICAGO AREA PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
Why pay more?
. . . for the best
call CLEVELAND.

"They didn't stay sold . . ."

There they were . . . forty-four of them . . . sleek, trim hair dryers . . . styled by a nationally famous designer . . . full of eye-appeal and buy-appeal . . . but every last one was going back to the manufacturer. Why? — because they didn't stay sold. Out of the five original sales, four were already back. Irate customers had brought them in . . . they had worked for awhile and then shorted out . . . investigation showed that the electrical insulation wouldn't stand the heat. The Electric Sales Company couldn't take chances on future customer good-will with merchandise like that . . . and it would be a long time before that particular manufacturer got another order from them.

Whether you make home appliances, radio or electronic equipment, or industrial machinery, you need the extra protection of BH Fiberglas Insulations to guard against insulation failure, product breakdown, loss of customer good-will.

Take BH Special Treated Fiberglas Sleeving, for example. Here is a high heat insulation with remarkable resistance to sub-zero temperatures as well.

Dielectric and physical properties remain unchanged through a temperature range of −67° F. to 1200° F. BH Special Treated is permanently flexible, there are no impregnants or coatings to age or harden. But it is not completely limp. A patented heat process gives the sleeving body and rounds it . . . crimps crossing strands to prevent raveling and minimize fraying. It will not ravel when cut in short lengths, or when spread to cover knobs, terminals and irregular objects. Installation time is speeded.

BH Special Treated Fiberglas Sleeving is one of a family of electrical insulations, each designed to meet particular conditions in service. Give us a few facts about your requirements – product, temperatures, voltages—we will gladly furnish samples for testing purposes.

Address Dept. E-3

Bentley, Harris Manufacturing Co.
Conshohocken, Pa.

BH *Fiberglas**
SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

TUNG-SOL

BEAM POWER AMPLIFIER

for the ultimate in reliability where the 6L6 is called for . .

see other side for additional information

TUNG-SOL

5881

the beam power amplifier that embodies all the important improvements in electron tube design . . .

Available now in quantities

Absolute reliability!

There, in two words, is the net result of all the engineering which TUNG-SOL has put into the 5881. This completely new tube is designed to operate in circuits for which the 6L6 is specified and is completely interchangeable wherever the 6L6 is now in use. Full utilization of the design and production techniques which have proved themselves over the past 15 years, has created this exceptionally reliable tube. The 5881 has tremendous overload capacity. It maintains high efficiency throughout its life and provides low cost operation through reduced maintenance.

The 5881 is manufactured under laboratory conditions accompanied by the most severe tests. It is rugged both mechanically and electrically. Here are six major features which assure its premium performance:

1. Glass button stem permits compact construction with high resistance to mechanical shock.

2. Rugged micanol low-loss base provides full lifetime electrical insulation and minimizes base leakage.

3. Cathode materials of exceptional stability give more uniform emission with greater life expectancy. Cathode is not poisoned by inactivity during standby periods.

4. Maximum control of grid emission achieved by gold plating and carbonizing.

5. Zirconium anode coating is most active under overload conditions providing ample gettering action to prevent accumulation of gases.

6. Life tests are made under severe overload conditions to assure adequate safety factor.

Where reliable service is essential in audio circuits, the TUNG-SOL 5881 is a "must." Order it from your regular TUNG-SOL supplier.

MECHANICAL DATA

Envelope	Glass RMA T-11
Base	Short shell micanol
Overall length	3-15/32"
Seated height	2-29/32"
Maximum diameter	1-7/16"

ELECTRICAL DATA

Maximum Ratings—(Design Center System in accordance with RMA Standard M8-210)

Plate dissipation	23 WATTS
Screen dissipation	3 WATTS
Plate voltage	360 VOLTS
Screen voltage	270 VOLTS
Heater-cathode potential	200 VOLTS
Heater voltage	6.3 VOLTS

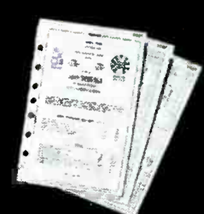
ELECTRICAL DATA

Typical Operating Conditions and Characteristics (Class A Amplifier)

Heater voltage	6.3	6.3	6.3	VOLTS
Heater current	0.9	0.9	0.9	AMP.
Plate voltage	250	300	350	VOLTS
Screen voltage	250	200	250	VOLTS
Grid voltage	−14	−12.5	−18	VOLTS
Peak A-F signal voltage	14	12.5	18	VOLTS
Transconductance	6100	5300	5200	μMHOS
Plate resistance	30000	35000	48000	OHMS
Zero signal plate current	75	48	53	MA.
Zero signal screen current	4.3	2.5	2.5	MA.
Maximum signal plate current	80	55	65	MA.
Maximum signal screen current	7.6	4.7	8.5	MA.
Load resistance	2500	4500	4200	OHMS
Power output	6.7	6.5	11.3	WATTS
Total harmonic distortion	10	11	13	%

TUNG-SOL
ELECTRON TUBES

The TUNG-SOL engineering which has produced the 5881 is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Information about these and other types are available on request to TUNG-SOL Commercial Engineering Department.

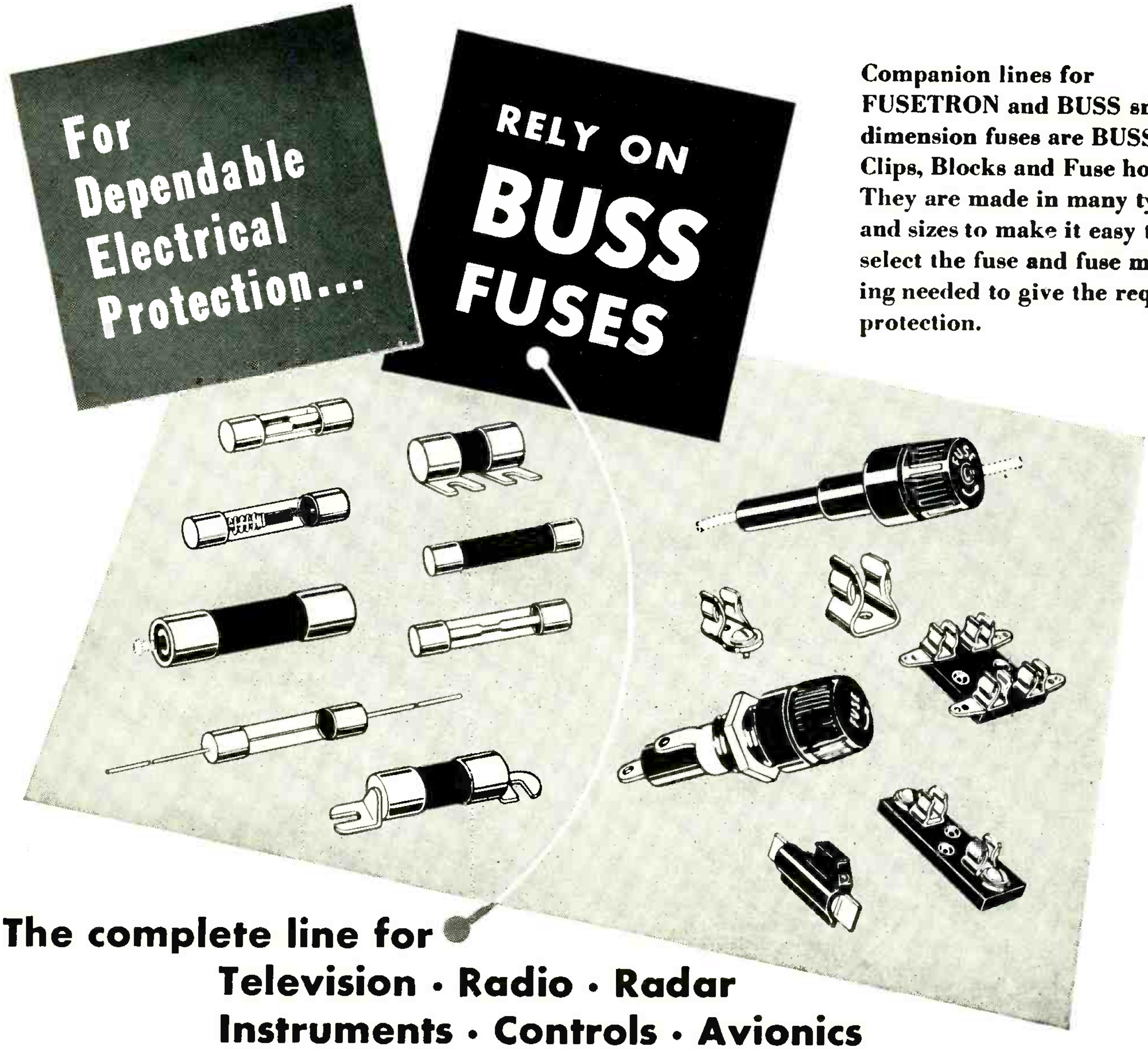


TUNG-SOL ELECTRIC INC., NEWARK 4, NEW JERSEY

SALES OFFICES: ATLANTA · CHICAGO · CULVER CITY (CALIF.) · DALLAS · DENVER · DETROIT · NEWARK

TUNG-SOL MAKES ALL-GLASS SEALED BEAM LAMPS; MINIATURE LAMPS; SIGNAL FLASHERS; CATHODE RAY, RADIO, TV AND SPECIAL PURPOSE ELECTRON TUBES.

MARCH, 1952



Companion lines for FUSETRON and BUSS small dimension fuses are BUSS Fuse Clips, Blocks and Fuse holders. They are made in many types and sizes to make it easy to select the fuse and fuse mounting needed to give the required protection.

The complete line for
Television · Radio · Radar
Instruments · Controls · Avionics

Buss is the one source for any fuse you need: — standard type, dual-element (slow blowing), renewable and one-time types . . . in sizes from 1/500 ampere up.

Manufacturers and service men the country over have learned that they can depend on BUSS Fuses for dependable protection under all service conditions. The name BUSS has meant unquestioned high quality for more than 37 years.

To make sure that quality is always maintained, EVERY BUSS FUSE IS ELECTRONICALLY TESTED. The sensitive testing device rejects any fuse that is not correctly calibrated, properly constructed and right in all physical dimensions.

BUSSMANN MFG. CO. St. Louis 7, Mo.

Division of McGraw Electric Company

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

You can help protect your good-will and your reputation, when you standardize on BUSS Fuses.

If you have a special problem, let us help you select or design the right fuse or fuse mounting to meet your needs. Our staff of fuse engineers and research laboratory are at your service.

SEND THE COUPON for Complete Facts

Bussmann Mfg. Co., University at Jefferson
St. Louis 7, Mo. (Division McGraw Electric Co.)

Please send me Bulletin SFB on BUSS Small Dimension Fuses and Fuse Holders.

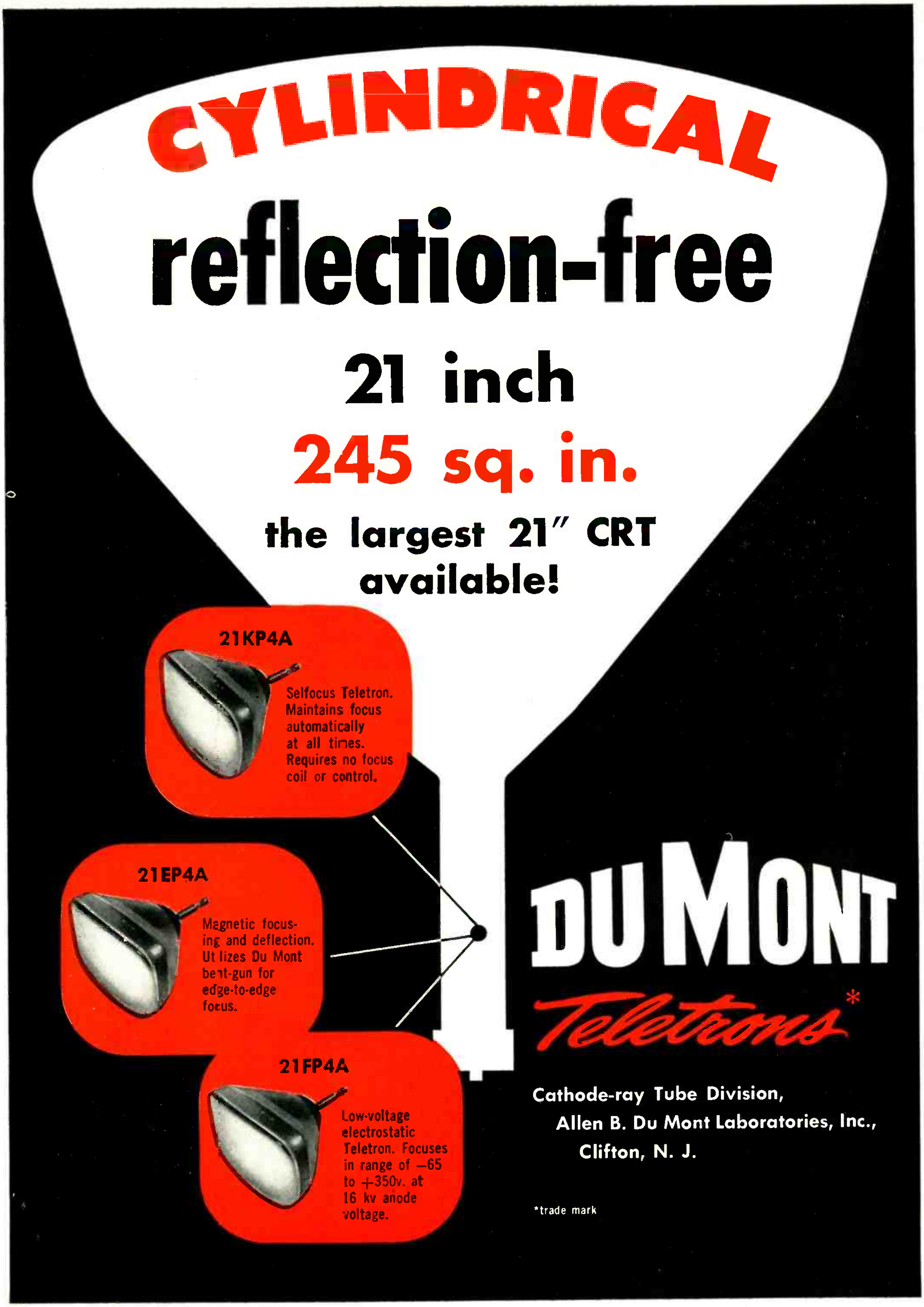
Name ______________________

Title ______________________

Company ______________________

Address ______________________

City & Zone ______________ *State* ________ 352
ELRC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reflection-free
21 inch
245 sq. in.
the largest 21" CRT available!
21KP4A
Selfocus Teletron. Maintains focus automatically at all times. Requires no focus coil or control.
21EP4A
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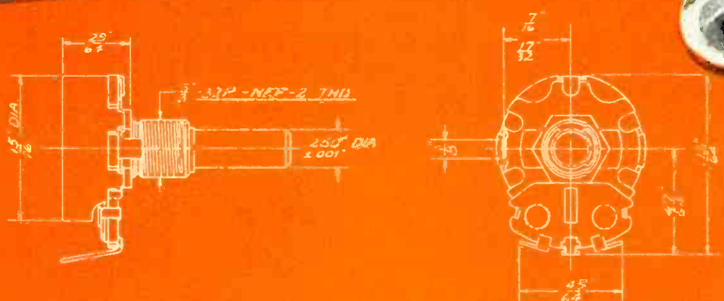
21FP4A
Low-voltage electrostatic Teletron. Focuses in range of −65 to +350v. at 16 kv anode voltage.
DU MONT
Teletrons*
Cathode-ray Tube Division,
Allen B. Du Mont Laboratories, Inc.,
Clifton, N. J.
*trade mark

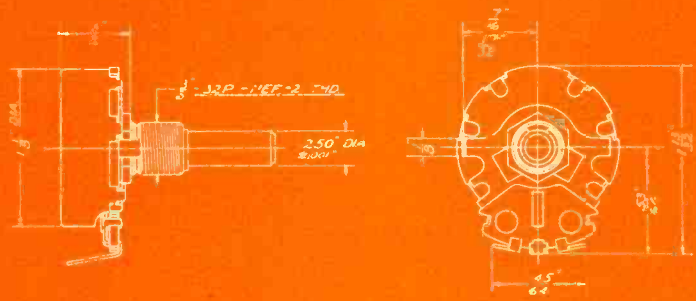
A Complete Line that

TYPE 45
(JAN-R-94, Type RV2)



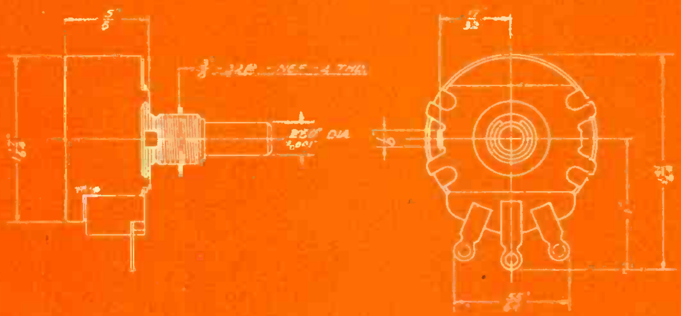
¼ watt, 1⁵⁄₁₆" diameter variable composition resistor.
Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

TYPE 35
(JAN-R-94, Type RV3)



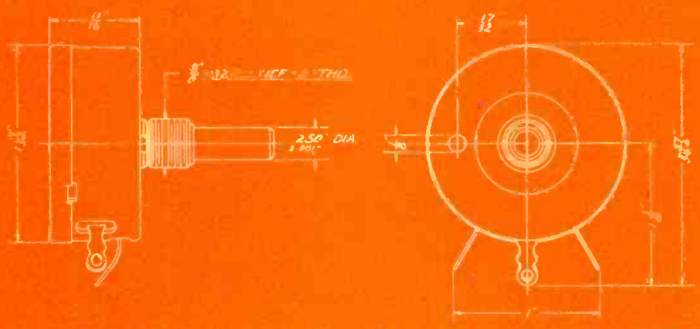
½ watt, 1⅛" diameter variable composition resistor.
Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

TYPE 252
(JAN-R-19, Type RA20)



2 watt, 1¹⁵⁄₆₄" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19. Attached Switch can be supplied.

TYPE 25
(JAN-R-19, Type RA25)



4 watt, 1¹⁹⁄₃₂" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19. Attached Switch can be supplied.

For additional information on these 7 controls, write for Data Sheet No. 160

EXCEPTIONALLY GOOD DELIVERY CYCLE on military orders due to enormous mass production facilities . . . *Immediate delivery from stock* on more than 170 different types and resistance values . . . Please give complete details on your requirements when writing or phoning for further information.

NEW COMPLETE CTS CATALOG. Write for your copy today.

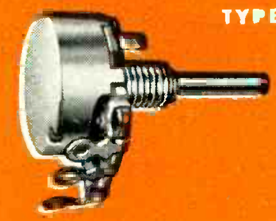
BURTON BROWNE ADVERTISING

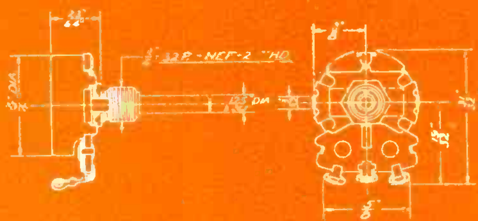
of Variable Resistors

MEETS MILITARY SPECIFICATIONS

−55°C to +150°C . . . complete aridity to saturation . . . are the unprecedented temperature and humidity range of Types 65, 90 and 95. These controls are used in military equipment subjected to extreme temperature and humidity.

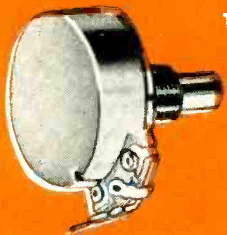
TYPE 65

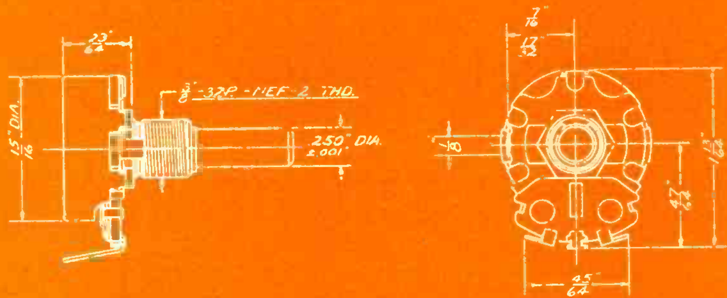




½ watt 70°C, ¾" diameter miniaturized variable composition resistor.

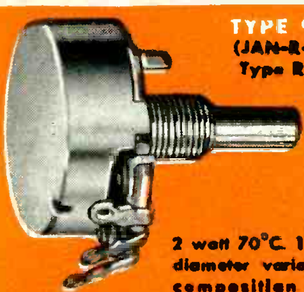
TYPE 90

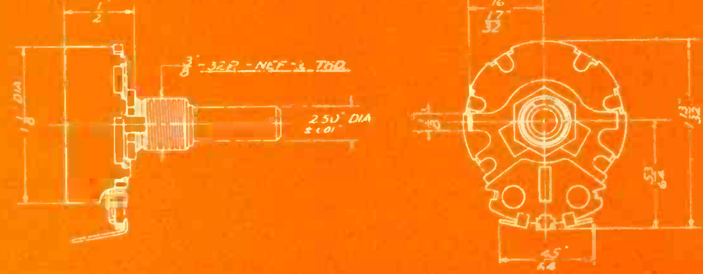




1 watt 70°C, 15/16" diameter variable composition resistor. Attached Switch can be supplied.

TYPE 95 (JAN-R-94, Type RV4)





2 watt 70°C 1⅛" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94. Attached Switch can be supplied.

Specialists in Precision Mass Production of Variable Resistors

FOUNDED 1896

CHICAGO TELEPHONE SUPPLY *Corporation*

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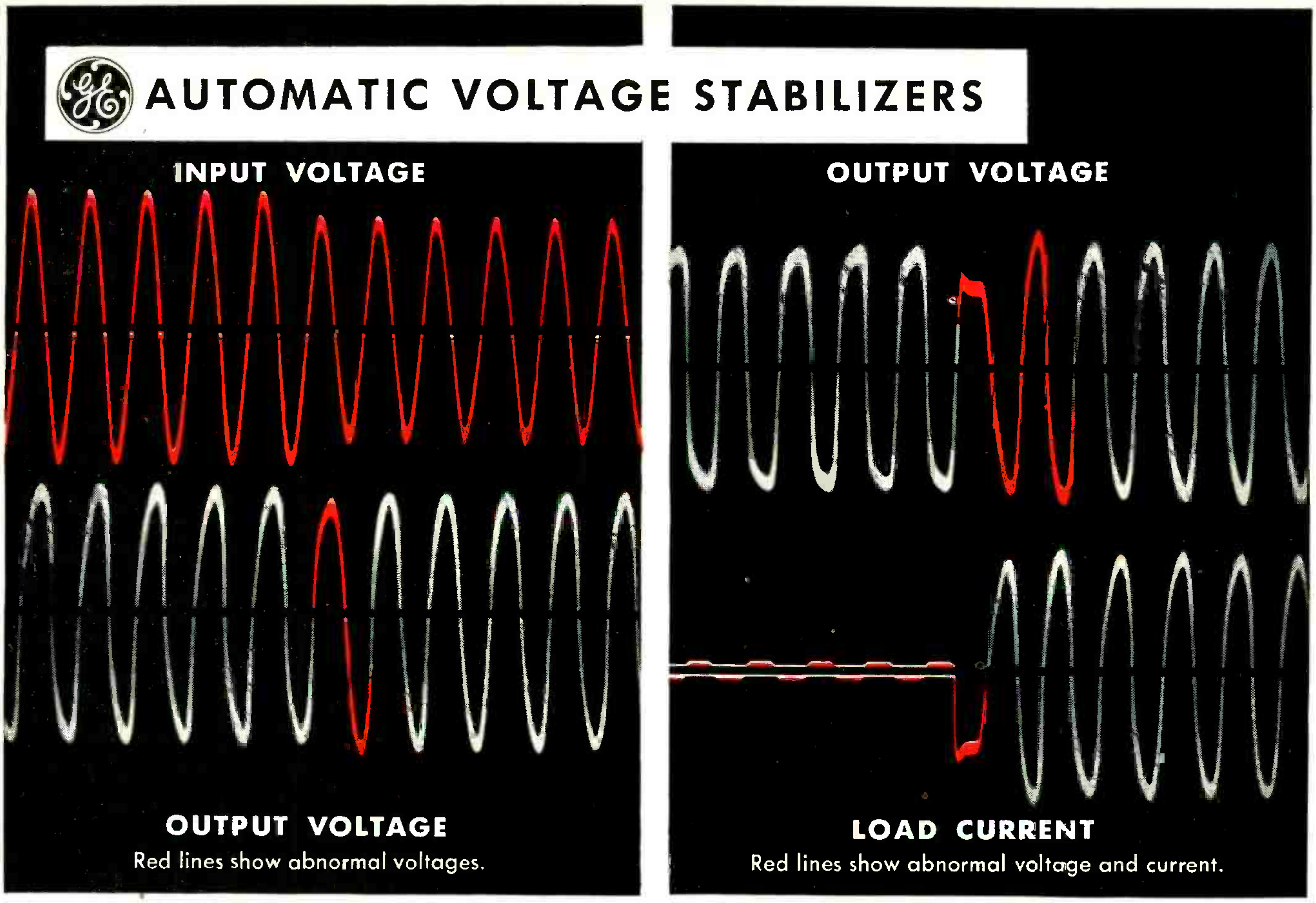


Output voltage stabilized in less than one and one-half cycles as input drops from 130 to 100 volts.

Output voltage stabilized within two cycles as load current jumps from 0 to full load.

Split-cycle action of G-E Stabilizers assures top performance of your product

A common cause of substandard performance of electrical equipment is fluctuating a-c voltage supply. The simplest way to prevent local voltage conditions from affecting your product performance is to use G-E Automatic Voltage Stabilizers.

MADE TO FIT ANY APPLICATION

Light, compact, standard models are now made in sizes 15 to 5000 va. These models can easily be used in a wide variety of applications: laboratory and factory testing equipment, signal and alarm systems, and many others. To do specific jobs, special designs are available or can be made.

CORRECTS WIDE RANGE OF VOLTAGES

Standard G-E Voltage Stabilizers correct for all fluctuations between 95 and 130 volts, or 190 to 260 volts, delivering a stable 115 or 230 volts to your product within $\pm 1\%$. Special models can stabilize to an even closer degree.

EASY TO INSTALL; NO MAINTENANCE

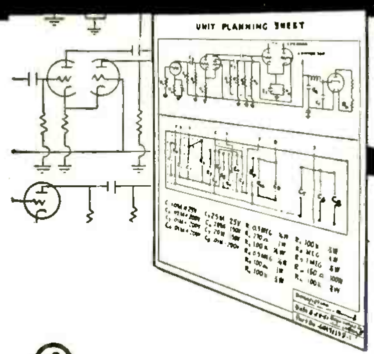
Only two sets of terminals to connect: one for supply and one for the load. Since there are no moving parts or electronic components, need for replacement parts, adjustments or any other maintenance is virtually non-existent. Operation is completely automatic. *General Electric Co., Schenectady 5, N. Y.*

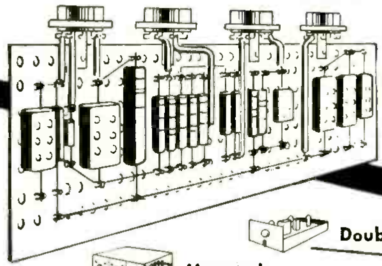
SENSITIVE EQUIPMENT, such as this Type H Leak Detector, functions accurately only when voltage is properly stabilized. G-E voltage stabilizers perform this stabilizing function.

GENERAL ELECTRIC

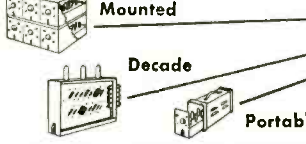
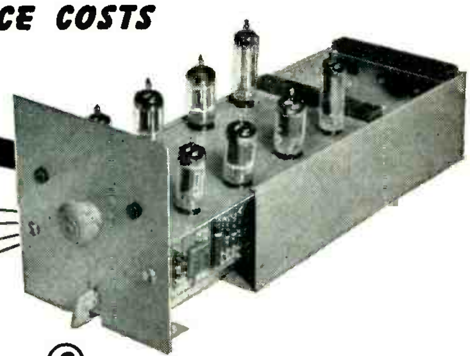
411-99

BRING THROUGH EQUIPMENT FAST!





FROM STANDARD STOCK COMPONENTS YOU CAN SIMPLIFY DESIGN — SPEED PRODUCTION — AND CUT SERVICE COSTS

①

ORGANIZE CIRCUITS QUICKLY

Schematics of most electronic equipment can be broken down into circuit blocks of logically associated functions. These functional circuit blocks can be mounted readily either in the Alden "20" plug-in packages or Basic Chassis unit. Tube sockets and associated components quickly lay out on full scale Unit Planning Sheets for mounting on terminal cards. These special pre-punched, multi-hole terminal cards have wide flexibility to take an infinite variety of circuit variations. Both sides of card can be used to obtain maximum component density area. Using the Unit Planning Sheets, functional circuit units are all planned in one step.

②

GET EASY SUB-DIVISION OF LABOR

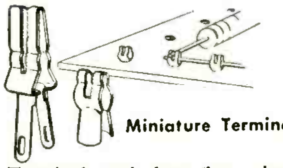
Solder terminals and sockets quickly rivet to Alden terminal card according to layout on Unit Planning Sheet. Components snap into the special Alden Miniature Terminals which hold them for soldering — (No twisting or wrapping of leads necessary) — With all tube sockets and their associated components mounted on one card — the wiring and soldering of circuits is an open, easy-to-work sub-assembly operation.

③

CUT SERVICE AND MAINTENANCE COSTS IN FINAL EQUIPMENT

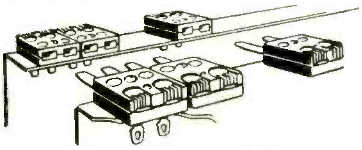
In field, shop, or office your equipment maintenance is reduced to 30 second changeovers. Basic replacement elements are small enough in weight and size to be shipped by parcel post for repair.

IT'S AS SIMPLE AS THIS!



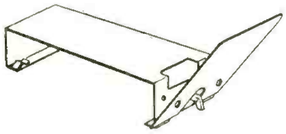
Miniature Terminals — 650 Series

Terminal cards have been designed to accommodate tremendous number of circuit variations — to make neat tube and component sub-assemblies with a minimum of wiring and simplified assembly techniques. Special Alden Miniature Terminals are new and radical punch press configuration — ratchet slot holds various size component leads for soldering — no twisting of leads with pliers. Figure "eight" shape accommodates cross wiring and buss leads. Terminals are punch press parts — so take a minimum of solder, reduce solder time, eliminate danger of cold solder joints.



Back Connectors — 462MIN Series

Alden Terminal Card System means minimum of inter-cabling — but even this cabling can be laid out easily and proceed as simple sub-assembly. Open sided chassis construction makes cable easy to wire to front panel, terminal cards and back connectors. The Alden Back Connectors are units that can be discretely positioned on the back of the chassis — isolating lines with incompatible voltages, currents, or frequencies. This design insures accessible solder terminals for soldering — avoids rat nests of congested conventional back connector wiring. Color coded, the Alden back connectors provide beautiful operational or service check points for all leads to and from chassis.

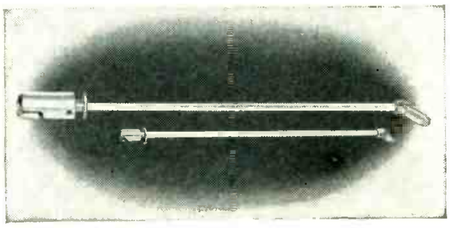


Hinged Front Panel Design

Hinged front panel design of chassis allows rheostats, indicator lights, jacks, etc. to be mounted on panel as another easy-to-work sub-assembly. This panel attaches easily to chassis — is wired — swung up and fastened with Alden Target Screws.

Target Screws

These screws have concave head with arced notch so power screw driver locates head quickly, no danger of it slipping out and marring panel surface — yet same screw can be unfastened with coin in order to hinge forward the front panel for servicing and check in the field.



"Serve-A-Unit Lock"

Assembled — the Basic Chassis simplifies operation of equipment — Slashes service and maintenance time. Smooth, positive insertion and removal of the chassis is provided by the Alden "Serve-A-Unit Lock." A simple twist of the handle and the chassis backs off with finger tip ease. It also pilots the chassis back into place — securely locking it for operation with the same facility.

TO GET STARTED QUICKLY!

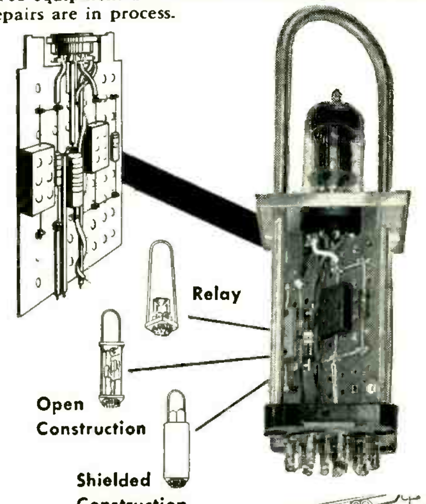
Wire for sample Basic Chassis at $40. — and Alden "20" Plug-in Packages at $10. — write Dept. B for booklet "Basic Chassis and Components for Plug-in Unit Construction."

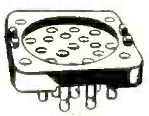
SEE US AT BOOTH N3 THE IRE SHOW, GRAND CENTRAL PALACE, NEW YORK CITY

NA-ALD

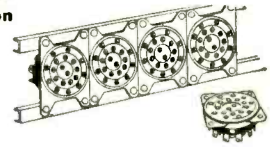
FOR SMALLER UNITS ALDEN "20" PLUG-IN PACKAGES

Here is a plug-in package unit using the above method of converting schematic into finished assembly quickly. Simply mount the completed terminal card sub-assembly on the Alden "20" Non-Interchangeable base, dip solder the leads — add cover or housing and handle and it's completed — In operation, visual or instrument checks are easily made — if trouble occurs doubtful units are quickly isolated — these units easily unplug and a comprehensive inspection made. Spare units can be plugged in so equipment doesn't have to be inoperable while repairs are in process.



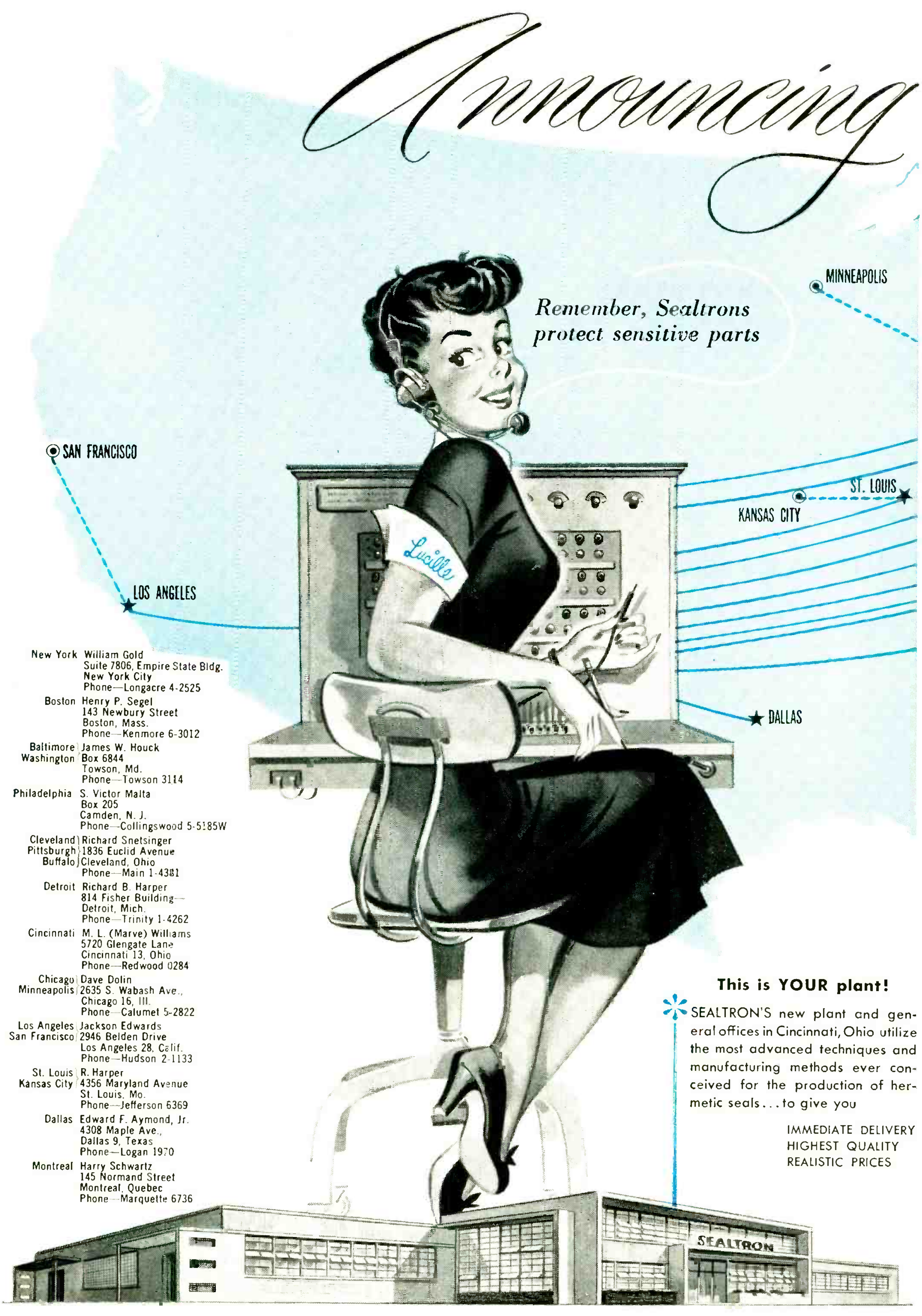


"20" Non-Interchangeable Base



"20" Rack and Chassis Mounting Sockets

ALDEN PRODUCTS COMPANY 127 North Main Street, Brockton, Massachusetts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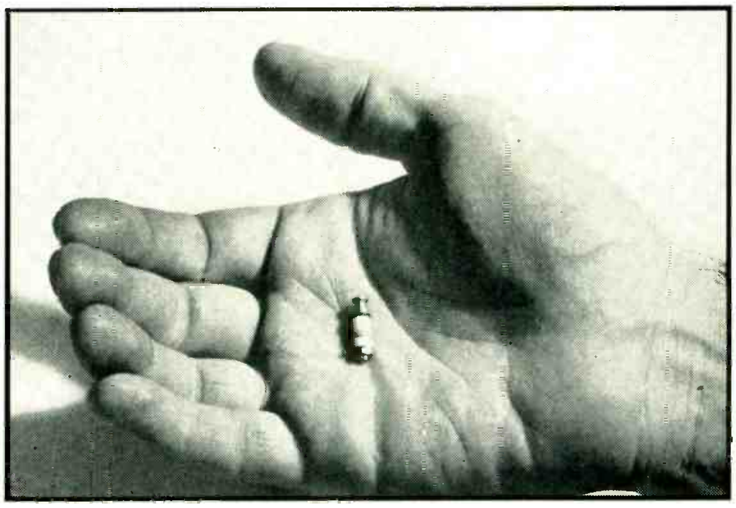


HELDOR TERMINAL No. 187

small in size...BIG in application!

Now, at last, a SMALL yet rugged terminal that's the answer to space and performance problems of hermetically sealed components. Literally "peanut" in size (the smallest compression-type, hermetically-sealed bushing assembly on the market today), it can be depended upon to perform as well as any of its "big brothers".

If space is at a premium in your hermetically-sealed component design . . . and you want TOP PERFORMANCE . . . it will pay you to get complete data on the amazingly versatile HELDOR TERMINAL No. 187.

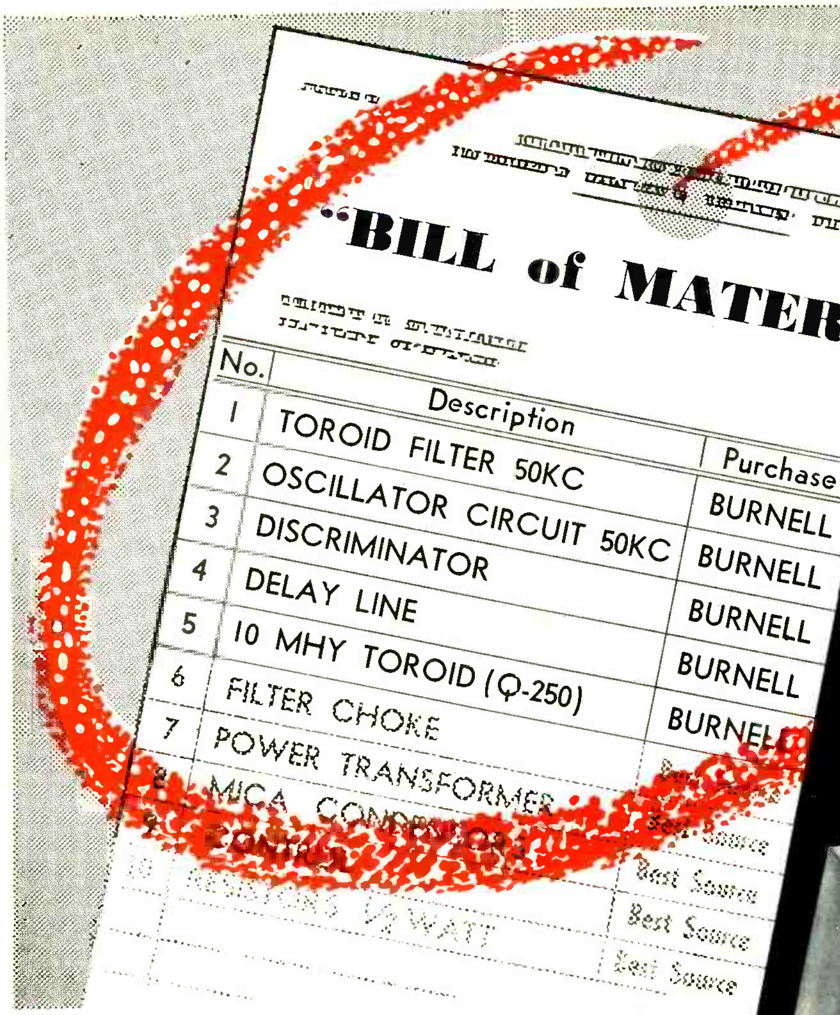
WRITE FOR DATA

Send Data on HELDOR Terminals #187
Name .... Title ....
Company ....
Street ....
City .... Zone ...... State ....

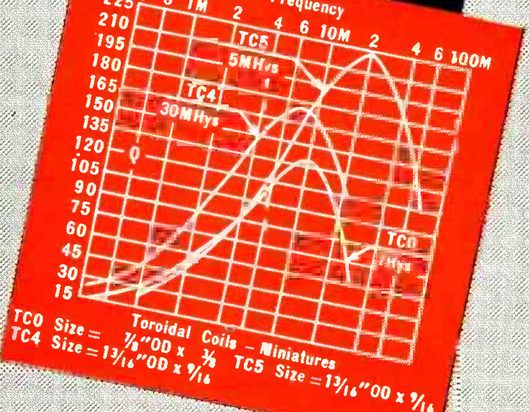
NEW! Watch for important announcements on Heldor's new #500 G and #875 BX bushing assemblies AND . . . the new Heldor Condenser Terminals made to pass JAN-C-25 specifications.

HELDOR BUSHING & TERMINAL CO., Inc.

Heldor 225 Belleville Ave., Bloomfield, N. J.



PREFERRED SOURCE FOR QUALITY TOROIDS & FILTERS



For every "Burnell" toroid or filter specified in the bill of materials for Electronic equipment, we chalk up another credit for our "Burnell Customer Service."

In this highly specialized and technical field, individual attention to the customer's problem assures him of obtaining the best filter for his application. It is the job of our engineering sales department to thrash out every detail of the customer's problem until it is sure that the specifications will guarantee correct performance.

The next step would be to choose from our file of thousands of designs, one which meets the requirements. In many instances, of course, it is necessary to create an original design but *at no extra cost to the customer.* In either case, we can state unequivocally, that the result is invariably one of customer satisfaction. This is why Burnell has been the "preferred source" with so many engineers.

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Need permanent magnets and expert magnet services?

Substantial supplies of Carboloy Alnico permanent magnets now available for most D.O.-rated applications

CARBOLOY magnet engineers are experts at designing assemblies with circuits that provide more useful energy with less magnetic material. Their services are yours when you need help in magnet design and application.

TWO helpful bulletins are yours for the asking: a clear, informative Permanent Magnet Design Manual with latest technical data, and the newly released catalog of Stocked Carboloy Alnico Permanent Magnets. Send coupon for your free copies.

Substantial, increasing quantities of Carboloy Alnico permanent magnets are now available to all plants that can extend their D.O. ratings under C.N.P. Regulation No. 3. For nearly all applications except toys, novelties and a few other accepted uses, you can plan to use magnets for modernization of present products, new products in the experimental stage or expanded production of present applications. Carboloy magnets are available in cast or sintered form . . . will be job-designed and built to your specifications or furnished from standard stocks.

And, as always, experienced Carboloy magnet engineers will assist you in magnet design and application. Their skills with Carboloy Alnico magnets may supply just the extra touch you need to help you improve that meter, motor, instrument, control, generator, magneto, TV speaker or whatever product you produce.

Guaranteed Energy

You'll get superior magnets, too. Carboloy magnets are built under the most rigid controls practiced anywhere. They are checked and tested for quality and uniformity, and each one is *guaranteed* to meet or surpass the industry's external energy minimum.

Get in touch with us today. From design to *delivery on the day promised*, we'll do everything possible to give you service and satisfaction . . . *plus* the magnets you need to make your products better, your profits greater.

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DEPARTMENT OF GENERAL ELECTRIC COMPANY

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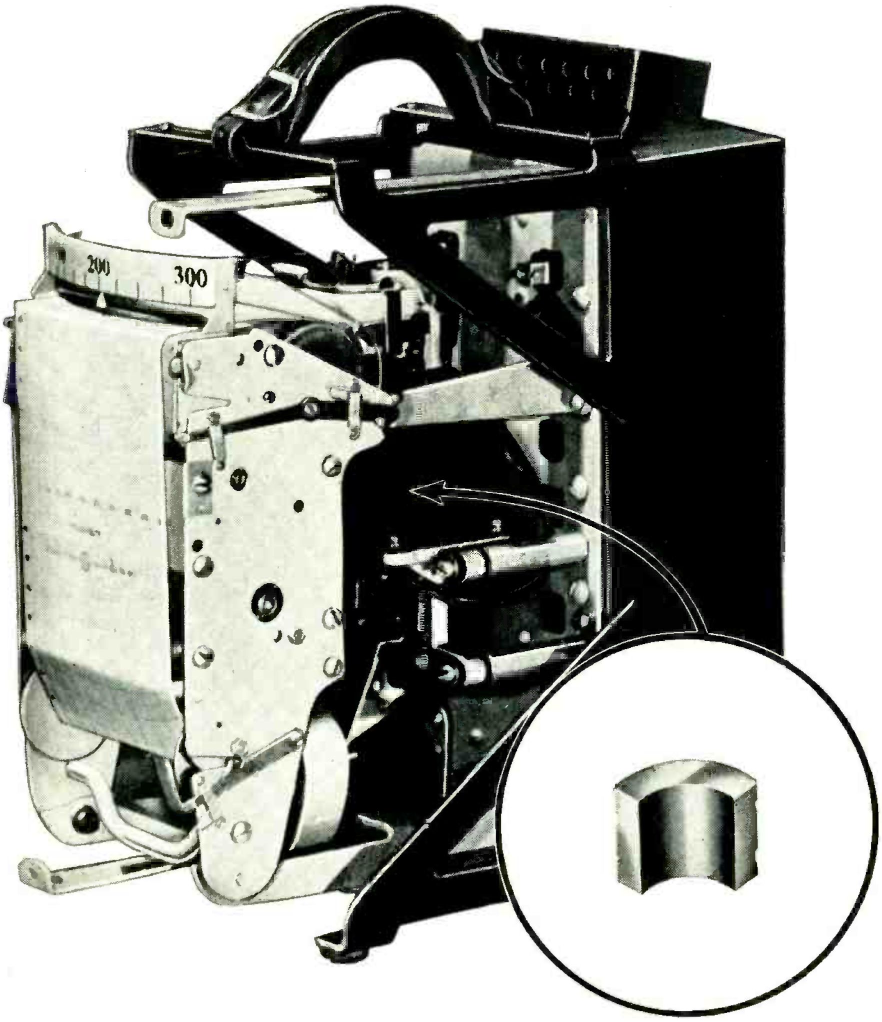

METERS and instruments are but one of the many fields where permanent magnets work wonders. In the Current Recorder above, a concentric magnet element of Carboloy Alnico is the measuring mechanism. Being small in size, but tremendously powerful, it simplified the design . . . reduced the recorder's weight by 10 pounds . . . greatly contributed to its sensitivity and accuracy. Here is a typical case where modernization through permament magnets pays off in improved products.

GET THESE 12 OUTSTANDING ADVANTAGES! SPECIFY CARBOLOY PERMANENT MAGNETS

1 **SIMPLE**—Compact, self-containing sources of energy with no operating parts.

2 **UNIFORMLY POWERFUL**—Guaranteed to meet or surpass the standard external energy minimum.

3 **LAST FOREVER**—Will supply a constant, uniform magnetic field indefinitely.

4 **NO WIRING**—Eliminate need for coils, windings, or other electrical fixtures.

5 **COOL-RUNNING**—Won't generate heat; need no provisions for heat dissipation.

6 **NO OPERATING COSTS**—Operate without maintenance costs or any power supply.

7 **NO POWER FAILURES**—There is no outside source of power to fail!

8 **COMBINE ELECTRICAL AND MECHANICAL FEATURES**—Transform electrical energy into mechanical motion; mechanical motion to electrical energy.

9 **SIMPLIFY MECHANICAL ASSEMBLIES**—Exert strong tractive force for holding, lifting and separating devices that eliminates component parts, makes product design and fabrication extremely simple.

10 **UNINTERRUPTED OPERATION**—Magnetic energy flows *continually* and forever!

11 **CREATE SAVINGS**—Reduce weight, save space, lower cost of fabricating and eliminate other, often more costly, power-supplying parts.

12 **MOISTURE-RESISTANT**—No coils to collect moisture.

CARBOLOY

ALNICO PERMANENT MAGNETS

Designed Right . . . Built Right . . . Delivered Right on Time and with Energy-Potential Right!

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I am interested, without obligation, in receiving information about the 12 outstanding advantages of Carboloy Alnico Permanent Magnets.

☐ Send me free copies of Design Manual and Standard Stock Catalog.

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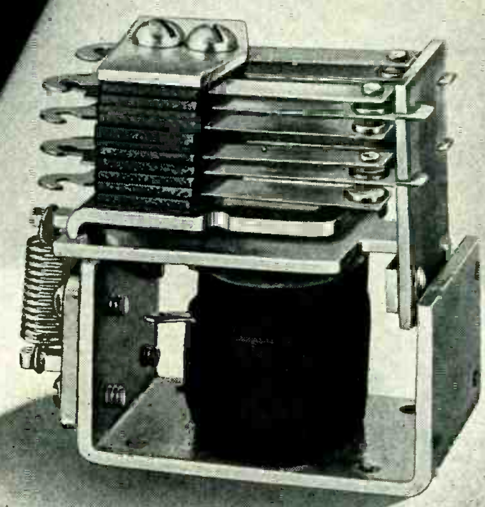
PEAK

IN POWER VERSATILITY QUALITY PERFORMANCE



TYPE PK RELAY

HERE ARE THE FACTS AND FIGURES:

CONTACTS: 10 amp. standard. 24 volts D.C., 115 volts A.C.
15 amp. contacts available.

SENSITIVITY: D.C.: 4 pole 1.5 watts
2 pole .7 watts
A.C.: 4 pole 5 volt amperes
2 pole 2.5 volt amperes
Can also be furnished in 6 pole AC and DC up to 4000 Ohms.

COIL: To 115 volts D.C., 230 volts A.C.

NOMINAL HEAT RISE: D.C. 30°C above room ambient
A.C. 45°C above room ambient

MAX. INPUT FOR 85° RISE: D.C. 5 watts
A.C. 11 volt amperes

MOUNTING: Base or end mounting

WEIGHT: 4.5 oz. 4 P.D.T.

WEIGHT HERMETICALLY SEALED: 7.7 oz.

DIMENSIONS: Open Relay—2 1/16", 1 1/8", 2 1/16"
Sealed Relay—3 1/8", 1 1/2", 2 5/16"
Overall Mounting Flange—3 1/8"
Center to Center Mounting Holes—2 11/16"

A Quality Relay

The new Allied PK Relay is designed to offer versatility in a power relay where quality and low cost are factors. Besides stability in operation its reliability allows a range in applications from high quality instruments to vending machines. The PKU relay will comply with Underwriters' Laboratories requirements and can also be supplied hermetically sealed.

Bulletin PK gives complete details. Send for your copy today.

Be sure to send for your copy of Allied's Relay Guide. It gives the engineering data for 27 Allied relays in a concise tabular form for easy reference.

AL-113

ALLIED CONTROL COMPANY, INC. 2 EAST END AVENUE, NEW YORK 21, N.Y.

The Brochure You've Been Waiting For Is Off The Press!

Are you one of the thousands of electronic engineers who has already requested a copy of this important, new, 32 page brochure on hermetic sealing? If not, send your name in today for your FREE copy.

Nothing before has ever been done in this highly specialized field that can compare with this new presentation on glass-metal headers.

Beautifully printed in 3-colors, this brochure will bring you up to date on hermetic sealing, because it shows a remarkable exposition of what HERMETIC SEAL PRODUCTS CO. has achieved in miniature and sub-miniature plugs and seals, as well as in standard-size headers.

Years of creative, fruitful effort by HERMETIC have made it the largest exclusive manufacturer of hermetic seals in the world. This company has pioneered and introduced almost every important innovation in this most exacting field.

HERMETIC's specialist-engineers, with such a background, are eager to help you with your problems in the ever-expanding usage of hermetic sealing.

VISIT HERMETIC'S BOOTH NUMBER 129 AT THE 1952 I. R. E. SHOW.

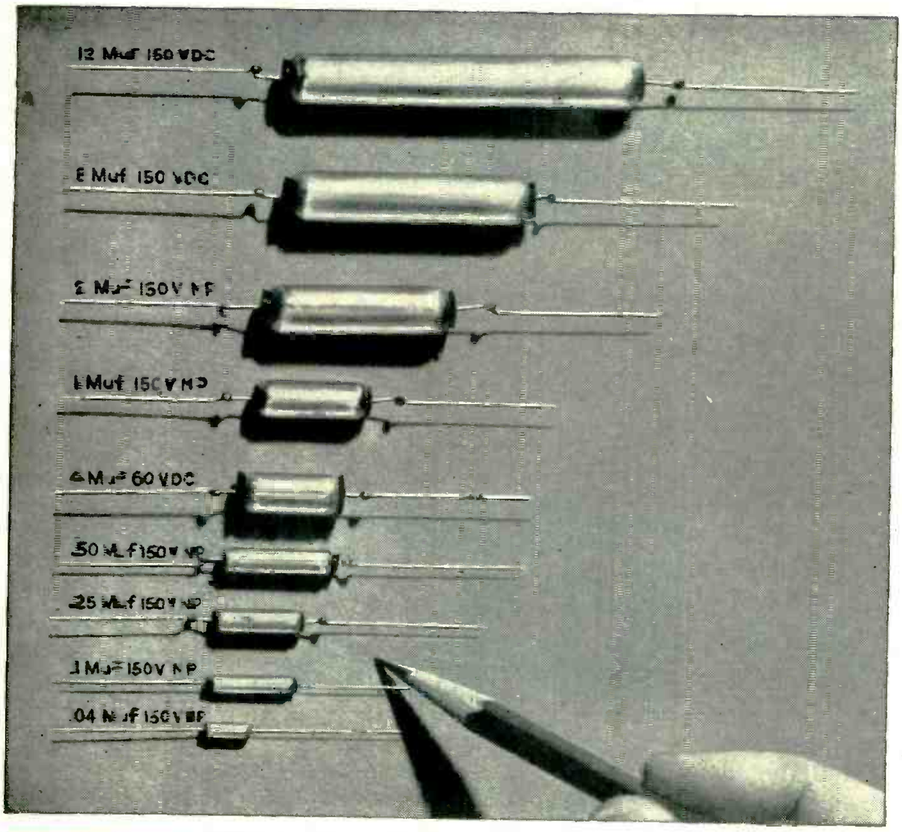
SEALED IN by HERMETIC HEADERS

HERMETIC SEAL PRODUCTS CO.

31-33 SOUTH SIXTH STREET • NEWARK 7, NEW JERSEY

DESIGNER'S

FOR SMALL SIZE, SUPERIOR PERFORMANCE IT'S G-E TANTALYTIC CAPACITORS

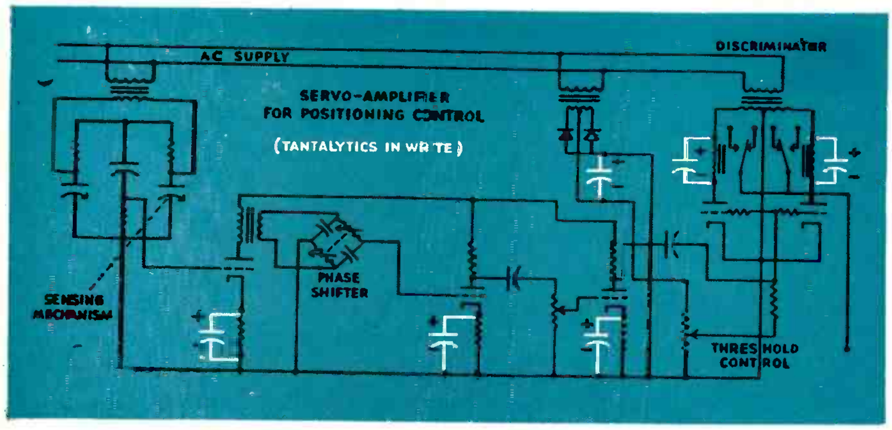


NEW tantalum-electrolyte units offer excellent low-temperature properties

Superior performance and large capacitance per unit volume make new General Electric Tantalytic capacitors valuable wherever miniaturization is a "must." Designed for low-voltage, direct-current applications, these capacitors excel in low-temperature properties and shock resistance.

Other advantages: Long shelf life ● Exceedingly low leakage current ● Hermetic sealing ● Good stability ● Chemically-neutral electrolyte

Operating temperatures range from −55C to +85C, ratings from .02 muf to 12 muf at 150 volts d-c. For further data, send coupon for Bulletin GEA-5753. For specific applications, list temperature range, leakage resistance values, and operating voltage and write *Capacitor Sales Division, General Electric Co., Hudson Falls, N. Y.*



For example: on this gun control system—

Design specifications for the circuit of a gun control servo-amplifier system required capacitors with great stability over a wide temperature range. Airborne equipment was involved, so size and weight were also extremely important. G-E Application Engineers were called in while the design was still on the board. Tantalytic capacitors were recommended because they are small, light, chemically stable. Result: a finished design that meets every requirement.

GENERAL ELECTRIC

667-19

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

FOR RELIABLE DC TO AC AMPLIFICATION

NEW Second Harmonic Converter

The new G-E second harmonic converter is a magnetic-amplifier-type unit which converts low-level d-c error signals (such as those generated by thermocouples) to double-frequency AC. Developed for exhaust gas temperature control of jet engines, it's also applicable to control approach systems, industrial measurements, computing devices, and numerous servo mechanisms and electronic control systems.

Designed for use on 400-cycle power (800-cycle output) the converter can be adapted for use on other frequencies by selecting the proper external capacitance. Reliability and long life result from these features: hermetic sealing, static operation, low temperature rise. Write now for full details in Bulletin GEC-832. Then, if you have an application, contact your General Electric Apparatus Representative.

(Actual Size)

ANTI-BREAKDOWN PROTECTION

NEW Hermetically-Sealed Relay

General Electric's new hermetically-sealed aircraft relay for operation in exposed locations features extra protection against permanent breakdown due to voltage surges. Special polyster compound used to mold contact arms into the stack insulation is non-tracking, provides greater arc resistance. More powerful magnet structure yields higher tip pressures for surety of make. Rated 28 volts d-c, 3 amp. See Bulletin GEA-5729.

125 DEVICES DESCRIBED

NEW Measuring Equipment Catalog

G-E's complete line of measuring equipment for laboratory and production testing is concisely described in this new 80-page reference catalog. Measuring and testing devices include photovoltaic cells, time meters, the current-limited high-potential tester, and dozens of other products. Prices, application information, and condensed tables of important characteristics are all given in this illustrated booklet. Check Bulletin GEC-1016.

EQUIPMENT FOR ELECTRONIC MANUFACTURERS

A partial list of the thousands of items in the complete G-E line. We'll tell you about them each month on these pages.

Components

Meters and instruments	Timers
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Pulse-forming networks	Generators
Delay lines	Selsynes
Reactors	Relays
*Thyrite	Amplidynes
Motor-generator sets	Amplistats
Inductrols	Terminal boards
Resistors	Push buttons
Voltage stabilizers	Photovoltaic cells
Fractional-hp motors	Glass bushings
Rectifiers	Dynamotors

Development and Production Equipment

Soldering irons
Resistance-welding control
Current-limited high-potential tester
Insulation testers
Vacuum-tube voltmeter
Photoelectric recorders
Demagnetizers

*Reg. Trade-mark of General Electric Co.

General Electric Company, Section A667-19
Schenectady 5, New York

Please send me the following bulletins:

Indicate: √ for reference only
X for planning an immediate project

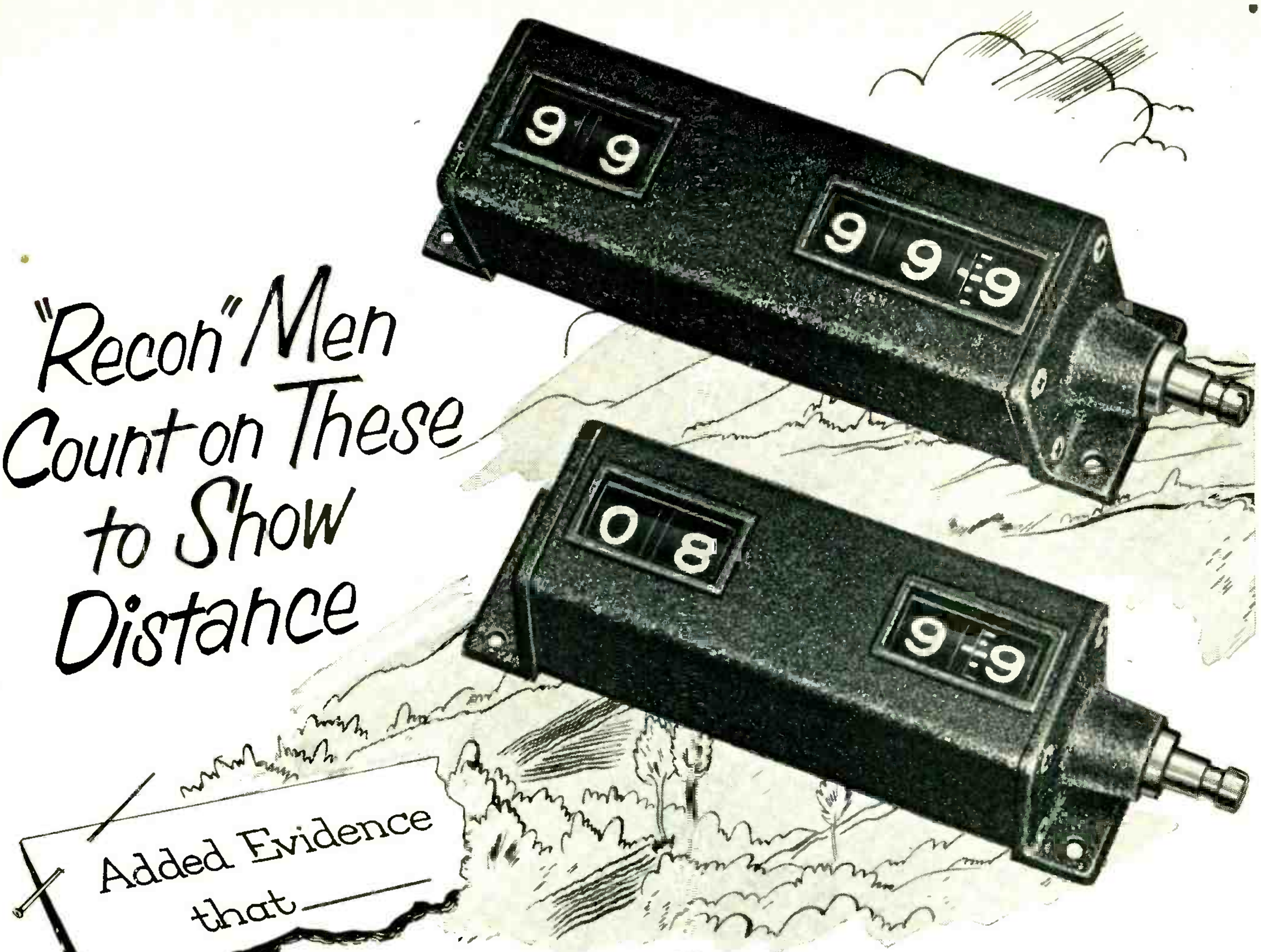
( ) GEA-5729 Hermetically Sealed Relays
( ) GEA-5753 Tantalytic Capacitors
( ) GEC-832 Second Harmonic Converters
( ) GEC-1016 Measuring Equipment

Name ....

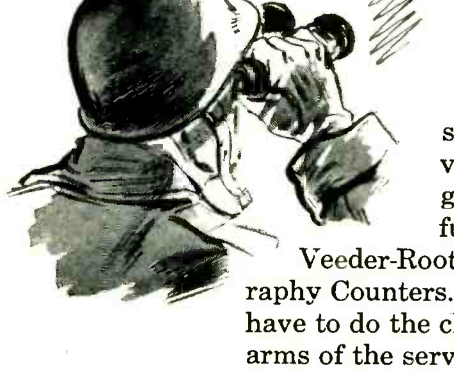
Company ....

Address ....

City .... State ....



Everyone Can Count on VEEDER-ROOT



Military reconnaissance men know the value of the "intelligence reports" faithfully rendered by these Veeder-Root Distance and Topography Counters. And other men, who have to do the close figuring in other arms of the service, they too count on Veeder-Root Counters in more ways than you could shake a "slip-stick" at.

Now if we can help *you* to help these men, by figuring out some new and unusual application of Veeder-Root *Count*rol in defense production, then you can count us at your service, *beginning right now.*

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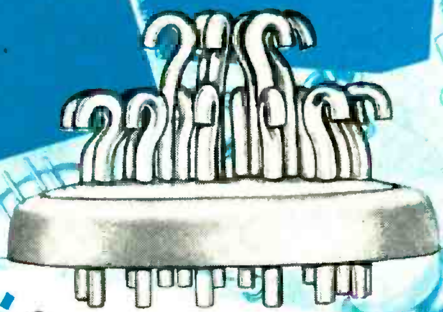


10 YEARS!

OF SPECIALIZATION IN

MULTIPLE HEADERS AND SEALED LEADS

Ten years specializing in the production of over 100,000,000 precision built, hermetically sealed multiple headers and sealed leads. Simply stated, that is the record of E-I engineers — a record that attests to the quality of these terminals and the ability of E-I designers to meet specifications on the toughest of terminal sealing problems! Currently, E-I offers over 100 standard types, with numerous optional features — for the quick, economical solution of most sealing requirements.

When circuit conditions indicate special types of unusual characteristics, you can depend on E-I to produce terminals to specification at reasonable unit cost. Literature on request.

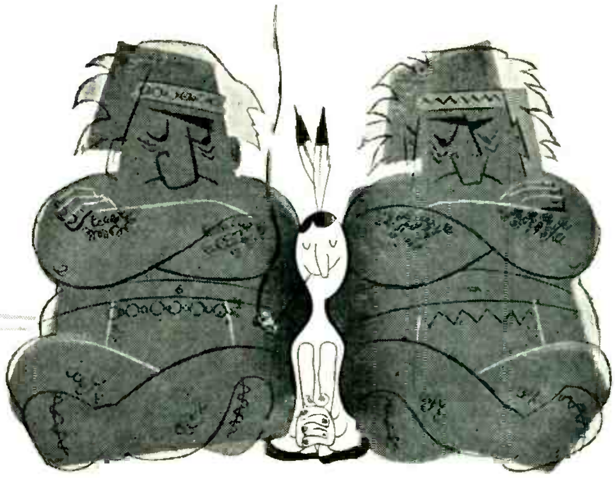
See the Complete line at the IRE show BOOTH 212

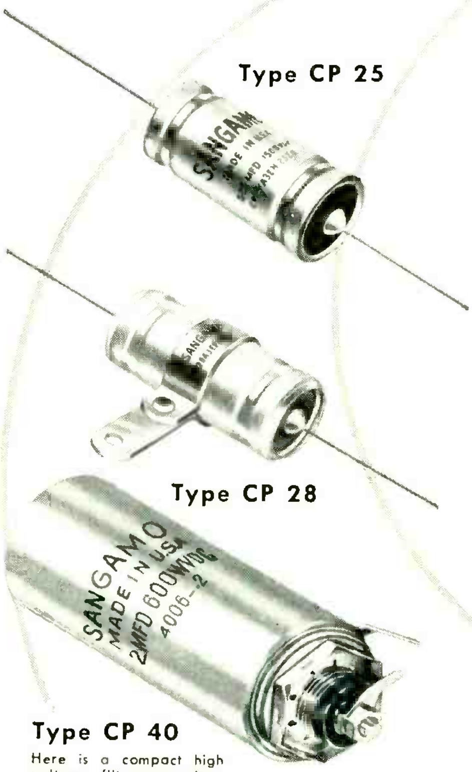
E I INC

ELECTRICAL INDUSTRIES • INC

44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

SANGAMO
Paper Capacitors
"Fit in tight Spots!"





Type CP 25

Type CP 28

These Paper Can Types are produced to meet the physical dimensions and electrical requirements of JAN-C-25 specification.

Where exceptionally small hermetically sealed paper capacitors are required for filter, by-pass, or coupling applications, the Sangamo CP 20 Line is a sound choice. These capacitors are mineral oil impregnated for E Characteristic and assure excellent performance with long life at temperatures from − 55° to + 85° C. They are ideal for use in military equipment, aircraft, or industrial applications. Two typical units of the CP 20 Line are illustrated at left.

Type CP 40

Here is a compact high voltage filter capacitor, designed to conserve space. Type 40 is Diaclor* impregnated and filled and mounts easily to the chassis.

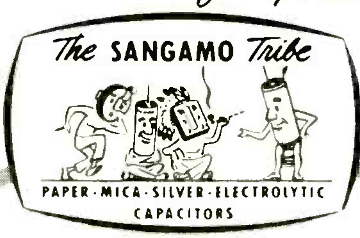
All approved for Armed Services Applications

Type CP 70

A fabricated can type, Diaclor* filled, power supply paper capacitor. Excellent for use in transmitting apparatus, portable communications equipment, sonar or radar sets, and ground control approach equipment.

*Trade Mark Registered. (Chlorinated dielectric oil)

Your Assurance of Dependable Performance



SC52-2

SANGAMO ELECTRIC COMPANY

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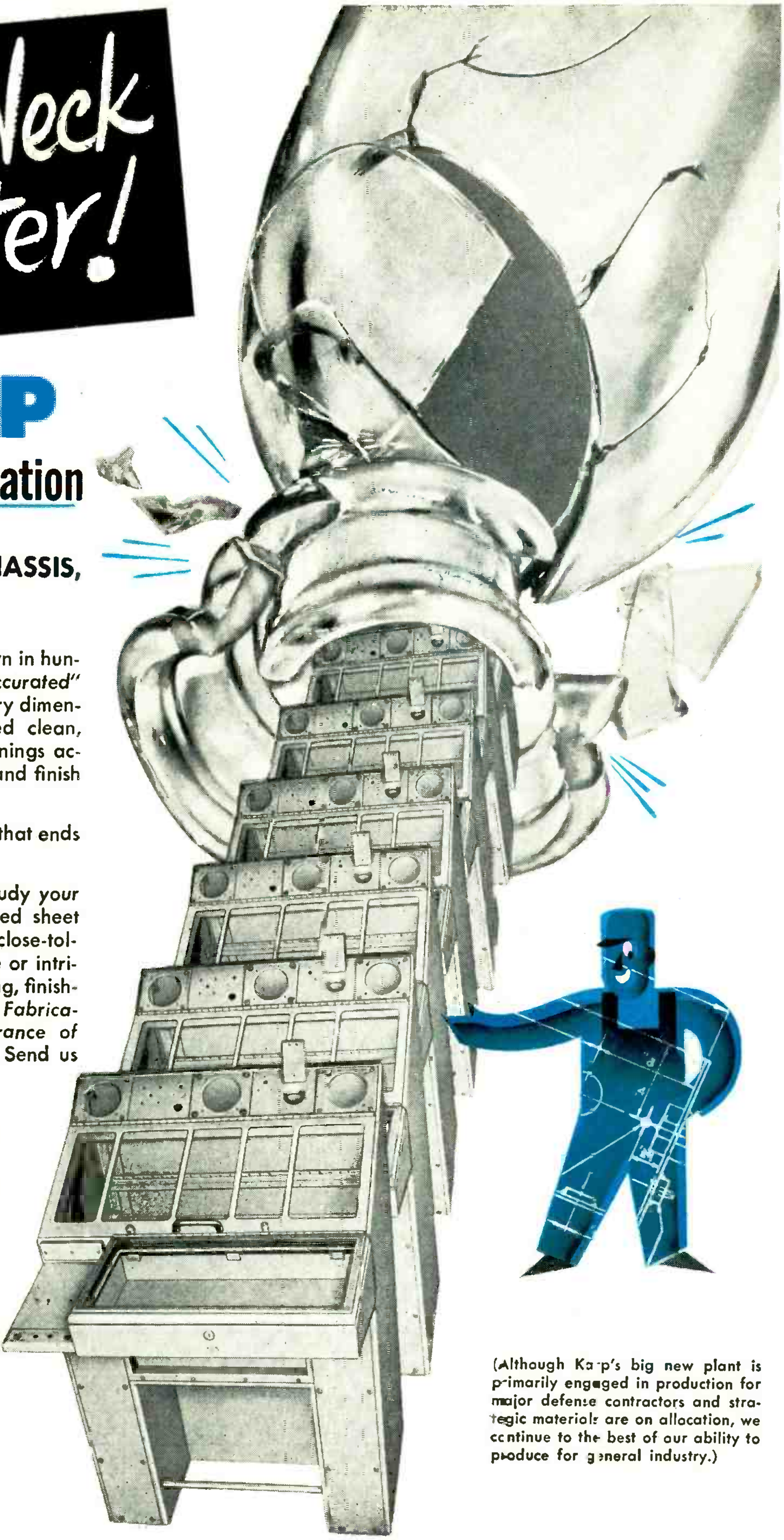
IN CANADA. SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

Bottle Neck Buster!



...KARP
"Accurated"* Fabrication
OF SHEET METAL CABINETS, HOUSINGS, CHASSIS, ENCLOSURES

Production is rolling and costs stay down in hundreds of plants, thanks to *KARP "Accurated" Fabrication*. Here is insurance that every dimension is accurate . . . every hole drilled clean, correctly sized and positioned . . . openings accurately spaced . . . all units uniform, and finish perfect.

That adds up to smooth, fast assembly that ends lost motion and builds volume output!

Why not let Karp Design Engineers study your assembly requirements for a fabricated sheet metal unit? Whether it's a liberal or close-tolerance job—whether it calls for simple or intricate forming, drawing, bending, welding, finishing, or all combined . . . *"Accurated" Fabrication* the Karp way *means real insurance of assembly ease, speed, and economy.* Send us your blueprints.

***Jobs are rated for required tolerances—liberal or close—with quality maintained at its best.**

(Although Karp's big new plant is primarily engaged in production for major defense contractors and strategic materials are on allocation, we continue to the best of our ability to produce for general industry.)

SEE US AT THE I. R. E. SHOW BOOTHS 49-50

Karp
INDUSTRY'S PARTNER IN PRODUCTION

KARP METAL PRODUCTS CO., INC.

215 63rd STREET, BROOKLYN 20, NEW YORK

Specialists in Fabricating Sheet Metal for Industry

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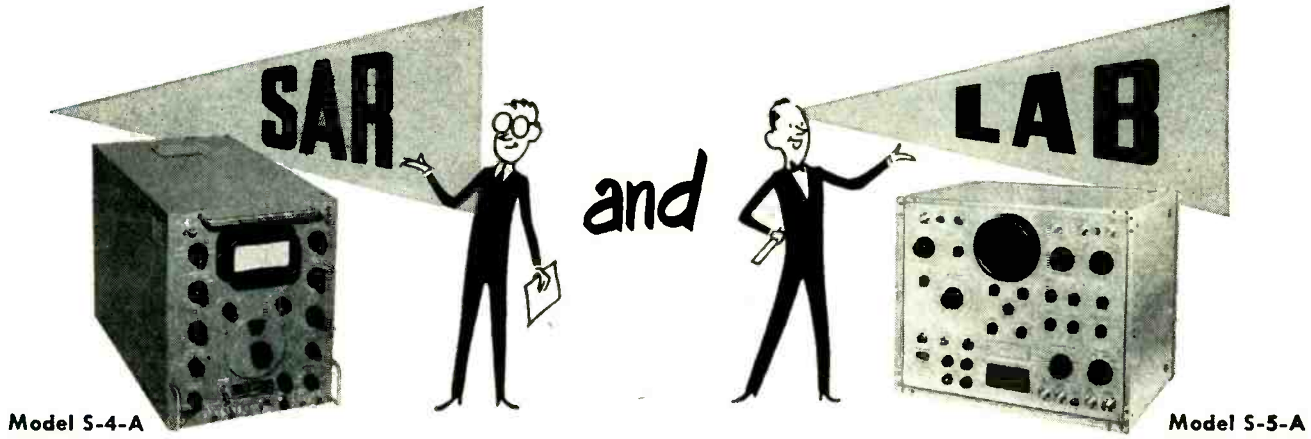
PULSESCOPE®



Model S-4-A

Model S-5-A

PULSESCOPES are Oscilloscopes to portray the attributes of the pulse: such as shape, amplitude, duration and time displacement. Both of the PULSESCOPES have Video amplifiers with frequency response up to 11 megacycles with Video delay of 0.55 microseconds and pulse rise and fall time better than 0.07 microseconds.

S-4-A SAR PULSESCOPE—Video Sensitivity 0.5vp to p/in. S Sweep 80 cycles to 800KC, either trigger or repetitive. A Sweep 1.2 microseconds to 12,000 microseconds. R Delay 3 microseconds to 10,000 microseconds directly calibrated on precision dial. R Pedestal (or Sweep) 2.4 microseconds to 24 microseconds. Internal Crystal Markers 10 microseconds and 50 microseconds. Size 9⅛ x 11¼ x 17¼". Weight: Less than 32 pounds.

S-5-A LAB PULSESCOPE—Video Sensitivity 0.1vp to p/in. Sweep 1.2 microseconds to 120,000 microseconds with 10 to 1 expansion. Sweep either trigger or repetitive. Internal Markers synchronized with Sweep from 0.2 microseconds to 500 microseconds. Trigger Generator and built-in precision amplitude calibrator. Completely cased. Size: 16½ x 14⅛ x 14½". Weight: Less than 60 pounds.

WATERMAN RAYONIC TUBE DEVELOPMENTS

3 SP

Since the introduction of Waterman RAYONIC 3MP1 tube for miniaturized oscilloscopes, Waterman has developed a rectangular tube for multi-trace oscilloscopy. Identified as the Waterman RAYONIC 3SP, it is available in P1, P2, P7 and P11 screen phosphors. The face of the tube is 1½" x 3" and the over-all length is 9¼". Its unique design permits two 3SP tubes to occupy the same space as a single 3" round tube, a feature which is utilized in the S-15-A TWIN-TUBE POCKETSCOPE. On a standard 19" relay rack, it is possible to mount up to ten 3SP tubes with sufficient clearances for rack requirements. All RAYONIC cathode ray tubes are available in P1, P2, P7 and P11 phosphors. We are authorized to supply 3SP1, 3JP1 and 3JP7 with JAN stamp. All RAYONIC tubes listed below operate on 6.3 volts heater with .6 amp. current.

3 MP

TUBE	PHYSICAL DATA			TYPICAL VOLTAGES				DEFLECTION FACTOR V/IN.		MAX. VOLTS	
	Face	Length	Base	Anode # 3	Anode # 2	Anode # 1	Grid # 1	D1 to D2	D3 to D4	Anode # 3	Anode # 2
3JP	3 inch Round	10 inches	Medium Diheptal 12 Pin	3000	1500	300 to 515	−22.5 to −67.5	127 to 173	94 to 128	4000	2000
				4000	2000	400 to 690	−30 to −90	170 to 230	125 to 170		
3MP	3 inch Round	8 inches	Small Duodecal 12 Pin		1000	200 to 350	0 to −68	140 to 190	130 to 180		2500
					2000	400 to 700	0 to −126	280 to 380	260 to 360		
3SP	1½ x 3 inches	9.12 inches	Small Duodecal 12 Pin		1000	165 to 310	−28.5 to −67.5	73 to 99	52 to 70		2750
					2000	330 to 620	−58 to −135	146 to 198	104 to 140		

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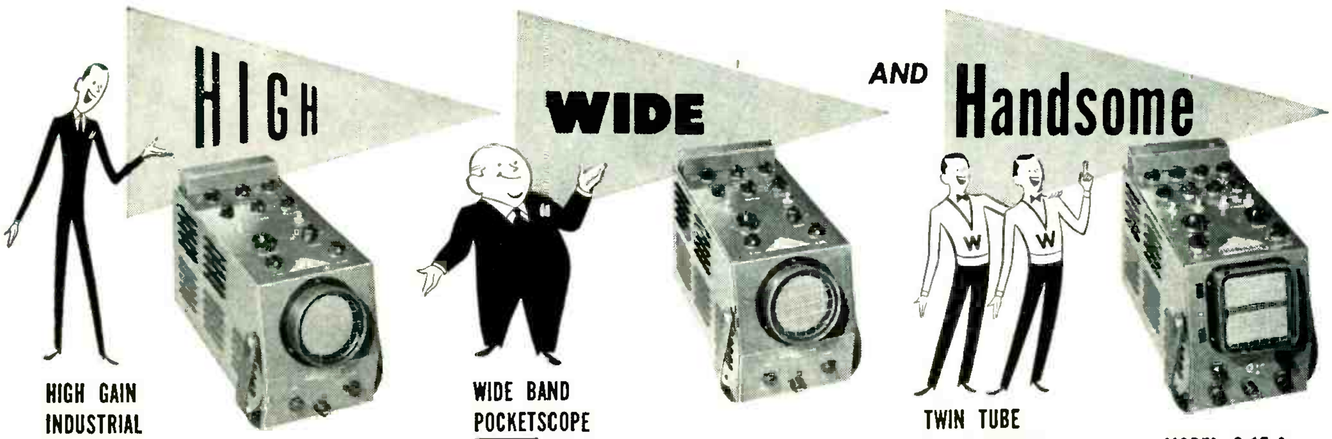
THE WATERMAN LINE-UP

POCKETSCOPE®



HIGH GAIN INDUSTRIAL POCKETSCOPE — MODEL S-14-A

WIDE BAND POCKETSCOPE — MODEL S-14-B

TWIN TUBE POCKETSCOPE — MODEL S-15-A

HI, WIDE and HANDSOME POCKETSCOPES are characterized by small size, light weight, and outstanding electrical performance. All units have frequency compensated attenuators as well as non-frequency discriminating gain controls. All units have both periodic and trigger sweeps from ½ cycle to 50KC. The amplifiers are direct coupled thus frequency response starts from 0 cycles. No peaking coils are used, thus, the transient response is good. Full expansion of trace, both vertical and horizontal, is built in. Means for amplitude calibration are provided. DC coupling in POCKETSCOPES provides unusual stability of the trace, regardless of the line voltage changes or variations of impedances in the input circuit. The HI, WIDE and HANDSOME POCKETSCOPES are the outgrowth of Waterman pioneering of the first commercial miniature oscilloscope, which has proved to be useful and reliable over a period of years. Combination filter and graph screens are used for better visibility, thus traces can be observed even under high ambient light conditions. Binding posts for convenience of connections, with an effective shield, are used. S-14-A has sensitivity of 10 mv/inch with pass band above 200KC. S-14-B has sensitivity of 50 mv/inch with pass band above 1 megacycle. S-15-A is similar to S-14-A except that it has two independent CR Tubes for multi-trace oscilloscope work. Accessories such as carrying cases and probes are available.

S-11-A

The Model S-11-A Industrial & Television POCKETSCOPE is a small, compact, lightweight instrument for observation of repetitive electrical circuit phenomena. The Industrial & Television POCKETSCOPE is a complete cathode ray oscilloscope incorporating the cathode ray tube, vertical, horizontal, and intensity amplifiers, linear time base oscillator, blanking, synchronization means and self-contained power supply. The Industrial & Television POCKETSCOPE can be used, not only for AC measurements, but for DC as well, inasmuch as it has vertical and horizontal amplifiers which are capable of reproducing faithfully within −2 db, from 0 to 200KC. The sensitivity of the vertical and horizontal amplifiers is high and is in the order of 100 mv rms/in.

S-12-B

Model S-12-B RAKSCOPE has the features of S-11-A POCKETSCOPE, plus. The RAKSCOPE is JANized and the government model number is OS-11. The Sweep, from 5 cycles to 50KC is either repetitive or triggered. Vertical and horizontal amplifiers are 50 millivolts rms per inch with band pass from 0 to 200KC. Special calibrating circuitry is provided for frequency comparison. Both the vertical and horizontal amplifiers are identical and use no peaking. The panel is only 7″ high and the scope fits standard rack. The functional layout of the control permits ease of operation.

WATERMAN PRODUCTS CO., INC.

WATERMAN PRODUCTS

PHILADELPHIA 25, PENNA., U.S.A.

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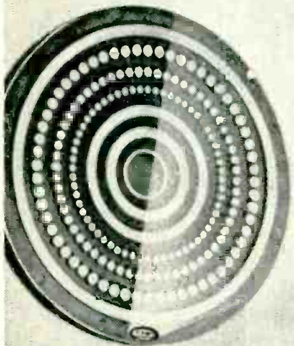

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INJECTION MOLDED GRADES

MYCALEX 410

Mycalex 410 is approved fully as Grade L-4B under National Military Establishment Specification JAN-I-10 "Insulating Materials, Ceramics, Radio, Class L."

Power Factor, 1 megacycle	0.0015
Dielectric Constant, 1 megacycle	9.2
Loss Factor, 1 megacycle	0.014
Dielectric Strength, volts/mil	400
Volume Resistivity, ohm–cm	$1x10^{15}$
Max. Safe Operating Temp., °C	350
Water Absorption, % in 24 hours	nil
Tensile Strength, psi	6000

MYCALEX 410X

Mycalex 410X can be injection molded, with or without metal inserts, to extremely close tolerances.

Power Factor, 1 megacycle	0.012
Dielectric Constant, 1 megacycle	6.9
Loss factor, 1 megacycle	0.084
Dielectric Strength, volts/mil	400
Volume Resistivity, ohm–cm	$5x10^{14}$
Max. Safe Operating Temp., °C	350
Water Absorption, % in 24 hours	nil
Tensile Strength, psi	6000

MACHINEABLE GRADES

MYCALEX 400

Mycalex 400 is approved fully as Grade L-4A under National Military Establishment Specification JAN-I-10 "Insulating Materials, Ceramics, Radio, Class L."

Power Factor, 1 megacycle	0.0018
Dielectric Constant, 1 megacycle	7.4
Loss Factor, 1 megacycle	0.013
Dielectric Strength, volts/mil	500
Volume Resistivity, ohm–cm	$2x10^{15}$
Arc Resistance, seconds	300
Max. Safe Operating Temp., °C	370
Water Absorption, % in 24 hours	nil
Tensile Strength, psi	6000

MYCALEX K-10

Mycalex K-10 conforms fully to Grade HIC5H4 under National Military Establishment Specification JAN-I-12.

Dielectric Constant, 1 megacycle	10.6
Q Factor, 1 megacycle	300
Loss Factor, 1 megacycle	0.034
Dielectric Strength, volts/mil (0.10 in. thickness)	270
Fractional Decrease of Capacitance with Temperature Change	0.0056
Fractional Increase of Capacitance with Temperature Change	0.0076

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ECONOMICAL — Comparative in cost to ordinary phenolic sockets, but far superior electrically. Dimensional accuracy unexcelled.

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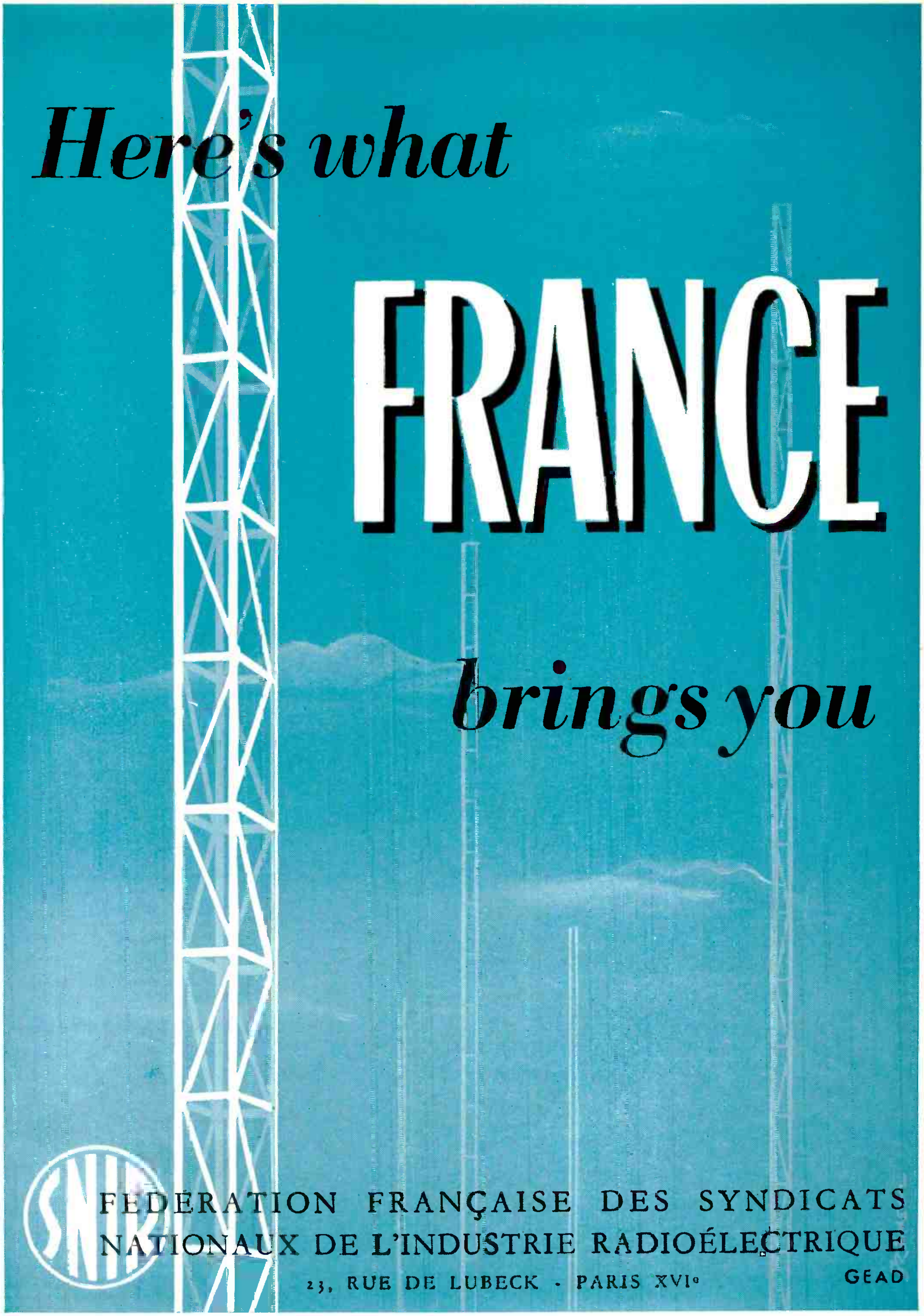
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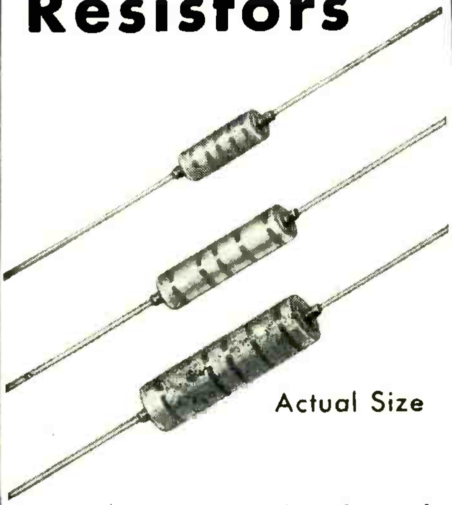

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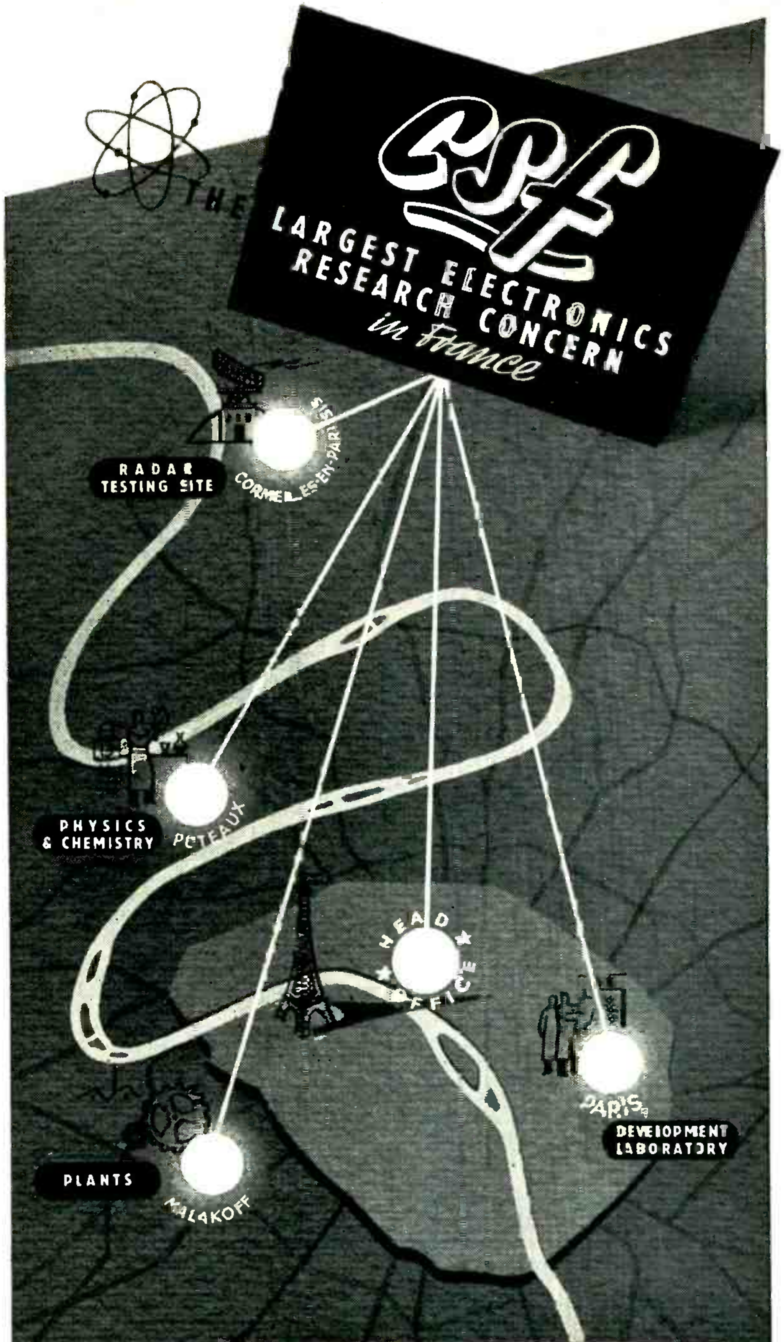

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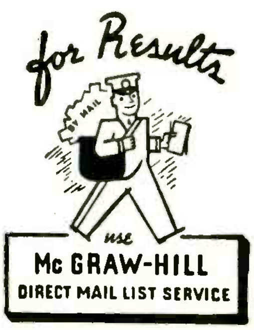

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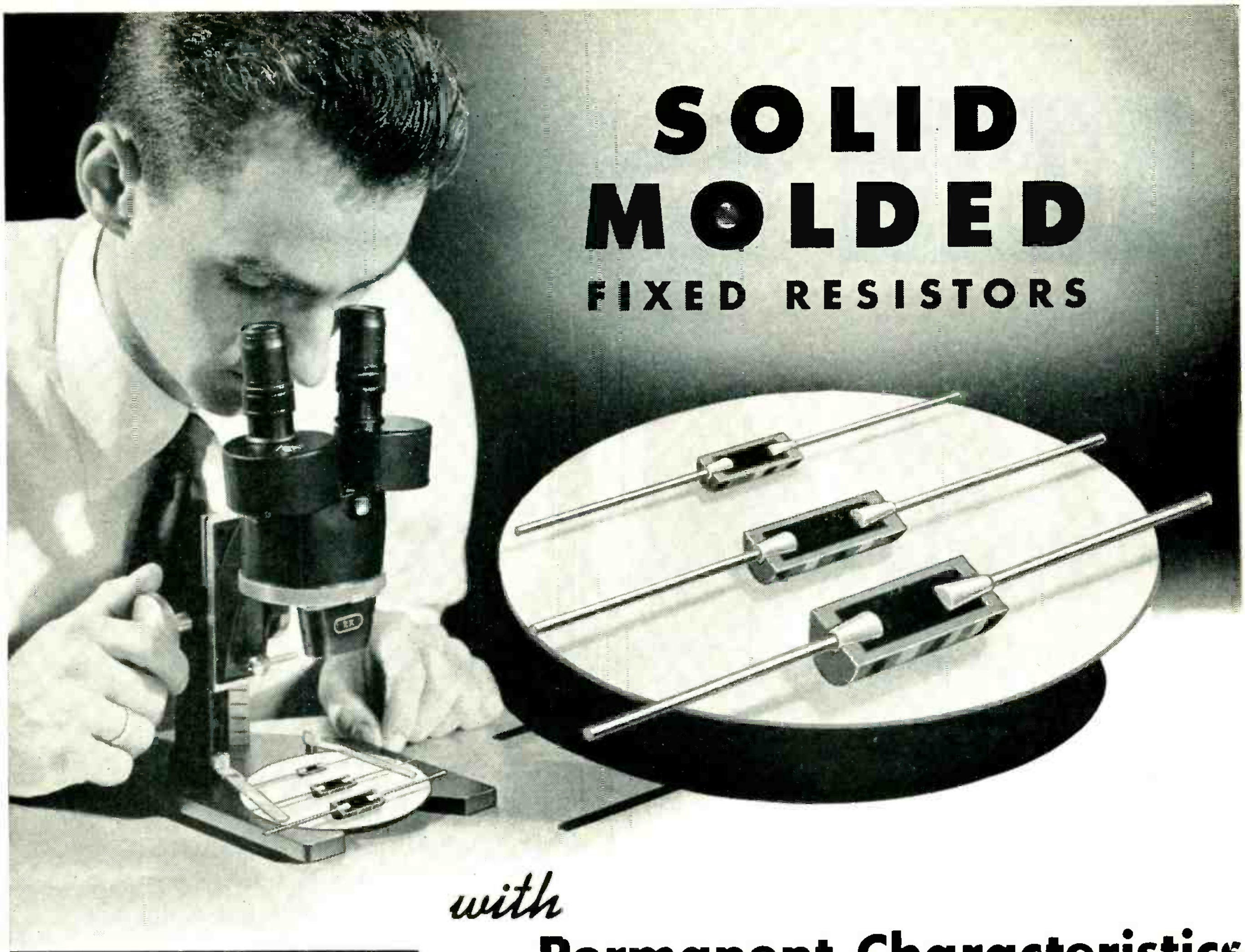

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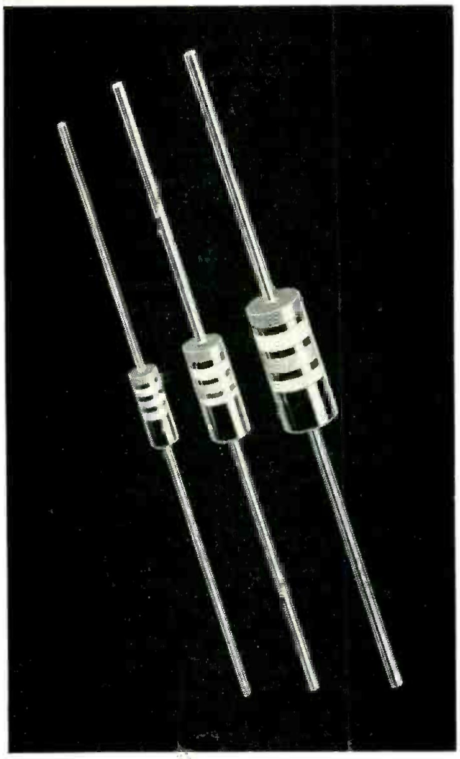

The solid molded construction gives Bradleyunits a wide safety factor. They are not crowded for performance because they are rated at 70C . . . not at the usual 40C. Under continuous full load for 1000 hours, the resistance change is less than 5 per cent.

They withstand all extremes of temperature, pressure, and humidity. And, don't forget that Bradleyunits require no wax impregnation to pass salt water immersion tests.

Bradleyunits are packed in honeycomb cartons to keep the leads straight and avoid tangling during assembly operations. Made in standard R.T.M.A. values in ½ and 2 watt ratings from 10 ohms and 22 megohms; 1 watt from 2.7 ohms to 22 megohms. Let us send you an A-B resistor chart.

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SIZES OF BRADLEYUNITS

Rating	Length	Diameter
½-w	3/8"	9/64"
1-w	9/16"	7/32"
2-w	11/16"	5/16"

A-B Quality

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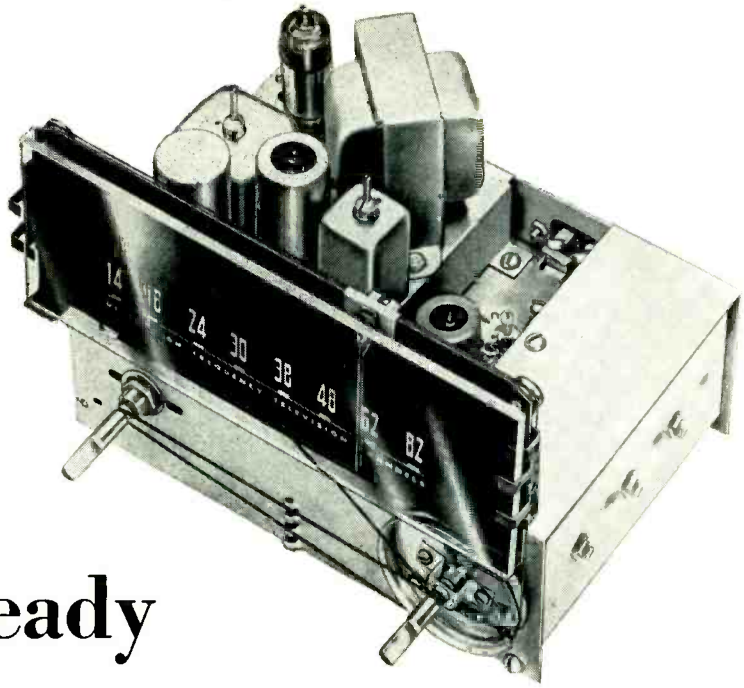
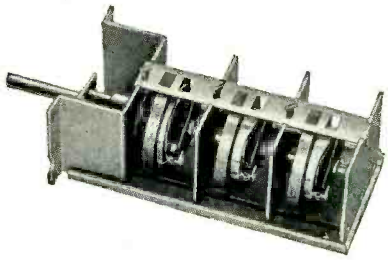
Sold exclusively to manufacturers QUALITY of radio and electronic equipment

UHF



Mallory Is Ready

to equip any receiver for UHF channels



Mallory UHF Tuner

A new version of the continuously variable Mallory Inductuner®, consisting of three sections of variable inductance. Covers the range between 470 and 890 megacycles with approximately 2 micromicrofarads of shunt capacity and in 270° of shaft rotation. Selectivity is excellent over the entire band.

Available now for assembly in your converter or as an auxiliary UHF tuner in your receiver.

Now In Development
A combination VHF-UHF tuner.

The Mallory UHF converter has been designed to permit the tuning of *all* UHF channels by *any* TV receiver, with no sacrifice of VHF reception. Connection to the receiver involves only the power line and antenna leads—no internal adjustments are required. Check the characteristics listed below and in the panel at the left describing the basic tuner.

Physical dimensions 8⅛″ x 6¼″ x 5³⁄₁₆″

Built-in IF amplifier operating at the conversion frequency (channels 5 and 6) makes up for conversion and tuning losses

Temperature compensation and stabilization prevents frequency drift after initial warm-up

Low noise figure

High image and IF rejection ratios

The converter chassis is now available to set manufacturers for assembly with cabinets, dial plates and knobs of their design. Complete technical literature will be sent promptly on request.

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CROSS TALK

▶ LONG LINES . . . Someone, and it might as well be we, should congratulate the Long Lines Department of AT & T on the tv picture quality displayed by the coast-to-coast microwave relay. It's unbelievably good, considering there are 107 relays involved. After 15 years of looking at tv images, we still can't be sure at first glance whether a program is originating here in New York, ten miles away, or in Hollywood 2,900 miles away.

By eye, that is. By ear we can spot the difference, because the accompanying sound has the flat dull tone, long familiar on the radio nets. It's a long circuit, and it's limited to 5,000 cycles, and it sounds like it.

So we have a puzzle: excellent picture and mediocre sound. It gives us to think that the 4,000-kc circuit required for the picture is better engineered than the 5-kc circuit for the sound, despite the fact that the audio engineers had a 25-year head start on the video boys.

As usual such puzzles turn up with economic backgrounds. The alleged justifications of poor sound quality involve the higher cost of better sound circuits. According to the published tariffs on such matters, the 5-kc audio circuit can be had for a monthly cost of $6 per mile and $75 per station connected. If you want a 15-kc circuit and can get the facilities (Continental has one between Washington and New York) it costs $10 per mile and $150 per station, just about double for a multi-station hookup. This 100-percent increase explains why *radio* networks are not flirting with 15-kc lines.

But the economic justification for poor sound quality is vastly less cogent in a *tv* network. The comparable figures (16 hours uninterrupted service daily for a month) for a picture circuit are $51 per mile and $540 per station. With 5-kc sound service this totals $57 per mile and $615 per station. If you want 15-kc sound you have to pay only about 10 percent more (7 percent on the mileage and 12 percent on the station connections). Maybe radio networks, on a falling market, can't afford good sound at 100 percent extra. But tv networks, on a steeply rising market, can certainly afford it at 10 percent extra. We have first-class video circuits, coast-to-coast. Why in tunket can't we give the bird another seed and get first-class audio circuits into the bargain?

▶ DELAY . . . Our investigation into tv networks, incidentally, reveals that the coast-to-coast audio circuits are all carried at radio frequencies, either by microwave or coaxial cable, to keep the sound synchronized with the picture. If conventional wire circuits were used on any distance comparable to the width of the continent, the sound would lag behind the picture by a tenth of a second or more. All of which reminds us that there is a law relating the delay in a circuit and the frequency of operation, which says that short delays come with high frequencies. And another law (less strictly enforced) says that bandwidth comes cheaper on higher-frequency circuits. Which leads to the suspicion that it wouldn't cost too much to widen the tv-sound circuits from 5 to 15 kc, so long as you have to contend with the delay problem in any event. Murray Hill papers please copy, if true.

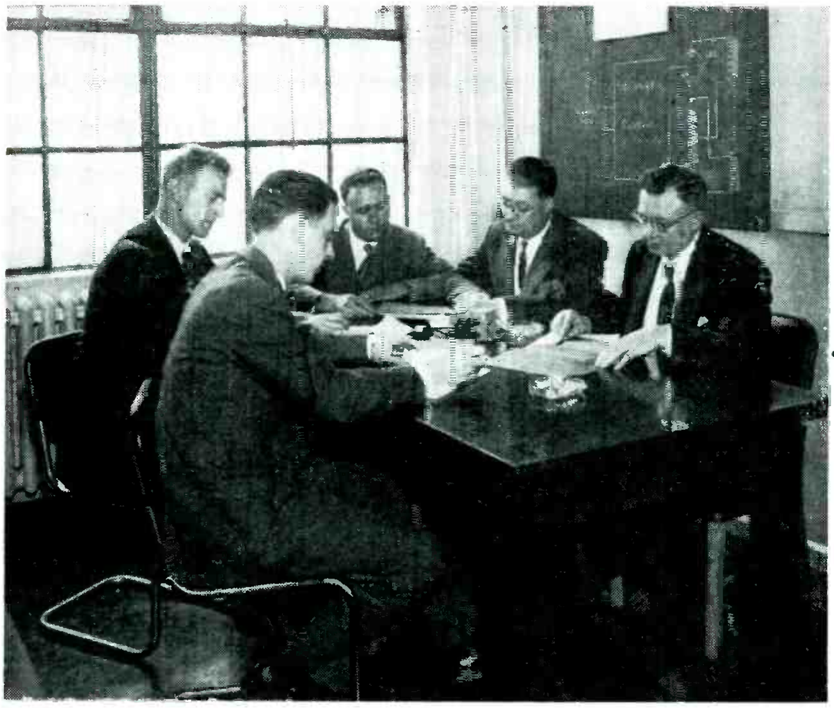
▶ TOP SECRET . . . In a recent issue of *Newsweek*, General Carl Spaatz wrote a piece "Electronics: The Next Winner" in which he quite properly assessed the importance of electronics in winning a future war. But he went on to say, "Electronic inventions and improvements should be top secret. Some device that improves television reception in your home may be just the thing, when applied to fighting machines, that would give us a decisive edge."

We can be expected to argue with that one, and we do. It's completely unrealistic to suppose that an improvement in television receivers can be kept from the enemy. It can't be unless it's suppressed, not used, and the word kept from our own technicians, beyond the few hundred who can properly have access to secret papers. Even then it's not really secure. The answer is not secrecy, it's continued rapid progress. We do ourselves more good if we pass around purely technical information (keeping operational matters under wraps) just as fast as we can pass it.

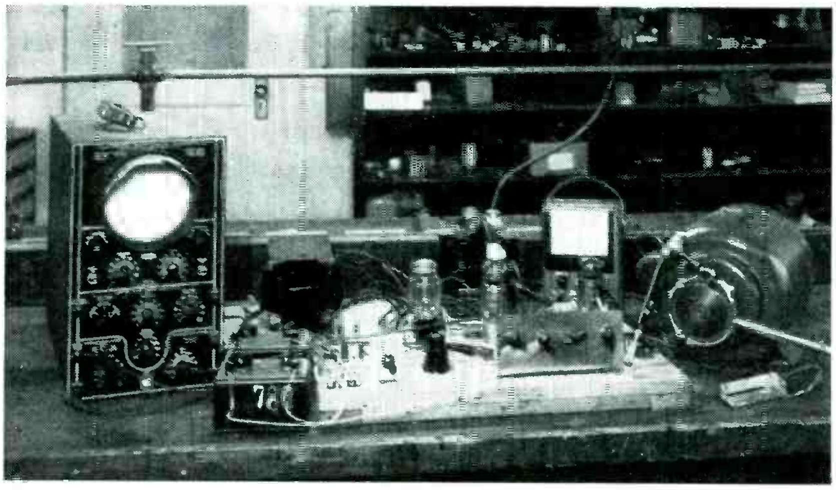
How to

By OSCAR E. CARLSON

Vice-President
Servo-Tek Products Co., Inc.
Paterson, New Jersey



1 Conference meeting of management and engineering for initial planning. Initial decisions made here determine broad policy and design objectives



2 Breadboard model and test setup for functional tests. Major component specifications are determined at this point as well as basic circuit design

3 Engineering and drafting for prototype design. Close engineering supervision of all the necessary drafting assures attainment of the proper end result

ENGINEERING DESIGN requires a knowledge not only of basic electric, electronic and mechanical fundamentals, but a thorough understanding of the end requirements as to the equipment's operating conditions and environment. This presupposes a knowledge of the functional equipment requirement.

Normally, the electronic designer is aided in equipment layout and mechanical detail by a mechanical engineer or design draftsman with considerable mechanical design ability. A knowledge of metals, shop practices, production methods and product end use are all a part of the co-ordinated requirements for a complete design problem. A thorough and successful electronic designer must have a minimum basic knowledge of all these fields in addition to his required electronic ability.

A further prerequisite that may be inserted here rather parenthetically, but not of minimum importance, is an understanding of the economics involved, not only for design, but for the entire path of flow, from product conception through design, drafting, production and final marketing of the product. In short, a properly background-educated design engineer becomes by these requirements capable of simultaneously bridging functions which, in many organizations, require a regular family tree of design and executive personnel. The closer a design engineer comes to these requirements, the more valuable he is to an employer, big or small.

→ **Initial**

Develop a New Product

Practical step-by-step procedure for putting a new electronic product on the market successfully is carried through product conception, design, drafting, production and final marketing. Desirable qualifications for development engineers are emphasized

It is one of the inconsistencies of modern mass-production factories that on one hand broad individual ability is needed, and on the other hand personnel are often trained by such methods that each man has a specific mechanized function. By this type of engineering training employers lose much of the inherent ability that exists in their engineering personnel.

One cannot say that colleges and engineering schools must deliver graduate engineers meeting all the prerequisites. But, the in-plant training and job assignments for student and junior engineers should not be limited to the engineering department nor to straight design functions. Student and junior engineers should become familiar with production methods, tests, purchasing, raw-material specifications, field problems, shop burdens, management burdens and product merchandising. In short, they should learn considerable about the business of which they form a part. It is only when a thorough knowledge of all these has been integrated into their relationship with a product of the company that the company officials may choose the proper paths of administrative action.

The Motive

The primary object of design is profit. This is rather a cold statement. But few companies are in business just for the fun of it. The first questions concerning a contemplated design are then, naturally: "Is there a market for the item? Do similar items sold by competitors have an apparent corner on the market? Will our version do a better job at less expense? Is our merchandising ability such that we can get a share of the available business sufficient unto the size of our organization and the capital risk involved in initiating such design, production and marketing?"

The latter question is extremely important. Few products or designs are exclusive to the functional operation of such an item and, therefore, few electronic designs are new and revolutionary. In short, there is always competition.

Has competition kept pace with the state of the art? The answer is often no. Once a product has been designed and tooled up it becomes difficult in the extreme to make radical modification without large expense for retooling. Henry Ford stuck to the Model T for many many years. But refusal to keep pace with the art was extremely costly. How long may a design be expected to remain modern? Tooling and design costs must be completely amortized before anticipated obsolescence of the design.

The sea of industry is a stormy one. Even the well-established manufacturers with tremendous capital investment and reserve are not immune from the effects of progress. The railroads put the canals out of business. The railroads have suffered severely from motor trucks and aviation, and are now little farther advanced than they were in 1910. It becomes the function of engineering and management to maintain a flexibility for adaptation to rapidly changing state-of-the-art conditions so that business is not lost to a younger and more energetic competitor cognizant of new conditions in the field.

The Concept

Let us first assume that the proposed article is to be made by an established design and manufacturing firm. The problems of design, manufacturing and sales as related to the design engineer and his employer for a new firm are so contingent upon the firm's financial ability to weather the design, tooling and merchandising storm, that those problems are transients rather than more stable, nearly steady-state conditions of a going concern. It must be remembered at this point that it is nearly always a prerequisite that a product of new design have a nonprofit growth period. This usually holds equally true for a new design and manufacturing firm.

The sales manager or various sales representatives for an established firm may request the factory to expand the line of manufactured items. The management group is informed that there is a large market potential, as an example, for electronic variable-speed motor-control systems. This large potential is a relative thing that might not be attractive enough for an extremely large firm.

Upon such a request management is faced with the analytical task of determining answers to the profit-motive questions. It is at this point that the engineering staff is first called upon. First, the existing items on the market must be ex-

Design Planning of a Product Leads To . . . . ⟶

amined from the designer's viewpoint. This examination may in many instances be made only on specifications and published data, without physical examination of actual equipment. The latter is, of course, to be preferred.

Many months of research and laboratory work may be needed to determine if a unit can be produced better than or equal to that of present competition at equal or less price than the competitors'. Can our company improve the design by simplification? What is the patent situation? Are the patent holders manufacturing such items? Can licensing be arranged if needed? Are there any improvements in mind that are of patentable calibre? Are most of the required components available as stock items from other manufacturers, or will the tooling costs be high to make such components?

If tooling costs are likely to be high, will such an expenditure tend to prevent additional competition? It is to be emphasized at this point that being tooled for a production is oftentimes more valuable to a manufacturer than a large number of easily infringed-upon patents.

After managerial assessment of answers to these and other questions, aided by the engineering department, the engineering department may be given the OK to proceed with a preproduction design and functional models. Tentative design specifications are agreed upon between sales and engineering, weighing carefully the claims and merits of the competitors' items. Don't depend on their advertising—analyze their stipulated operational specifications. Fantastic claims can be made for even the poorest design. Here engineering may reduce costs by weighing requirements of sales for gadgets and gimmicks. But remember, the sales manager may know more about the required end results needed than does the equipment design engineer. Therefore, the liaison between sales and design must be cognizant of the abilities and responsibilities of each.

The circuit design must be basically completed in laboratory mock-up units. Radical design changes at a later date during production can be extremely costly. The basic circuit design and qualification testing of same constitutes the culmination of product conception. But the product has a long way to go before that conception gives birth to a recognizable end product.

The Development

Some of the preliminary laboratory design and mock-up work for the typical example of a motor control is, of course, done with non-optimum components. The electronics engineer faced with such a design is brought to the rude awakening that all his electronic specialization has left him lacking in the knowledge of other units associated to his design. The electric motor theory required for such a design necessitates that he do a little homework, brushing-up and plain research in that field. It is soon established that one of the engineering team must be assigned to the problem of becoming a motor expert.

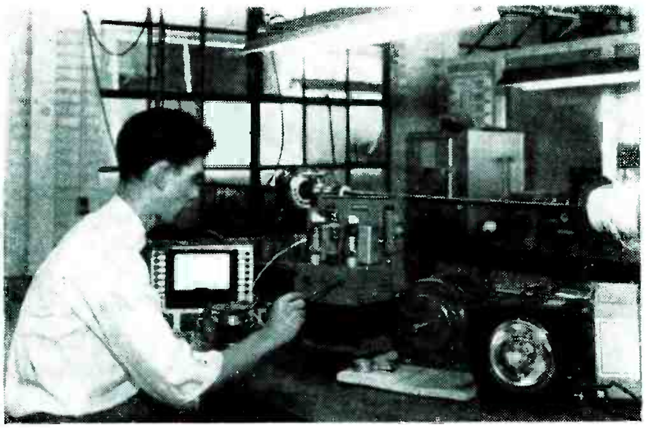
Let us take as a further example the design of a half-wave thyratron-type bidirectional motor control for a d-c motor. For simplicity, the unrectified d-c voltage is desired to be 220 volts. What requirements does this impose on the motor armature? One may assume the motor to be a coupling device between the rectifier tube and the mechanical load, so that it simply converts electrical to mechanical energy.

It will be necessary, therefore, to have a motor armature of such design as to develop at desired base speed a generated emf far below the value for the peak voltage of the applied rectifier sine-wave plate potential. An arbitrary initial design point of logical selection is to allow a long conduction period over the halfwave period. If the first mock-up work is done on a standard 220-volt-armature d-c motor, the results must be prorated on the above basis.

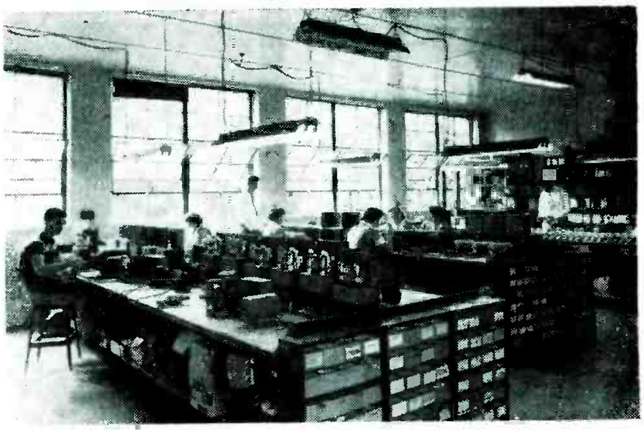
It is known that the motor torque in this instance is proportional to the d-c armature current. But what of the rms value? Evidently the motor must be derated due to this extra heating. How much?

The electronic designer on this assignment must provide tentative motor specifications to the motor

→ . . . . Final Testing, Production, Marketing and



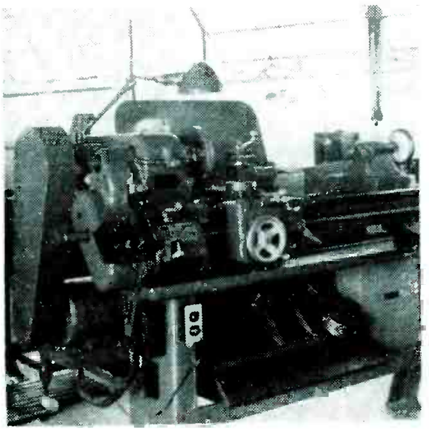
4 Final prototype unit test by engineering. Engineering tests on this unit finalize design for pilot production



5 Electronic assembly and testing. Careful assembly and testing in clean pleasant rooms assure well-constructed products supplier. Considerable help may, of course, be obtained from the engineering staff of such a motor manufacturer.

While the prototype transformers and motor are being processed, the design engineering group may give thought to final cabinetry or housing. How much heat is to be dissipated in the unit? Will this require forced air cooling? How is the equipment to be mounted? What are the environmental conditions that might affect the housing and cooling requirements? Are

Application



6 Product application. One of the Servospeed units is shown installed on a lathe

service shutdowns permissible? Remember this is no a-c/d-c radio that may lay around the service shop for a couple of weeks. It may have to be restored to operation within minutes of a failure to prevent costly down time on an industrial machine. Servicing must be done by relatively inexperienced personnel. Can plug-in components be used for all critical components such as capacitors, resistors and the smaller sizes of coils and transformers?

For the prototypes or preproduction units the designer should provide sketches to drafting for chassis and enclosure. He should then check these drawings by himself, using model-shop facilities to construct such units. This checks drawings and design for ease of manufacture and results in many small final improvements. If the designer is not set up to perform such model-shop procedure in a particular plant, he should check closely the model-shop procedure and obtain design criticism comments from the model shop. The time and place to iron out manufacturing difficulties is prior to production. This is, of course, not completely capable of achievement, but many wrinkles that crop up in production are the faults of designers!

With circuitry and preproduction models completed, the testing, specification writing and material procurement may be initiated. Upon receipt of preproduction component samples from vendors, further tests must be made to OK such component suppliers to proceed with their production.

The sales group again enters the picture to obtain engineering help in preparing sales literature, new-product releases and advertising data. Comprehensive instruction books and service manuals can be prepared during this interim of procurement. Much of this data is available only from the design group and close liaison is needed. It is of considerable help at this point if the designers have visited and inspected potential installation points and become familiar with actual operational applications of the product.

The End Point

With advertising in the publication mill and the sales group obtaining the first few hard-won sales, the first pilot production run may be launched. The quantity of this first production may be best arrived at by careful analysis of anticipated requirements and delivery schedules that it is desired to meet. Let us emphasize at this point that deliveries should be made from stock on any item for which, as a catalogue or standard item, a company has released data. Nothing is more disillusioning than to get an answer to an inquiry informing a potential customer that deliveries of a newly announced product can be made in several months. In that case the item was not ready for release.

It is regrettable that, at this particular time, items of current manufacture are on long delivery due to defense priorities. That is not, however, an excuse for using new-product releases for market analysis as is consistently done by many manufacturers in the electronic field, including some of the largest and otherwise most reputable.

With the pilot production run there will occur many new problems that require the design engineers' attention — manufacturing procedures, tolerances, minor changes to aid manufacture and tolerances that add up so as to impair performance. All of these may be expected and must be promptly corrected or compensated for in the pilot run to insure a potentially smooth production flow for subsequent production.

The engineering responsibility for the product continues through the plant and for the successful operation of the product in the field. Field failures and complaints may well require design changes of some magnitude to be inserted into subsequent production runs. The drawing and plant record system for such changes must always be kept up to date by engineering so that the shop builds what the drawings call for. There is no excuse for products being constructed contrary to drawings and specifications because of paper-work lag on the part of engineering. Nor can unauthorized deviations from drawings or specifications be allowed to exist where such manufacturing deviations were required. Immediate paper-work correction steps must be taken so that an unbroken record chain carries the complete factory story for the product.

If and when the job of a design has been properly completed and production started, it should be possible for a competent but completely new staff to take over such a design and production at any stage and follow through from the complete and accurate records of the original group. There is no known substitute for complete and accurate drawings together with process sheets and test data to cover a complete product operation.

It is only by such a complete and accurate system that engineering can delegate production authority to less skilled technical personnel so that engineering may return to the starting point of this product for another new one.

Simultaneous A-M and F-M

Two full-time channels on a single carrier allow transmission of complicated data for which sampling techniques are inadequate. One is a video channel 5 megacycles wide used for waveforms and other experimental signals from sounding rockets

By W. CULLEN MOORE*

Project Supervisor
Upper Atmosphere Research Laboratory
Boston University
Boston, Mass.

SIMULTANEOUS amplitude and frequency modulation with two independent messages on a single carrier finds an excellent application in upper atmosphere research using sounding rockets where space, weight, and recording or transmission facilities are controlling factors in determining how many experiments can be included in any one flight. This is particularly true for continuous-carrier transmitters used for relaying video-type signals because the associated power supply usually accounts for a large portion of the total weight of the equipment. The potentialities of the system would seem to justify a fuller investigation than has been reported in the literature.[1,2,3]

The Johns Hopkins Applied Science Laboratory system[4] and the M.I.T. Laboratory for Electronics system[5] are examples of the trends in telemetering from rockets in which sampling techniques are used to increase the number of independent items of information being handled. There are, however, a number of experiments being performed in upper atmosphere research yielding outputs that cannot be sampled. Rapidly varying phenomena, unusual waveshapes, and randomly timed impulse-type signals all require continuous transmission and often large bandwidths.

A cursory examination of the equation for the distribution of energy in the carrier and sidebands of a frequency-modulated wave might lead one to believe that it would be impossible to prevent the frequency-modulation signal from appearing in the output of the amplitude-modulation portion of the system, and vice versa. The relative amplitudes of the carrier and sidebands, given by Bessel functions for the frequency-modulation components, vary through a range of values that may include zero as the signal frequency and amplitude are varied. However, amplitude modulation affects the frequency-modulation carrier and sidebands in the same proportion and therefore does not affect the phase of the vector resultant. Frequency modulation results in a single vector resultant current that varies in phase but is constant in amplitude. It is this constant-amplitude resultant that is subjected to amplitude modulation. As long as all of the significant sidebands of both modulation processes are accepted by the receiver with uniform amplitude response, there will be no transfer of information from either channel to the other ahead of the detection circuits. Experimental confirmation of this conclusion is presented in reference 6.

The radio link from rocket to ground used by Boston University operates on a carrier frequency of 183 mc. The output of a frequency-modulated oscillator operating at approximately 10 mc is increased to the output frequency by a combination of heterodyning and frequency multiplication. The amplitude modulation is applied to the carrier in the final stage either by control-grid modulation or by screen-grid modulation, the choice of modulation circuit depending on the bandwidths of the two signals.

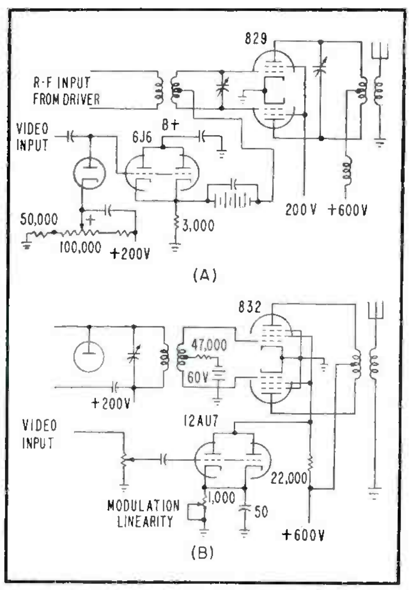


FIG. 1—Wide-band video signals produce a-m (A) by returning grid-bias of final to ground through load resistor of cathode follower. Diode restores d-c level. Screen-grid voltage of final is varied in (B) using tube as ground element of divider circuit

Phase and Frequency Modulators

Two types of frequency-modulation systems have been used successfully. One is the practical application of reactance modulation of the so-called overtone crystal oscillator[7]. This circuit has been used on several flights since its adoption in early 1949. The practical experience obtained and the theoretical analysis of the operation of the circuit carried out by this Laboratory confirm the performance characteristics attributed to it in the literature. On recent flights, a more conventional type of react-

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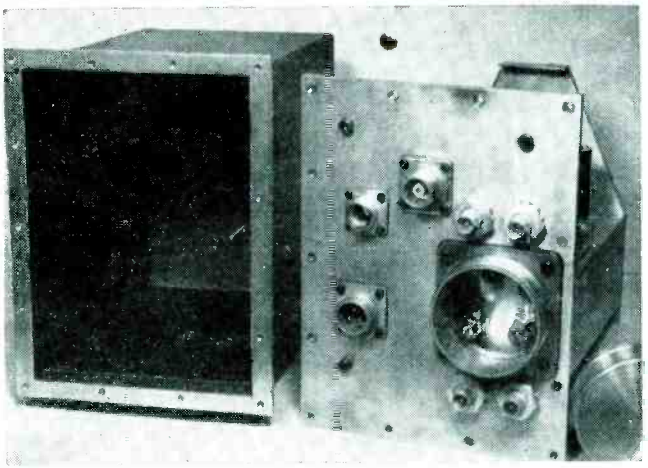
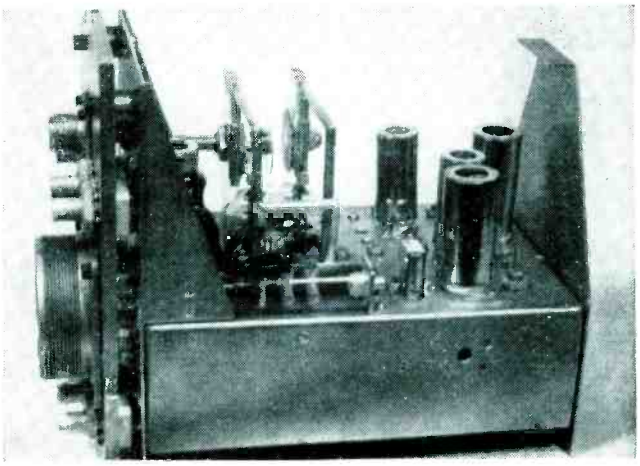
* Now Chief Engineer, Tracerlab, Inc. Boston, Mass.

in Rocket Telemetering





Rocket-borne transmitter showing massive construction, pressurized housing and pressurized access to adjustments over which cap is screwed

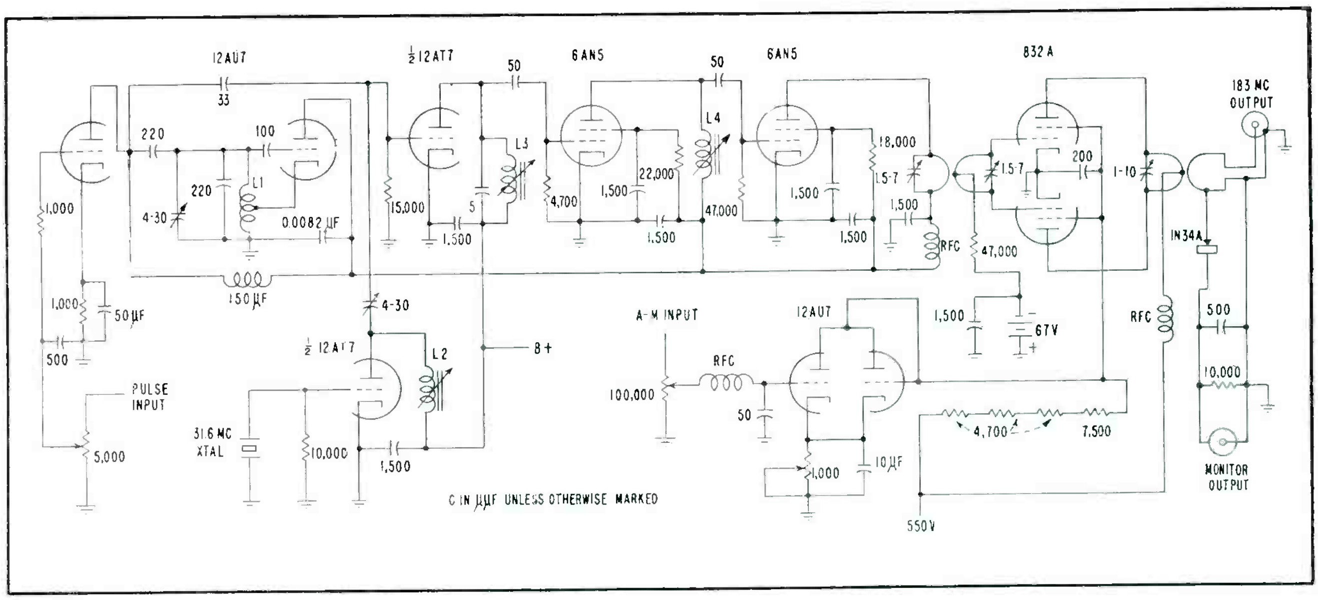


FIG. 2—Rocket-borne transmitter uses reactance modulator for f-m and screen-grid modulation of final stage for a-m

ance controlled oscillator circuit has been used because the transient nature of the pulse signals being handled excited spurious responses in the crystals used. Crystals obtained more recently show improved characteristics in this respect.

The system has been used in two distinct applications. In one case, video signals having components up to five megacycles were applied as amplitude modulation in the grid circuits of the final stage by using the circuit of Fig. 1A. The grids of the output tubes were returned to ground through the cathode-load resistor of a video-frequency cathode-follower stage. A clamp tube in the input of the cathode-follower circuit maintained proper black-level of the carrier.

In the second case, modulating signals having a continuous spectrum up to sixty kilocycles have been applied as amplitude modulation by varying the screen voltage of the final stage at the signal frequency as shown in Fig. 1B. In both cases, the frequency-modulation channel was carrying pulse groups requiring up to thirty kilocycles bandwidth for adequate reproduction. The superaudible signal has also been transmitted as frequency modulation in conjunction with the wideband video signal as amplitude modulation.

Choice of Modulation

In general, it is advisable to apply the modulating signal having the highest frequency components as amplitude modulation because of the requirements placed on the receiver bandwidth. In missile work, however, the signal received over the slant range from the missile to the ground receiving station varies over wide values in a short time and nonisotropic radiation from the antenna on a rolling missile will cause fades. The best allocation of modulation facilities will depend on which of the signals will more readily tolerate changes in output amplitude, the more critical signal being handled as frequency modulation. The circuit diagram of a recent model of a rocket-borne transmitter is shown in Fig. 2.

For a wide-band amplitude-modulated signal and a narrow-band frequency-modulated signal, separate receivers are satisfactory for recovering each modulation. The amplitude-modulation receiver must have a flat pass band over the full frequency excursion of the sidebands of the frequency-modulated signal. Otherwise, the frequency-modulated signal will recover on the sides of the selectivity curve of the amplitude-modulation receiver and appear as an unwanted signal in the output. The restrictions on the frequency-modulation portion of the system represent the ever-present engineering compromise between how well the frequency-modulation receiver will reject the amplitude modulation and the maximum depth of amplitude modulation required to produce satisfactory results in the amplitude-modulation receiver. In practice, it has been found that sixty-percent peak amplitude modulation represented a good design figure for the applications in which the system has been used, although it has been found possible to operate with up to eighty-five percent peak amplitude modulation.

When the amplitude-modulation signal contains abrupt changes in level, it is sometimes advisable to use types of amplitude limiters in the frequency-modulation receiver that do not depend on the time-constant of a circuit for their limiting action. Time-constant limiters may cause a brief loss of signal to the discriminator circuit immediately following a sudden decrease in signal level because the tube is biased beyond cutoff for the reduced signal. Figure 3 shows a composite modulation on the output wave for the case of plate current limiters as investigated by Schwartz of this Laboratory.[6] The gated beam tube also produces good results in this type of service. However, conventional circuits have been found satisfactory for many types of applications of simultaneous amplitude and frequency-modulated signals.

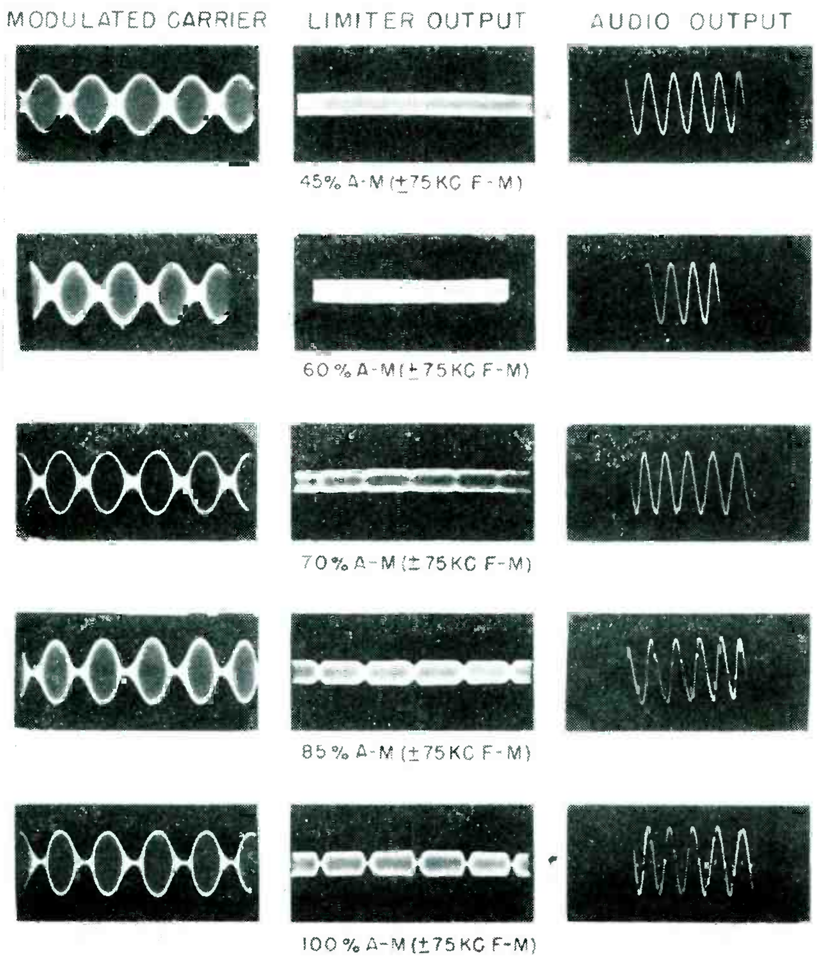


FIG. 3—Effects of varying amounts of amplitude modulation with constant-deviation frequency modulation observed at limiter output and from discriminator

Single Receiver for A-M and F-M

If both amplitude and frequency-modulated signals are of comparable bandwidth, it may be desirable to recover both in the same receiver. This is accomplished by flat-topping the intermediate-frequency signal response of the receiver so as to accommodate the maximum frequency excursions without producing slope recovery of the frequency-modulation sidebands ahead of the amplitude-modulation detector. The extent to which the interchannel crosstalk can be reduced is simply a matter of how much design and adjustment effort the end use of the signals justifies. The circuit of a receiver used for telemetering upper-atmosphere research data from high-altitude rockets is shown in Fig. 4. Both a limiter-current meter and the zero-center discriminator meter are used in the operation of the receiver. The severity of the crosstalk requirements will of course have to be met by equipment designed for each particular application.

To aid in making the final adjustment of percent amplitude modulation while the rocket is assembled in the launcher, a small portable oscilloscope has been modified to provide a base line by intermittently shorting the signal from the diode rectifier in the transmitter output circuit. The normally-open contacts of a relay are connected across the vertical axis input terminals of the oscilloscope and the relay coil is connected through a switch to the filament supply thus shorting the input each time the relay is activated by one half cycle of the alternating current. The

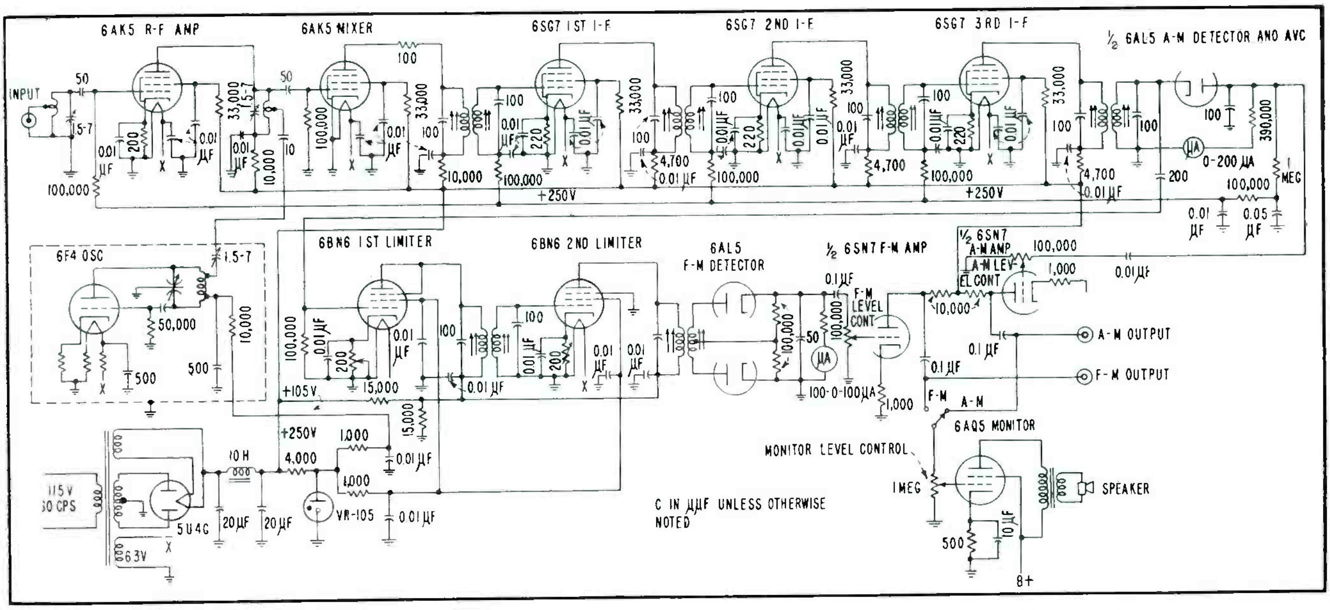


FIG. 4—Single receiver used to recover both a-m and f-m signals from separate detector circuits

result is the establishment of a reference line on the face of the oscilloscope tube which corresponds to the zero carrier level of the amplitude modulated signal being detected by the germanium diode in the transmitter output monitoring circuit. This procedure not only checks the modulation level to prevent loss of quieting in the frequency-modulation receiver, but also provides an overall systems test of the instrumentation feeding the amplitude-modulation circuit in the transmitter.

Pressurized Enclosure

A dual-modulation transmitter designed for use in an Aerobee rocket is illustrated. Since the rocket rises to regions of essentially zero atmospheric pressure, it is necessary to seal off the container at normal ground level atmospheric to prevent arcover of the high voltage at reduced pressures and to provide adequate rigidity to the case to withstand the fifteen-pounds-per-square-inch pressure differential that results when the missile leaves the atmosphere. Special connectors and silicone grease are used to prevent arcover in the high voltage connectors at high altitude. Several of the circuit adjustments, particularly those pertaining to adjustment of modulation levels, must be made with all of the equipment operating in the rocket. Access to these controls is available through the connector body on the front panel as shown. Antenna coupling and tuning are also accessible through front-panel fittings.

Another requirement placed on equipment intended for operation in rockets is resistance to high-acceleration mechanical shock, not only to prevent permanent damage following the shock, but in many applications to avoid transients being introduced into the data during the application of the shock. Tests for such characteristics are carried out on the drop-table type shock-tester. Details of the drop-table are discussed in reference 8. The transmitter shown here has yielded less than five-percent transient output during 55-g acceleration shocks for both amplitude and frequency modulation as observed on the system receiver and measured on an oscilloscope using the maximum sine-wave modulation as a reference.

In considering the adaptability of a simultaneous amplitude and frequency-modulation system to a given rocket telemetering problem, the power requirements of the transmitter and the size of the case are important factors. The performance of the frequency-modulation system must be predicated on the amount of power radiated at the depths of the amplitude-modulation envelope. A transmitter delivering twelve watts when unmodulated will be effectively only about a three-watt transmitter when amplitude-modulated to a depth of fifty percent. The extent to which the equipment can be reduced in size ultimately comes up against the problem of power dissipation within the sealed case and the maximum allowable temperature rise.[9]

The writer extends his appreciation to the staff of the Upper Atmosphere Research Laboratory of Boston University for their efforts in the development and field operation of this system, and in particular to Mr. Albert Panetta, coinventor of the overtone crystal oscillator circuit[7] and engineer on the transmitter herein described.

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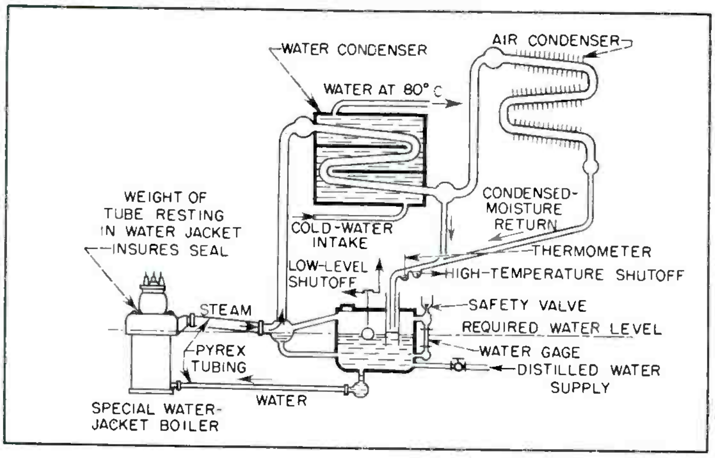
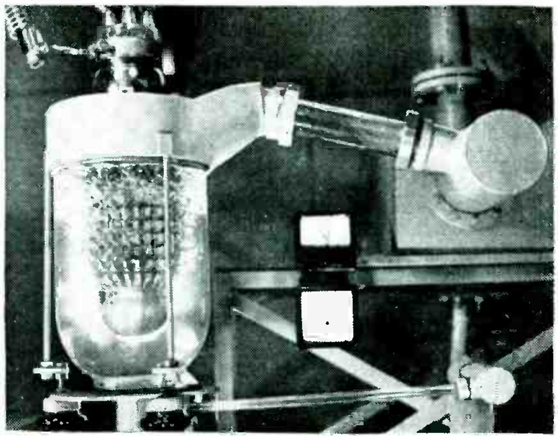


Evaporation-cooling system depends merely upon maintenance of proper distilled-water level and flow of cold water through water condenser. Ebullition at the special tube plate maintains circulation



Insulation of anode in experimental system depends upon distilled water flowing through long Pyrex tube (bottom) and dry-steam through short tube (above)

Evaporation-Cooled POWER TUBES

Novel anode design and ebullition in water-jacket permit pumpless cooling at three times normal power output of conventionally cooled tubes. System employed for broadcasting and industrial-heating power tubes can also furnish distilled water and building heat

By CHARLES BEURTHERET

Chief Engineer
Broadcast Transmitter Section
Compagnie Francaise Thomson-Houston
Paris, France

RADIO-FREQUENCY amplifiers and industrial high-frequency generators operate at limiting efficiencies of 70 percent, so that about a third of the input energy is dissipated as heat at the anode. At high power, forced-air or circulating water and air are required in removing the heat fast enough to avoid damaging the tubes.

From their inception about 1923, water-cooled vacuum tubes have been used with anode water jackets (usually separate, but sometimes attached to the anode as an integral part of the tube) in which a turbulent flow of water is maintained. The purpose of this turbulence, dependent upon viscosity, density and velocity of the fluid, is to effect a cooling efficiency that is appreciably higher than that in a smooth flow.

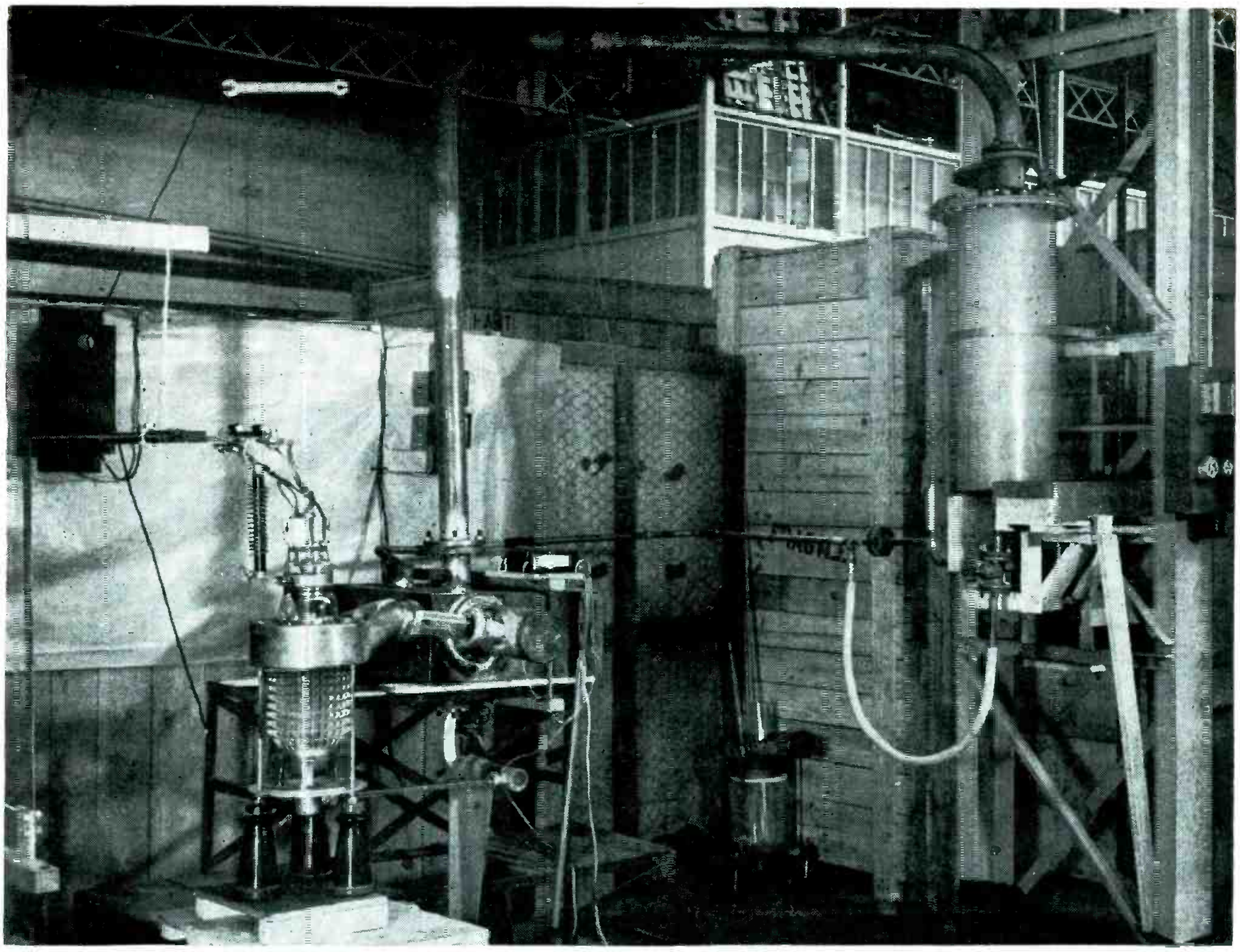
With heat-flux densities as great as those customarily encountered in these services, a water coating in contact with the hot metal may become vaporized. If this happens, an insulating layer of vapor prevents cooling and damage results. It is for this reason that turbulent flow is employed, since it prevents the accumulation of insulated spots.

Calefaction

There are practical limits, however, to the turbulent-flow technique. When an overload is applied to the anode, the boundary layer of vapor, instead of being condensed on the spot by the current of water, forms bubbles that are carried along. The operator is warned of this condition by a characteristic whistling sound. This heated-state phenomenon, known as calefaction, often results in destruction of the tube through perforation of the anode.

The characteristic noise heralding the onset of calefaction may be considered as arising from the violent condensation of steam bubbles in contact with the cold water that carries them along. In the closed water jacket under pressure there is no room for the vapor that occupies a volume a thousand times greater than the corresponding volume of water. This hypothesis is verified by placing such a tube in a pail of water open to the air. Since the bubbles can escape freely, the boiling is silent.

It can further be shown that a tube anode cooled by evaporation is not hotter than the same tube



Complete setup, with tube and water condenser at left and distilled water storage at right. Large copper tube across top acts as air condenser. The equipment served as prototype for an industrial installation as well as a broadcast transmitter

cooled by cold-water circulation. In fact, calculations indicate that the external temperature of the anode may reach values between 155° and 165° C, whereas the boiling point of the water at the pressure in the jacket is between 125° and 135° C. Temperatures in the order of 180° are encountered in air cooling of smaller power tubes.

New Tube

The tube illustrated has a true radiator of special shape that is extremely effective. Thermocouple measurements taken under conditions of evaporation cooling show that operation at 60 kilowatts, corresponding to three times maximum power with conventional water cooling, is accomplished at temperatures of only 120° C.

A salient point in the construction of the experimental evaporation-cooled tube is the use of a massive copper anode having an equivalent thickness between two and three times that for conventional tubes. This construction is necessary since if a point on the anode reaches a temperature more than 25° C above the boiling point of water, the cooling of this point by vapor ceases and can never reestablish itself. This point can therefore be cooled only by conduction through the metal to neighboring points at somewhat lower temperatures. The high conductivity of the copper mass prevents hot spots. Measurements on the new tube fins confirm that under evaporation cooling there is nowhere a temperature differential as great as 25° C above the boiling point of water even with 60-kw power input.

The use of this new cooling technique will allow manufacture of power tubes with output no longer limited by cooling of the anode. Although the internal construction will require redesign, it will be possible to realize more fully the potentialities of filament emission.

One of two experimental units installed on a 50-kw high-frequency furnace at Montreuil, France, has been in operation for over a year working at an average rate of four operations a day, each operation lasting approximately three hours followed by an idle period of one hour. A 100-kw broadcast transmitter on 1,070 kc has been operated successfully 18 hours a day since October 1951 by the French state broadcasting authority. Besides other economies of operation, such a system can supply distilled water and process or heating water in large quantity at a temperature of about 90° C.

F-M Subminiature

By EDWARD KASNER
Project Engineer
Utility Electronics Corp.
East Newark, N. J.

QUANTITY manufacture of the newest version of the Army's f-m transmitter-receiver, the RT-196/PRC-6, is now supplying troops in Korea. The new unit may be used with a number of other new front-line sets, which the older set did not do.

Frequency range for the 13-tube subminiaturized f-m receiver-transmitter is from 47 to 55.4 mc in 43 channels 200-kc apart with a 4.3-mc i-f. Weight of the entire unit, including batteries, is 6½ pounds. Minimum range is one mile over average terrain.

F-M transmitter-receiver in use. When not in use, stainless-steel whip antenna folds conveniently around case of instrument

Circuitry

All stages of the radio set employ single, slug-tuned resonant circuits. Discriminator and i-f slugs are locked in place after tuning. Each r-f slug carries a splined shaft which concentrically engages with a mechanical counter mechanism to indicate numerically the position of its slug. This arrangement permits presetting of the r-f stages when changing from one channel to another.

The schematic diagram of the radio set is shown in Fig. 1. The receiver is a conventional single superheterodyne with a crystal-controlled local oscillator. The transmitter section of the set consists of a Colpitts oscillator, a modulator, a buffer-doubler and a final amplifier.

The modulator is biased 4.5 volts negative by the battery supply. Bias for afc from the discriminator adds algebraically with the battery bias. Audio signals from the microphone are superimposed on the bias voltages.

The plate load of the modulator consists of a germanium crystal diode which is operated at a low current level where its nonlinear current-resistance characteristic is pronounced.

The afc bias and the audio signal control the plate current of the modulator which, in turn, controls the effective resistance of the crystal diode in the plate circuit. The r-f circuit consists of the series combination of this diode and the 6-μμf capacitor, shunting the oscillator tuning capacitor. The effective shunt capacitance across the tuning capacitor varies with the audio signal and the afc bias and, thereby, produces frequency modulation.

Antenna Coil

The 0.67-μh coil in the antenna input circuit serves as a transmitter final tank and as a receiver input coil. The receiver is operative in the transmit position in order to provide sidetone and afc bias. The front end is driven to saturation during transmission but because the resultant loading and detuning reduces the overall gain, no blocking occurs in the i-f stages.

The volume control returns to ground through a fixed resistor to maintain an audible output level at the minimum volume position. The purpose of this is to provide an aural indication of performance regardless of where the volume control is set. When the equipment is turned on, the characteristic f-m background hiss is heard, indicating that the receiver is functioning properly. The presence of sidetone when the PUSH-TO-TALK switch is depressed and the microphone is spoken into, indicates satisfactory transmitter operation.

Alignment Switch

The switch in the filament circuit of the first i-f stage is opened during transmitter alignment. Its purpose is to reduce i-f gain to prevent tuning to a spurious cross-modulation frequency which may be generated within the mixer. When the switch is opened, the predominant

Transmitter-Receiver

New Signal Corps f-m unit, already in use in Korea, has improved performance over previous model. Receiver uses two r-f and three i-f stages with crystal-controlled local oscillator. Transmitter has self-excited oscillator with reactance modulator

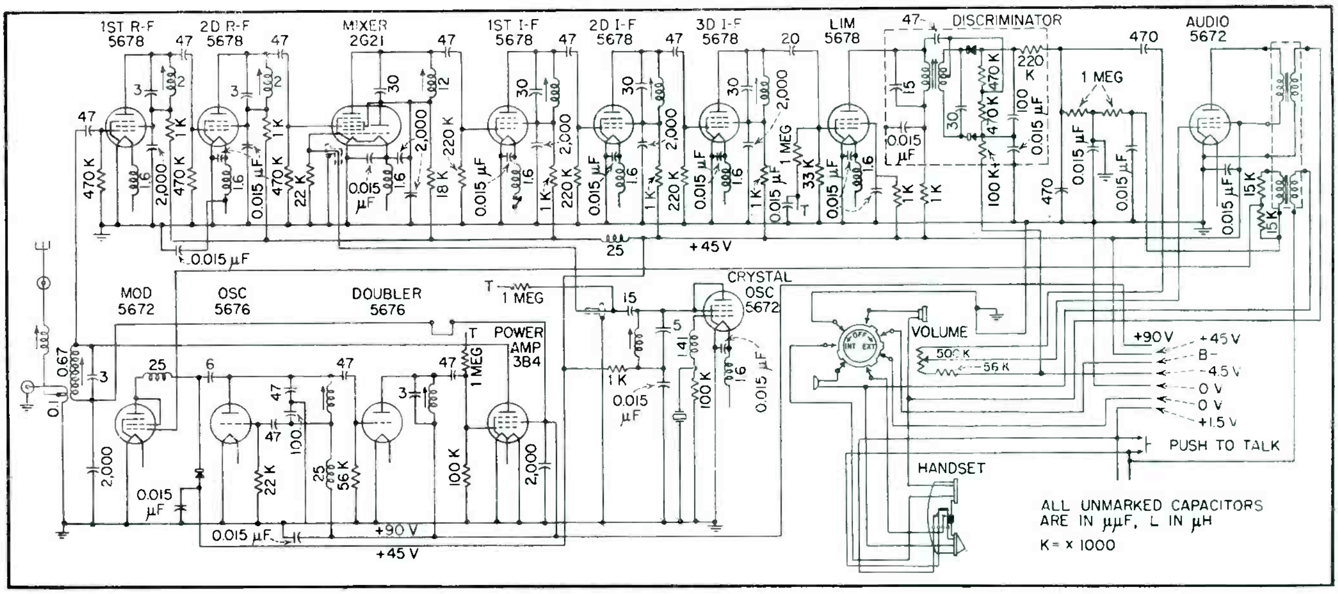


FIG. 1—Schematic diagram of the f-m hand radio transmitter-receiver. Leads marked *T* are convenient test points for maintenance purposes

4.3-mc mixer signal is coupled to the second i-f amplifier through the tube and distributed capacitances in the first i-f stage.

The master switch in the right-hand portion of Fig. 1 connects the plate and filament negative returns to ground in either ON position. The earphone and microphone returns are grounded in the INTERNAL position; the corresponding leads to the external handset connector are grounded in the EXTERNAL position. In the OFF position, all four controlled ground leads are opened.

Discriminator Design

The discriminator presented a severe coil design problem because of the small space available and the resultant difficulty in obtaining high Q and sufficiently loose coupling. The other components within the assembly had to be carefully located in order to maintain Q and minimize undesirable capacitive coupling between primary and secondary.

The discriminator is the source of afc voltage and, therefore, the stability of the transmitter is primarily dependent upon the quality of the discriminator. The tuning slugs are locked after alignment by collet and jamb-nut retainers. The discriminator can and cover are seam-soldered and leads are brought out through metal-to-glass feed-through insulators. A sealing cap and a rubber ring are tightened in place over each slug after alignment to provide a completely sealed discriminator which cannot suffer detuning from ambient climatic changes.

During development, considerable difficulty was encountered with i-f and front-end regeneration. Although specific cures are nonexistent, the following precautions are mentioned to assist other designers of subminiature equipments.

Interstage Shielding

Complete interstage shielding should be used. Short and properly located ground returns, adequate and properly located decoupling and bypassing and careful layout of leads and components to minimize intercoupling are recommended. Circuit designs should take into account the broad performance tolerance ranges of subminiaturized components, particularly tubes.

The author gratefully acknowledges the advice and assistance extended by U. S. Signal Corps personnel during the final development and early production phases of the work, particularly to Robert Johnson, Frank Caruso and Frank Kovalski.

New Industrial Motor Control Circuits

Step-by-step analysis of each stage in latest 16-tube electronic motor control system for regulating speed of a d-c motor at any desired value from zero to the top field-reduction speed, as required for maximum flexibility in industrial plant drives

By E. F. KUBLER
Control Department
General Electric Co.
Schenectady, N. Y.

THE ELECTRONIC d-c motor control has proven itself in hundreds of industrial applications over the past few years. Because of an everwidening demand for precise control at reasonable cost, electronic drives have been redesigned to provide improvement in operating characteristics and increased flexibility.

The purpose of this article is to explain in some detail the circuit operation of the latest Thy-mo-trol electronic panel for ¾ to 3-hp motors operating over both the armature and field ranges, with reversing. Five control features are provided:

(1) A speed control circuit regulates the speed at any value from zero to top speed under any load condition. The speed is varied in the armature range by increasing the armature voltage until rated motor voltage is obtained, and in the field range by decreasing the field current until top speed is obtained.

(2) An IR drop compensation circuit increases the armature voltage by an amount proportional to the load current.

(3) A current limit circuit prevents the flow of excessive current during acceleration or under abnormal loads.

(4) An overvoltage circuit prevents the generation of high voltages during deceleration or reversal.

(5) A constant-power accelerating circuit provides the maximum torque during acceleration in the weak-field range.

Armature power for the motor is furnished by thyratrons V_1 and V_2 whose grid voltages are phase-shift-controlled by the inductance-resistance bridge method, as shown in Fig. 1. Saturable reactor L_1 is used as a variable inductance to provide a shift of 180 degrees when the d-c control current changes from zero to 4 ma.

Capacitors C_4 and C_5 minimize the magnitude of undesirable signals induced into the grid circuit and resistors R_4 and R_5 limit the grid current during conduction.

The field power supply, shown in Fig. 2, is similar to the armature power supply. A resistor (R_F) with constant thermal coefficient is used in series with the field to provide a 30-volt drop for control purposes. Where the motor speed range does not require field weakening, a simpler uncontrolled two-phanotron rectifier is used.

Control current for the saturable reactors and plate voltages for all amplifiers are provided by rectifier V_5 in Fig. 1, with V_6 and V_7 providing fixed reference voltages even though currents range from 5 to 40 ma.

Motor Speed Control

Operation of the speed regulator must be considered separately for two distinct conditions, when the motor is operating at full field and below rated armature voltage, and when the motor is operating at rated armature voltage in the weak-field region.

The armature voltage is regulated by the lower portion of the circuit shown in Fig. 1. The filtered rectifier output voltage across C_{11} is compared with the reference voltage by means of resistance divider R_{12}-R_{13}. When the motor armature voltage is higher than the preset reference value of P_1, the grid of triode V_8 is driven positive and the resulting increased plate current increases the voltage drop across plate load resistor R_{16}. The voltage drop across this tube is correspondingly reduced, thereby driving the grid triode V_9 more negative. This phases back thyratrons V_1 and V_2 and cuts off the power supplied to the motor. With power shut off, the motor coasts toward a lower speed until the voltage across C_{11} matches the armature reference voltage, where the thyratrons conduct again in order to maintain the motor speed.

Armature IR Compensation

If the motor voltage had been low, the reverse action would have taken place and the motor would have been accelerated until the proper motor voltage had been reached. The armature thyratrons V_1 and V_2 are thus continuously controlled so the motor voltage matches the reference voltage regardless of motor load.

Because of armature IR drop, motor speed will droop with increasing load. This means that the motor voltage must be increased by an amount equal to the IR drop to maintain the motor speed constant. This is obtained with an IR compensation circuit, shown just above the phase-shifting circuit in Fig. 1. The two primary windings of a special current transformer are corrected in series with armature

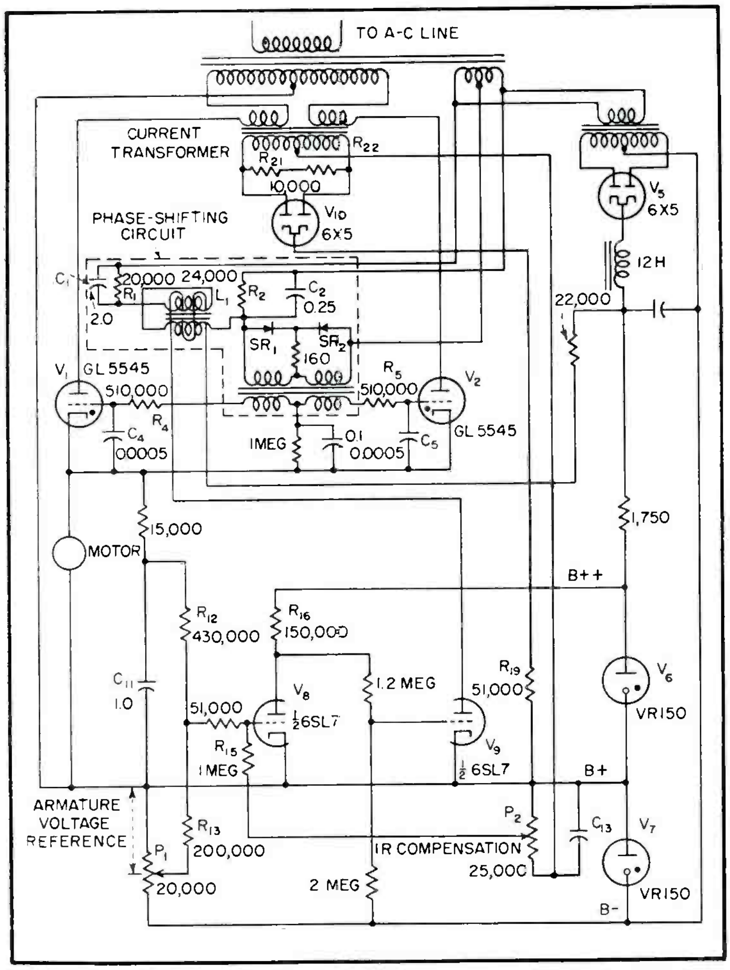


FIG. 1—Basic speed control circuit for furnishing armature power to the d-c motor

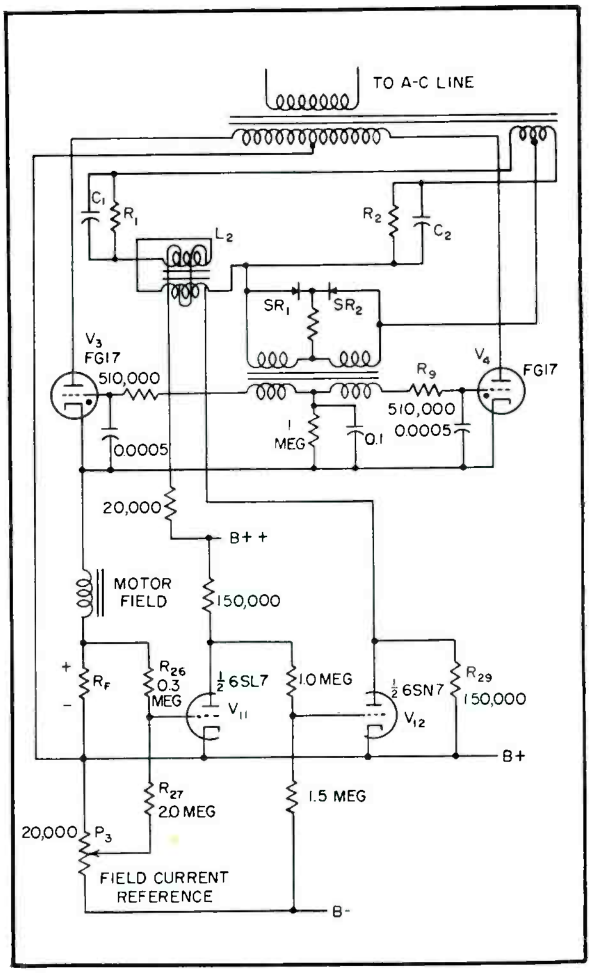


FIG. 2—Field current power supply for field-weakening speed control

thyratrons V_1 and V_2, with polarity such that the resulting magnetic flux due to the current pulses in each winding is equivalent to an a-c flux. The secondary winding is connected to loading resistors R_{21} and R_{22} which determine the transformer output voltage. Tube V_{10} rectifies the secondary a-c voltage and provides across R_{19} and P_2 a d-c voltage proportional to the armature current. The IR compensation control P_2 applies a preset portion of this voltage to the grid of V_8 through R_{15}, so that a signal voltage proportional to motor current is added to the speed reference signal, producing an increase in armature voltage with an increase in load current.

Field Current Control

By adjusting P_2 it is possible to compensate for the IR drop and obtain any desired drooping or rising speed-load curve. Since the IR compensation operates on the armature voltage, it is independent of the field current and covers the entire speed range.

Field weakening is obtained with the control circuit of Fig. 2, in which the motor field is connected in series with resistor R_F. The positive voltage drop across R_F, proportional to the field current, is compared by means of resistance divider R_{26}-R_{27} with the adjustable negative reference voltage set by potentiometer P_3. Any difference voltage acts through triodes V_{11} and V_{12}, saturable reactor L_2 and the phase-shifting circuit to phase the thyratrons V_3 and V_4 further on or further off to correct the field current value and restore the voltage match, just as for the armature control of Fig. 1.

Resistor R_{29} is connected across V_{12} to avoid zero current in the saturable reactor, thereby preventing a complete shutoff of the motor field.

Armature and field reference potentiometers P_1 and P_3 are driven from a common shaft, and their resistance elements are arranged so that during the first part of a clockwise rotation an ever-increasing armature voltage reference is called for by P_1, with P_3 calling for a constant field current until rated armature voltage is reached. For the second part of the rotation P_1 calls for constant motor voltage and P_3 calls for an ever-decreasing field current until weak field is reached.

The angle of potentiometer rotation where the control reference changes from armature control to field control depends on the motor rating. For instance, a motor having a top speed equal to twice base speed would have a control device with the changeover point at one-half the total rotation, whereas a motor having a top speed of three times base speed would have the changeover point at one third of the total rotation.

The resistance element of P_3 is

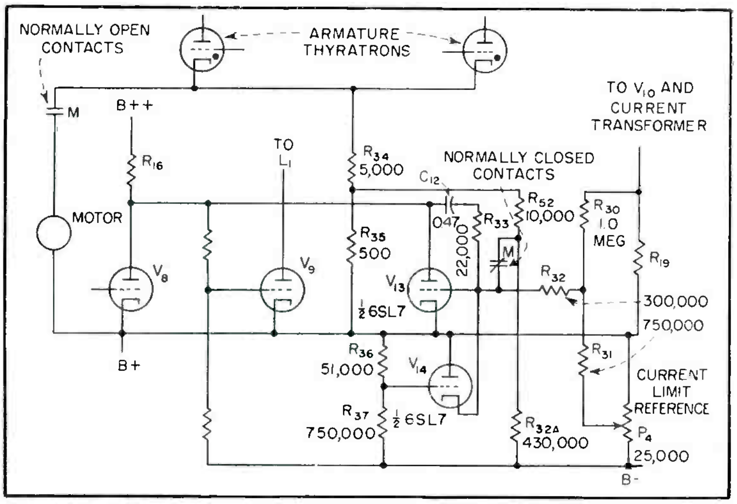


FIG. 3—Armature current-limiting circuit for protecting thyratrons during starting or heavy loading

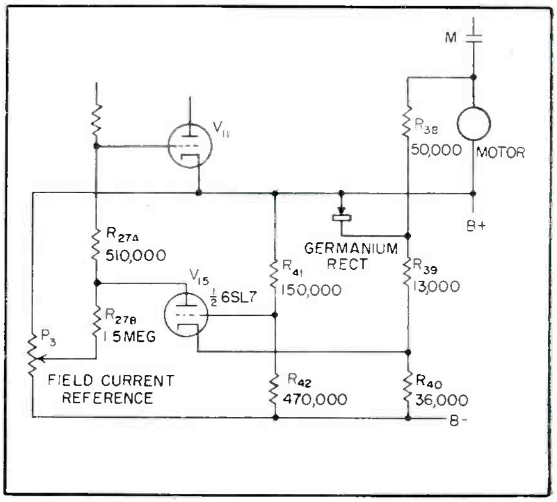


FIG. 4—Field-forcing circuit for maintaining maximum torque in field range

tapered to provide linear speed increments for equal angular increments of the potentiometer shaft.

The motor must be designed and built to operate in the field range if acceptable IR compensation is expected above base speed. For instance, a motor designed to operate solely in the armature range may have an undesirable rising speed-load characteristic when operating in the field range although the armature compensation is adjusted for flat compounding in the armature range. The reason for this undesirable performance can be found in the armature cross-magnetizing field. The cross flux distorts the main field flux and reduces the motor emf for a given speed, consequently the motor speed increases with load when operating in the weak field range. For satisfactory speed performance in the weak field range, the motor must be provided with a bigger air gap and a heavier field pole structure.

Current Limit Control

To prevent damaging current from flowing through the armature rectifier tube under starting conditions or heavy loading, the current-limiting circuit of Fig. 3 has been added to the speed-regulating circuit. For efficient operation this circuit must not interfere with the motor speed when it is operating at normal load. This means that the current limit circuit must have a sharp take-over characteristic when the motor current exceeds a preset value that is selected in advance.

Voltage divider R_{30}-R_{31} compares the voltage drop across R_{19} in the current transformer circuit with a reference voltage set by potentiometer P_4. Current limit tube V_{13} is in parallel with speed control tube V_8, hence V_{13} shuts off the armature thyratrons under current limit action when it overrides V_8.

Under starting conditions the current is regulated at a preset value until the counter emf is sufficiently high to limit the current to a smaller level. With normal motor load the grid of V_{13} is held sufficiently negative to keep this tube below cutoff, and speed regulator tube V_8 is in full control. Circuit components R_{33} and C_{12} filter the grid voltage of V_{13} and stabilize the operation of the current limit circuit.

Since the motor voltage is measured on the rectifier side of normally-closed contactor M, the speed-regulating circuit will hold the rectifier voltage at the value called for by speed reference potentiometer P_1 when the motor is disconnected from the rectifier. If the motor were started with P_1 set above base speed, the full rectifier voltage would be applied to the motor at the moment the contactor closes. Unfortunately the current limit circuit cannot operate instantaneously because the grid of V_{13} is held negative by P_4 when contactor M is open and C_{12} will prevent the grid of V_{13} from reaching the operating range instantly. This condition cannot be tolerated because currents of destructive magnitude would flow for the first instant after the motor is started, resulting in blown anode fuses. To remedy this condition the rectifier voltage is automatically regulated to a lower voltage when contactor M is open, by means of the preconditioning circuit.

Preconditioning Circuit

This circuit regulates the open-circuit rectifier voltage to a permissible value and provides good starting torque without harmful effects.

A part of the armature rectifier voltage, obtained from R_{34} and R_{35} (Fig. 3), is fed back to the grid of V_{13} through R_{52} and a normally-closed interlock of the main contactor M. When contactor M is de-energized the voltage across R_{35} is compared with the reference voltage provided by glow tube V_7 (Fig. 1) by means of resistance divider R_{52} and $R_{32}A$. These resistors are chosen so that a precondition voltage of 20 to 70 volts is obtained, depending on the horsepower rating of the motor. This particular resistance network is stiff enough to prevent any interference from the current limit reference.

A similar situation may occur when the speed is suddenly increased. If the motor is operating at light load, the grid of V_{13} is held very negative by virtue of current limit reference P_4, consequently C_{12} has a negative charge. If the speed potentiometer is suddenly turned to a higher speed a large instantaneous current flows because C_{12} prevents the grid of V_{13} from reaching the operating range immediately. Tube V_{14} prevents the grid of V_{13} from drifting too far below its operating range. The grid of V_{14} is held approximately 10 volts below its plate by R_{36} and R_{37}. Since the cathode of V_{14} cannot exceed this voltage, the grid of V_{13} is also held approximately 10 volts negative; this 10-volt negative bias prevents V_{13} from interfering with the normal operation of V_8.

Acceleration With Preset Top Speed

With the circuits previously described, it is possible to start and accelerate the motor to any preset speed without the risk of overloading any part of the equipment. However, if the speed control calls for a speed in the weak-field range, the motor will accelerate to top speed with a small accelerating torque depending on the field current value.

This condition is corrected by the field-forcing circuit of Fig. 4, which maintains full field through the armature range and maintains maximum torque in the field range.

When the motor armature voltage is less than 90 percent of rated value the cathode of V_{15} is held at 40 volts below B+ by the germanium rectifier and voltage divider R_{39}-R_{40}. Voltage divider R_{41}-R_{42} is adjusted to hold the grid of V_{15} 38 volts below B+ so that V_{15} is turned on as long as the motor voltage is less than 90 percent of rated values. With V_{15} turned on, the voltage drop across R_{39} provides a new reference for the field current regulator, forcing the field current to full field. When the motor voltage reaches 90 percent of rated value, V_{15} is slowly turned off and the reference is automatically transferred to P_3. With this circuit the armature voltage will be maintained at 90 percent of rated value during acceleration in the weak field range until the desired field current is reached. At that moment the armature voltage increases to the rated value, forcing the potential of the cathode of V_{15} above its grid potential and thereby preventing any further interference between the field reinforcing circuit and the normal field current regulating circuit.

Armature Forward Voltage Limit

When the speed control is suddenly turned from a high-speed weak field to a low-speed full field setting, the armature voltage may rise to a dangerous value as the motor coasts to the lower speed while full field is called for by the field current regulator. This voltage rise is prevented by an additional voltage-sensitive circuit in the field current regulator which reduces the field current when the armature voltage rises above a preset value. Figure 5 shows the components added to the field current regulator.

Under normal running conditions the voltage across R_{44} is much lower than the voltage across R_{46}, consequently V_{16} is biased off and has no influence on the field current regulator.

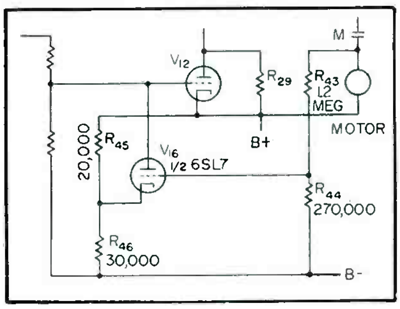


FIG. 5—Armature forward voltage limit circuit

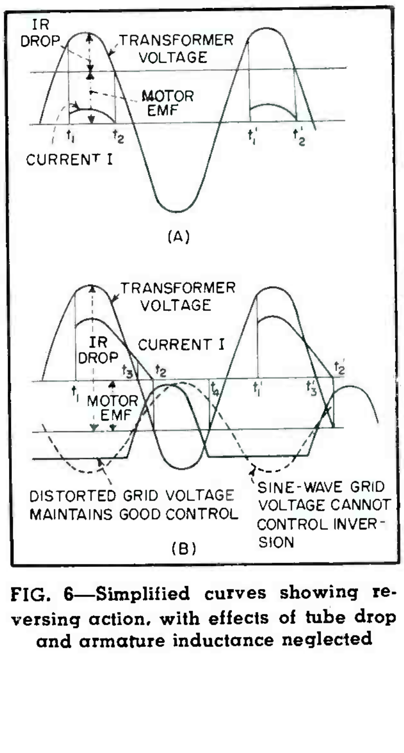


FIG. 6—Simplified curves showing reversing action, with effects of tube drop and armature inductance neglected

When the motor voltage rises beyond a safe value, the grid potential of V_{16} rises and this tube conducts, pulling down the grid potential of V_{12} and thereby phasing off the field thyratrons to reduce the generated motor voltage. During deceleration, the motor voltage is regulated at a preset value determined by R_{43}, R_{44}, R_{45} and R_{46}.

When the motor reaches the lower speed called for by the speed control, V_{16} returns to its normal biased condition with no further effects on the field current regulator.

Reversing of Motor

For simplicity the diagrams shown so far are for a nonreversing motor control. For reversing service, the d-c motor is reversed by changing the polarity of the armature with contactors. Since the overvoltage and field-forcing circuits are connected to the positive terminal of the motor, a simple arrangement of resistors and selenium rectifiers is used to maintain positive polarity for these circuits regardless of direction of rotation.

Dynamic Braking

For efficient dynamic braking it is advisable to maintain the motor voltage near the rated value as long as possible during the deceleration in the field range. This is done by the field-forcing circuit, which also controls the acceleration as previously mentioned.

Under dynamic braking action the armature voltage tends to fall and the field current rises as V_{15} is turned on. This tube will hold the armature voltage at a value determined by R_{38}, R_{39} and R_{40} in Fig. 4.

Under normal conditions when the motor pulls a mechanical load, the armature emf opposes the rectifier output and the motor IR drop is represented by the difference between rectifier output voltages and the emf, as shown in Fig. 6A.

Current I starts at t_1 where the thyratron fires, and stops at t_2 where the emf becomes larger than the transformer voltage. At that moment the emf tends to reverse the direction of current flow, but since the thyratron cannot conduct in the reverse direction, the current through the motor stops. However, if the motor is suddenly reversed, then while the motor still rotates in the original direction, the emf adds to the transformer voltage and the IR drop is equal to the sum of the emf and transformer voltage. As Fig. 6B shows, from t_1 to t_3 the current flows in the same direction as the transformer voltage, and consequently power is supplied from the power system to the motor. However, from t_3 to t_2 under the influence of the emf the current flows against the transformer voltage and the power flow is reversed from the motor into the power system.

If after motor reversal the thyratron grid had been phased back to point t_3, the tube would fire under the influence of the emf alone and all the power would flow from the motor into the power system. It is evident that the greater the emf the more power is returned to the power system. The emf cannot exceed the maximum transformer voltage, otherwise the tube anodes would remain positive and the thyratron control by grid action would be lost.

The foregoing operation, known as inversion, is a convenient and efficient method of reversing the motor because nearly all kinetic energy is returned into the power system as long as the motor rotates in the original direction.

The grid voltage is distorted away from a pure sine wave in the phased-off position by R_1, R_2, C_1, C_2, SR_1 and SR_2 in Fig 1. With a sine-wave grid voltage the tube would be refired at t_4 in Fig. 6B when the grid and anode voltages are both positive with respect to the armature emf, causing loss of control.

For satisfactory inversion operation the thyratron grids must be immediately phased back to a point where the current will not be excessive and the field-forcing circuit must be restrained to prevent the motor emf from exceeding a safe value.

The first condition is obtained by allowing a delay of 0.1 second between the opening of the forward contactor and the closing of the reverse contactor, so that sufficient time is allowed to phase back the thyratron grid by means of the preconditioning circuit shown in Fig. 7, which is similar to Fig. 3 except that a normally closed contact of relay *CR* is used in place of contactor *M*.

Relay *CR* is deenergized when both contactors are open. During the small time delay between the opening of the first contactor and the closing of the second one, the normally closed contact of *CR* will bring the grid of V_{18} into range and charge capacitor C_{12}. This helps to prevent a current overshoot when the reverse contactor closes.

Since the motor emf adds to the transformer voltage just after reversal, the small amount of phase-on due to the normal preconditioning circuit may cause a damaging slug of current for the first instant after the reverse contactor closes. To prevent this, R_{51} shuts off the armature thyratron by adding an additional positive voltage to the grid of current limit tube V_{13} when the motor is coasting in either direction.

The reverse motor emf is held at a safe value by adding a circuit to the overvoltage limit circuit of Fig. 5. As shown in Fig. 8, R_{45} and R_{46} are connected differently and R_{35A} and R_{35B} replace R_{35}. As long as the motor emf opposes the rectifier voltage, the junction of R_{35A} and R_{35B} is connected to B+ by SR_3 and V_{16} will protect the motor. However, the first instant after reversal the cathode of thyratrons V_1 and V_2 are negative because the motor still turns in the original direction. With SR_3 no longer conducting, the cathode of V_{16} goes more negative. The grid of this tube will remain stationary because of SR_1 or SR_2 in Fig. 7. The change in cathode potential turns on V_{16} and cuts off V_{12}, thus preventing an excessive inverse armature voltage.

The current limit circuit determines the magnitude of the current during reversal. It can be adjusted to prevent motor overheating if frequent reversals are required.

Jog at Low Speed

When the control system is adjusted to run at very low speed, the voltage called for by speed reference P_1 may be less than the voltage called for by the preconditioning circuit, a condition which causes sluggish motor starting. In this case the armature resistance prevents a large initial current flow, and the IR compensation circuit builds up the current after a small time delay. This condition is corrected by introducing a false IR signal obtained by precharging the IR compensation filter capacitor C_{13} through a normally closed contact of the *CR* relay and R_{54} in Fig. 7.

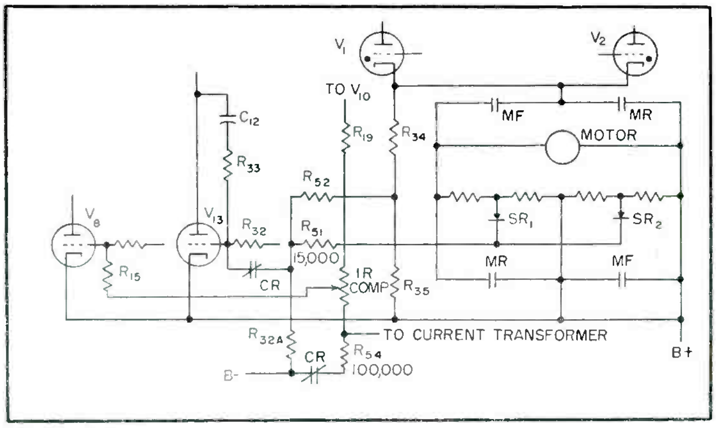


FIG. 7—Preconditioning circuit for phasing back thyratron grids

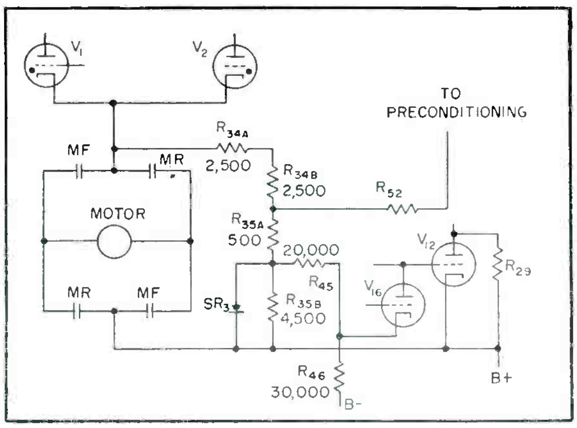


FIG. 8—Inverse voltage limit circuit

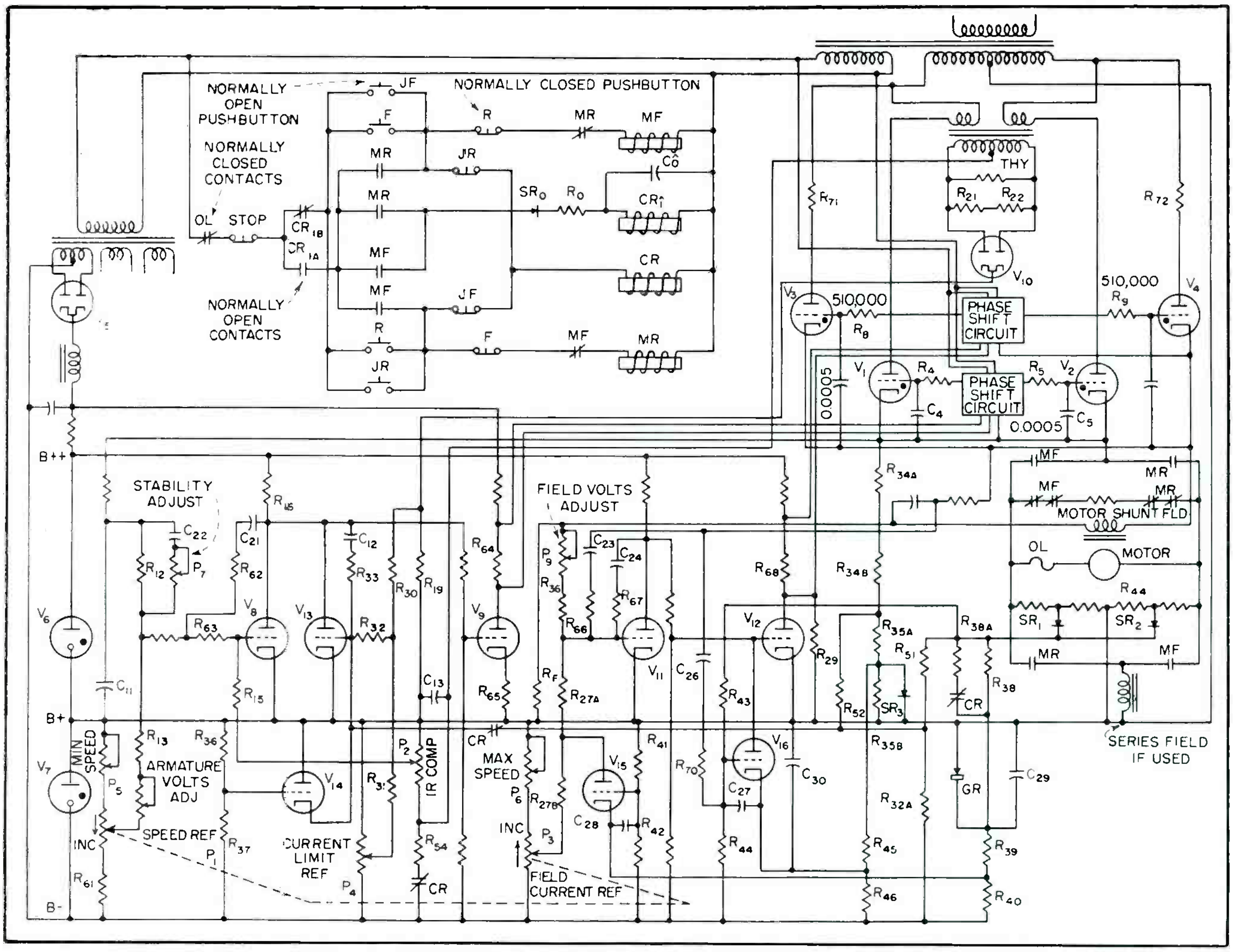


FIG. 9—Complete Thy-mo-trol electronic drive incorporating the individual circuits described in this article

Changing the value of R_{54} changes the initial starting torque over a wide range.

Complete Circuit

The circuits described are redrawn in Fig. 9 as a complete electronic motor control system. In the armature circuit here, P_5 sets the minimum speed. The armature adjustment compensates for poor resistor tolerances and sets armature voltage at full speed.

In the field circuit, P_6 sets the maximum speed and P_9 the maximum field current. Also, P_7 and C_{22} improve the speed of response of the system by transmitting small transient speed changes to the grid of V_8. Combinations R_{62}-C_{21}, R_{66}-C_{23}, R_{67}-C_{24} and R_{70}-C_{26} improve the stability of the armature voltage, the field current and the over-voltage circuit.

The field voltage for field stability circuits R_{66}-C_{23} and R_{70}-C_{26} is filtered by R_{69}-C_{25}; C_{27}, C_{28}, C_{29} and C_{30} are bypass filters preventing the amplification of ripple voltages; R_{61} reduces the maximum reference voltage; R_{63} in the grid circuit of V_8 places the IR drop compensation nearer the grid than the stability circuit R_{62}-C_{21} to minimize interference between the stability circuit and the IR compensation signal, giving priority to the latter signal when the motor is subjected to sudden load changes. Also, R_{64} and R_{68} bypass the d-c windings of the saturable reactor to provide a discharge path for the higher harmonic voltages induced into these windings; R_{65} provides a higher speed of response of the saturable reactor control circuit; R_{71} and R_{72} are surge resistors reducing the stiffness of the anode circuit of the field current rectifier so that smaller tubes can be used.

A quick slowdown attachment can be added to pull in a dynamic braking contactor to provide braking action when the motor coasts from a higher to a lower speed.

Another available feature is preset jog speed, which predetermines the speed at which the motor is jogged and allows accurate positioning of the armature.

A field loss relay can be used on those applications where the motor can be mechanically disconnected from the load. Under normal load conditions the motor comes to a stop when the field is lost because the small torque provided by the current limit and residual field is insufficient to overcome the load.

A tachometer follower drive will maintain any speed dictated by another machine. The rectified output of a solenoid control can also be used in the reference circuit, changing the drive from a speed control to a position control as required for reeling drives where a dancer roll operates the solenoid.

Stabilizing Vertical

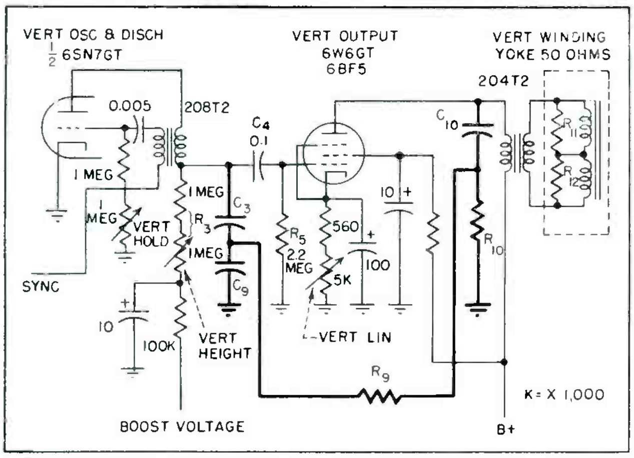


FIG. 1 — Blumlein's circuit employing inverse feedback for stabilization

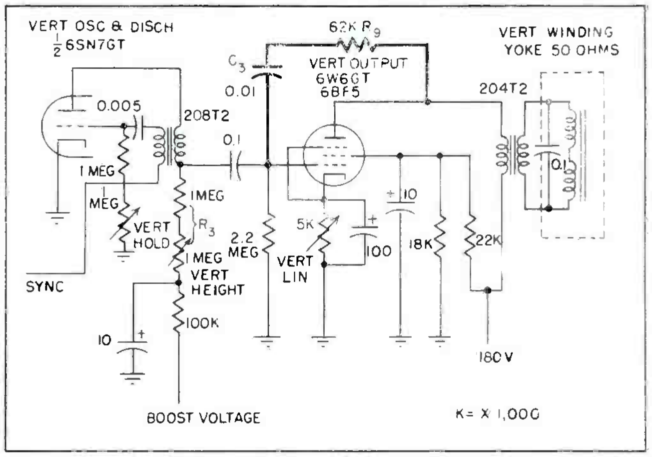


FIG. 2—Simplified circuit gives equivalent performance with fewer parts

VERTICAL DEFLECTION circuits for television have remained almost unchanged for more than a decade, in fact the circuits used in present-day receivers have almost precisely the same resistor and capacitor values as in 1938.

However, some engineers[1] have noted the changes both in height and linearity of the picture in many receivers during warm-up and with changes in the characteristics of the output tubes.

Also, triode output circuits have been used to the exclusion of beam tetrode or pentode due to the prevalence with the latter of objectionable horizontal white lines. These white lines, caused by small perturbations in the plate current of a large percentage of tetrodes and pentodes, are quite unstable, moving from one region to another in the structure of the picture.

While investigating the problems of white lines, linearity and stability of height, it seemed worthwhile to consider the performance of circuits with inverse feedback and also to analyze the factors influencing interlace stability.

Starting with the work done by A. D. Blumlein and described by O. S. Puckle[2] and then applying modifications of this approach, some remarkable improvements in vertical deflection stability have been obtained.

Blumlein's circuit is shown in Fig. 1. The feedback network is shown in heavy lines for clarity—the rest of the circuit being conventional. A detailed experimental analysis of the circuit reveals an important advantage, which is that the output is largely independent of changes in characteristics of the output tube. This makes vertical linearity virtually independent of tube age.

Further experiments and mathematical analysis led to the simplified circuit of Fig. 2, where again the feedback network is indicated in heavy lines.

This is no longer a normal combination of voltage inverse feedback and conventional deflection. Instead, the inverse feedback coupling capacitor and resistor are part of the sawtooth generating circuit, and the blocking oscillator tube is now intimately associated with them. The inverse feedback provides such excellent control of linearity that the usual damping resistors across the yoke are unnecessary. The cost of the improved circuit is actually lower than that of conventional circuits.

Operating Measurements

Detailed measurements were made of the required d-c voltages for full vertical deflection of 65-degree picture tubes operating at 15 kv. Comparatively low voltages are required for both the plate and the screen (180-volt supply). The accompanying waveforms show the results.

The new circuit can provide individually or in combination, compensation for variations in mutual conductance of a tube during life, or variations from one tube to another, and instability in a tube such as the type which produces white lines in a conventional tetrode or pentode circuit, in addition to giving excellent linearity, and stable amplitude.

Interlace Stability

For good interlace, without pairing, it is necessary to make both the amplitude and the waveform of the current in the vertical windings of the yoke identical for both the odd and the even line sweeps. Also, the timing must be accurate so that the alternate sweeps commence with and maintain a timing difference of one-half of a horizontal line time interval *H*.

It is also essential that any stray fields present at the picture tube neck be alike for both the even and odd sweeps.

Ripple voltages, from the power supply, both 60 and 120 cycle, are found to have negligible effect upon the interlace stability since the waveform of the 60 or 120-cycle ripple should not change from the

Deflection Amplifiers

Addition of simple inverse feedback network to vertical deflection amplifier circuit makes vertical linearity and height stability virtually independent of tube transconductance. Modified circuit furnishes full vertical deflection of 65-degree picture tubes operating at 15 kv with 180 volts on amplifier plate

By W. B. WHALLEY, C. MASUCCI and K. HILLMAN

Physics Laboratory
Sylvania Electric Products Inc.
Bayside, New York

odd sweep to the even sweep.

The horizontal incoming synchronizing pulses generated at the transmitter will have no detrimental effect upon vertical deflection since the pulses occur at twice horizontal frequency during the vertical synchronizing period. Of course, it is necessary that the horizontal synchronizing pulses be low in amplitude at the output of the vertical synchronizing filter (high attenuation of 15,750-cycle pulses), otherwise, one of the horizontal synchronizing pulses just preceding the vertical sync period might trigger the vertical blocking oscillator. Since only 2*H* pulses are present during the vertical synchronizing period and the commencement of this period shifts by one pulse from odd to even sweeps, the timing of the even sweep could be very accurately one-half of a line from that of the odd sweep.

However, any horizontal pulses which are locally generated can give severe trouble in interlace if introduced into any part of the vertical blocking oscillator-amplifier circuit. The horizontal pulses in the receiver continue steadily from line to line irrespective of whether it is the odd or even vertical sweep, hence overwhelming the accuracy of the timing of the incoming vertical synchronizing pulses.

As is well known, the horizontal retrace pulse at the anode of the horizontal output tube is of 5 to 6 kv. Hence, the vertical blocking oscillator grid and plate circuits should be well isolated from the horizontal circuits and should have very short and, if necessary, shielded leads.

Test pattern illustrates degree of vertical linearity obtainable

The horizontal pulses, even if present at the anode of the vertical output tube, can affect, to varying degree, the timing of the vertical blocking oscillator and the amplitude of the sawtooth. Analysis of the voltages present at the pins of the output and blocking oscillator tubes showed that there was frequently a large horizontal pulse at the anode terminal of the vertical amplifier tube. This pulse comes from yoke coupling between the horizontal and vertical windings when these are not correctly positioned and oriented with respect to each other. By placing a moderate-size capacitor across the secondary of the vertical output transformer, it was possible to reduce the amplitude of the undesired pulse at the plate of the vertical amplifier tube. This gave greatly improved interlace stability in all tests.

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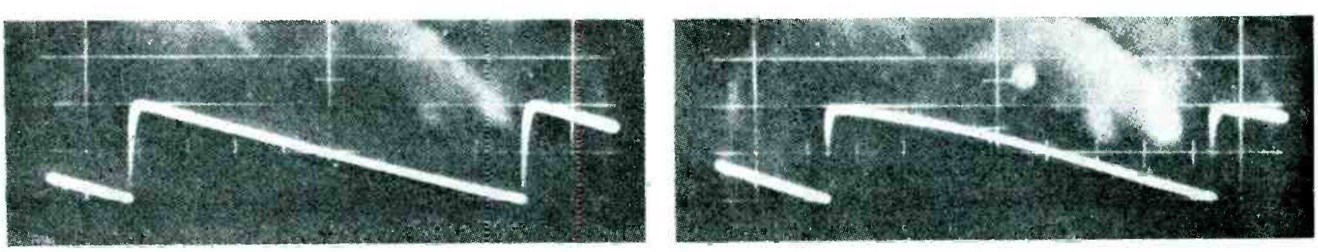


Waveform at left shows linearity of vertical sweep with simplified inverse feedback. Sweep with conventional circuit is shown at right

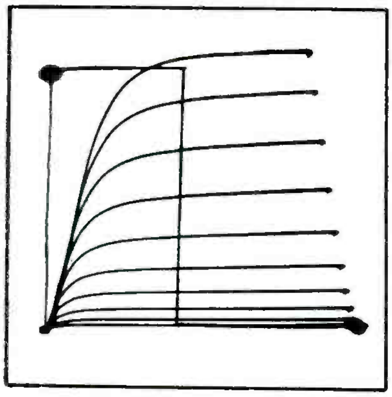


FIG. 1A—Family of $I_b - E_b$ curves for 6AC7 tube. E_{c2}, 150 v; E_{c3}, 0 v; ΔE_c, 0.5 v; E_c + max, + 1 v; I_b std, 15 ma; E_b std, 100 v; R_k, 75; R_L, 2,700 ohms

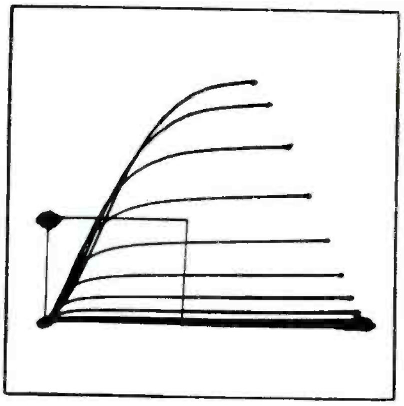


FIG. 1B—Same tube as Fig. 1A. E_{c2}, 150 v; E_{c3}, 0 v; ΔE_c, 0.5 v; E_c+max, +1 v; I_b std, 15 ma; E_b std, 100 v; R_k, 0; R_L, 2,700 ohms

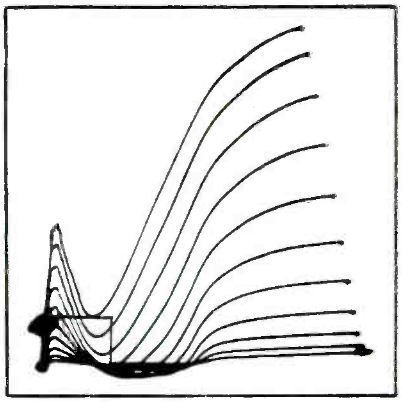
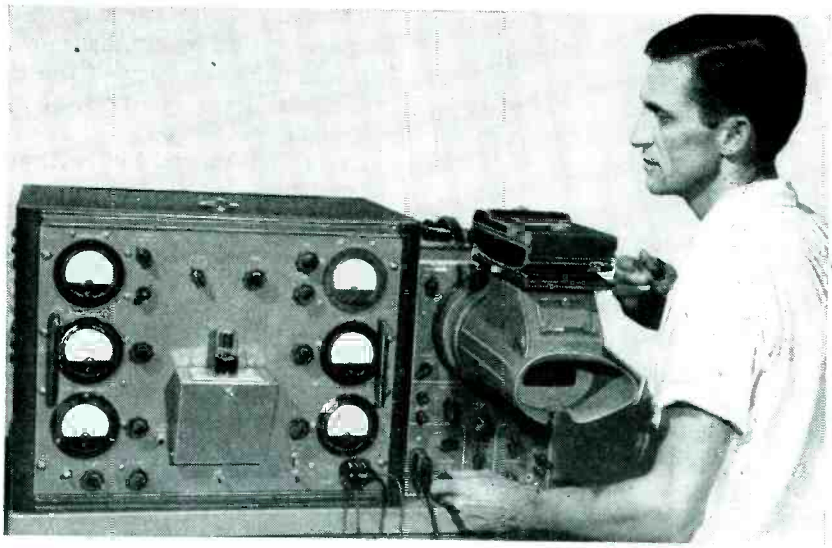


FIG. 1C—Same tube as Fig. 1A. E_{c2}, 150 v; E_{c3}, 150 v; ΔE_c, 0.5 v; E_c+max, + 1v; I_b std, 1.5 ma; E_b std, 50 v; R_k, 75 ohms; R_L, 2,500 ohms

ELECTRON-TUBE

by M. L. KUDER

Electronic Scientist
National Bureau of Standards
Washington, D. C.



Both the curve plotter and the associated cathode-ray oscilloscope take up only the top of a small laboratory table. A Land camera mounted atop the viewing hood produces a finished photograph of the family of curves

THE electronic tube curve generator developed by the National Bureau of Standards makes available the complete static plate characteristics of a vacuum tube. In addition to plotting dynamically a family of $I_b - E_b$ curves, the locus of the load-resistance line is shown.

Because of the continuously stable stationary pattern presented on the cathode-ray tube, a photographic record of the complete family is practicable. With a Land camera, a photographic record is available in one minute. The plate voltage is swept continuously from zero or a small negative value to a positive value. Corresponding to any instantaneous plate voltage, an *IR* drop that is proportional to the plate current appears across the plate current measuring element. The plate current, represented by the *IR* drop, and the corresponding plate voltage are applied respectively to the vertical and horizontal deflecting plates of the cathode-ray tube. By repeating this operation in rapid sequence for various values of grid bias, a family of conventional $I_b - E_b$ curves is obtained. In order that the display may be stationary and free from flicker, a power-line-frequency framing rate is included in the instrument.

All test voltages may be varied over a wide range giving the curve generator unusual flexibility. Families of curves for either screen or plate characteristics may be obtained for any fixed value of parameters for the other tube elements. During the test of the high current (low-bias lines of the family), overloading of the tube under test is avoided. When using the conventional point-by-point method it is necessary to keep the high current on continuously a sufficient time to make the meter reading.

The calibration rectangle on the cathode-ray oscilloscope has two adjustable metered coordinates that permit direct measurement of points in the $I_b - E_b$ plane. The locus of the adjustable load-resistance line is displayed and defined by a series of bright dots appearing at the terminals of the $I_b - E_b$ curves.

The unique feature of this instrument lies in the completeness of the data obtained with a minimum of effort on the part of the operator. The generation of such a pattern necessitates a complex cycling of various voltages in a synchronous fashion and with a definitely de-

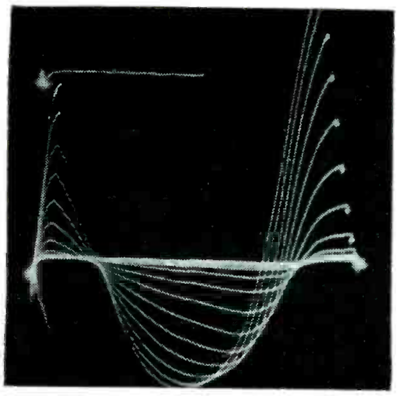


FIG. 1D—Same tube as Fig. 1A. E_{c2}, 180 v; E_{c3}, 180 v; $\triangle E_c$, 0.5 v; E_c + max, +1 v; I_b std, 1 ma; E_b std, 100 v; R_k, 330 ohms

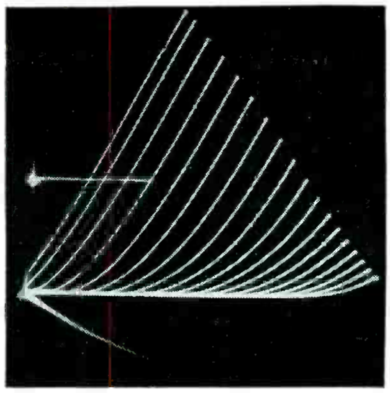


Fig. 1E—Type 6SN7 tube. E_b max, 300 v; $\triangle E_c$, 1 v; E_c+max, + 1 v; I_b std, 6 ma; E_b std, 100 v. The value of R_L is 12,000 ohms

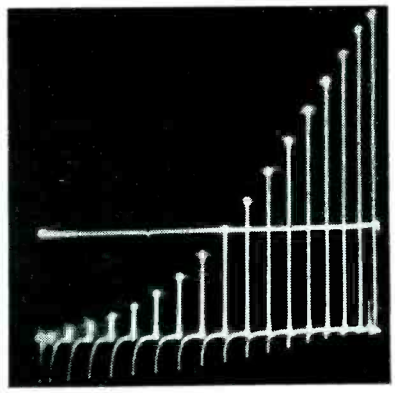


FIG. 1F—Family of $I_b - E_c$ curves for 6SN7 tube. E_b max, 300 v; $\triangle E_c$, 1 v; E_c+max, +1 v; I_b std, 7 ma; R_L 12,000 ohms

CURVE GENERATOR

Family of plate characteristic curves is automatically displayed on a cathode-ray screen together with the locus of the load line and coordinates for direct measurement. Receiving tubes can be analyzed with an accuracy of ± 5 percent using a Land camera. Information is obtained in less than two minutes

fined phase relationship. Reliable and stable operation has been achieved by deriving all timing signals from a single oscillator.

Performance Characteristics

Typical results obtained with the electronic tube curve generator are shown in Figures 1A through 1F. The oscillograms were photographed with a 1/25-second exposure at f3.5 on Super XX film. The c-r tube was a 5RP-A with 5 kilovolts between cathode and last anode. Appropriate data is printed under each family.

Curves in Fig. 1A through 1D were obtained by testing a type 6AC7 tube under various conditions. These families illustrate some of the possible departures from the normal handbook curves for this tube. The standard coordinate rectangle, which in Fig. 1A and 1B is 15 milliamperes along the I_b plane and 100 volts along the E_b plane, enables direct measurement of any point on the curve. The locus of the load-resistance line is the terminals of the curves. Curves in Fig. 1A, 1C and 1D were made with a degenerative unbypassed cathode resistor.

Curves in Fig. 1E and 1F were obtained testing a type 6SN7 tube. The curve of Fig. 1F is an $I_b - E_c$ family produced by the existing signals in this instrument. In this curve the horizontal input of the scope is energized by the step-wave grid signal to the tube under test; the vertical deflection results from the normal plate-current sweeps that dwell at their maximum. The resulting dots at the maximums describe a curve whose derivative is the G_m curve. This type of $I_b - E_c$ presentation is particularly convenient in that the grid voltage increments are directly defined by the calibrated vertical bars. The current standard appears as a horizontal bar in this display.

The slight inequality of spacing of the top two lines of the families in Fig. 1 is owing to the change of loading on the E_c cathode follower (V_{30} in Fig. 3). This is caused by a change to positive-grid-drive condition of the tube under test. The abrupt change in linearity of the E_c driving signal can be accounted for by calibrating the E_c increments in terms of the observed E_c step wave. The E_c step wave presents a linearly spaced increment on either side of $E_c = 0$, but this has a different spacing factor.

In all of these displays, overloading of the tube under test is avoided, since the average dissipation to which the tube is subjected is far below the peak values.

General System of Operation

The electronic tube-curve generator is shown in block form in Fig. 2. All the driving signals originate in the master oscillator (5). The plate voltage excursions for the tube under test are obtained from the oscillator as a large, positive, rising sawtooth wave via (6), (7), (13), and (18). The cathode follower (6) and the e_b maximum control (7) provide a means of controlling the magnitude of the plate-driving signal without loading the oscillator; cathode follower (13) provides ample driving power for the plate of the tube under test. Cathode follower (13) also performs the important function of isolating power supply (19) for the tube under test from the rest of the circuit. As a result, the only currents passing through R_{Ib} are the plate current of the tube under test and the plate currents of I_b standard dynamic (20) and I_b standard static (21). The R_L (18) is the adjustable plate load resistor for the tube under test.

Master oscillator (5) feeds a pulse into the pulse former (4) during the interval when the plate-sweep signal, discussed in the previous paragraph, is most negative. Pulses from the pulse former (4) operate a step counter (3) to provide a fixed-bias voltage for the grid of the tube under test. The grid sequentially becomes more positive, rising to a new d-c level each time the plate of the tube under test is driven negative. These stepwise, increasing, bias voltages are fed through the video divider (16) which reduces their amplitude to an appropriate level, and thence through cathode follower (22) to the grid of the tube under test. The E_{c0} control (14) acting through the clipper (15), provides for manual selection of a calibrated d-c level for the topmost (most positive) grid step, E_c.

Linearizing Circuit

In order that the sequence of grid-step voltages shall consist of uniform increments, a special linearizing circuit is employed. A rather precise equality of grid-voltage increments is obtained through the use of a constant-coulomb capacitor counter, shown by the ring-around path (4), (3), (10), (4). A system of pulsewise inverse feedback effects the transfer of a fixed charge of a capacitor into a larger capacitor with each pulse from the oscillator. The ΔE_c control (17) manually controls the inverse feedback to obtain any desired magnitude of grid-voltage increment.

The output of step counter (3) also feeds into the step number control (9). The step number control (9) can be manually set to deliver a pulse whenever any desired number of steps have accrued. The pulse delivered by step number control (9) signals the electronic switch (1) arresting the entire process.

In its arrested position the electronic switch (1) executes the following: actuates the step reset (2) which discharges the accrued voltage in step counter (3); shuts off the master oscillator (5); and turns on the I_b standard dynamic (20). The I_b standard dynamic (20) subsequently plots the ordinate of the standard rectangle. The magnitude of the I_b standard deflection on the oscilloscope is continuously monitored by a substitution method with I_b standard static (21), a matched tube, and its associated meter.

While the entire circuit is in the arrested state established by the electronic switch (1), a synchronizing pulse finally arrives from the synchronizing pulse amplifier (11). This pulse passes through the path (6), (7), (13), and thence to the E_b standard control (8). This provides an E_b sweep for the I_b standard vertical deflection until this sweep reaches a standard value of E_b selected on the E_b standard control (8) with its associated meter.

At the instant the divorced E_b sweep reaches the value set on E_b standard control (8), the pulse is delivered to the electronic switch (1) turning it on. Since the electronic switch previously had turned on the I_b standard dynamic (20), the signal from the E_b standard control (8) causes the almost instantaneous shutting off of the I_b standard simultaneously with the turning on of the master oscillator (5). This sequence results in the plotting of a standard coordinate rectangle.

Since all the plate voltage sweeps delivered from the cathode follower (13) to the plate of the tube under test pass through the plate-load resistor (18), the IR drop in the R_L (18) is automatically subtracted from the total plate voltage for each curve of the family. Thus, each of the $I_b - E_b$ curves in the family terminates at the load-resistance line. The locus of the load-resistance line is accentuated on the oscilloscope by terminating each of the $I_b - E_b$ curves with a bright dot. The dwell at the load-line intersections of the E_b sweeps is accomplished by the load line clipper (12) associated with the master oscillator (5).

Signal Source

All the signals generated in the instrument shown in Fig. 3 are derived from the rather special form of multivibrator V_{18} and V_{19}. The multivibrator has been constructed with multicontrol grid tubes on each side to facilitate its stopping and starting in a particular phase. The time constants of the two oscillating grids of the multivibrator have been chosen to give approximately a ten-to-one ratio, with the long period on the grid of V_{19}.

The short period on V_{18} allows for the generation of a relatively narrow positive pulse at the plate of V_{18}. Resulting from the choice of the long time constant in C_{17}, R_{20}, and P_3, a positive, rising, sawtooth signal having approximately ten times the duration of the pulse from V_{18} appears at the plate of V_{19}. The sawtooth output from the plate of V_{19} is fed through the cathode follower V_{21}. Cathode follower V_{21} lowers the impedance level and permits adjustment of the E_b sweep control without affecting the oscillator. The E_b sweep control effects the shift in the d-c level of the a-c signal coming from V_{21}.

A diode clipper tube V_{22} with its cathode anchored to a regulated bus clips the sweep from the oscillator to a regulated magnitude for all sweeps. This clipper also effects a desirable dwell of the sweep at its clipped maximum level. The dwell results in the intensification of the load-line intersection points. The clipped and d-c shifted sweep from V_{21} controls cathode follower V_{31} enabling V_{31} to deliver a low-impedance sawtooth signal to the plate of the tube under test. The signal from V_{31} passes through an appropriate load resistance selected in the associated network connected across terminal R_L. An ohmmeter connected across these terminals measures the value of R_L.

It will be noted that the E_1 power supply is disassociated from the rest of the circuit. This power supply serves to energize only the

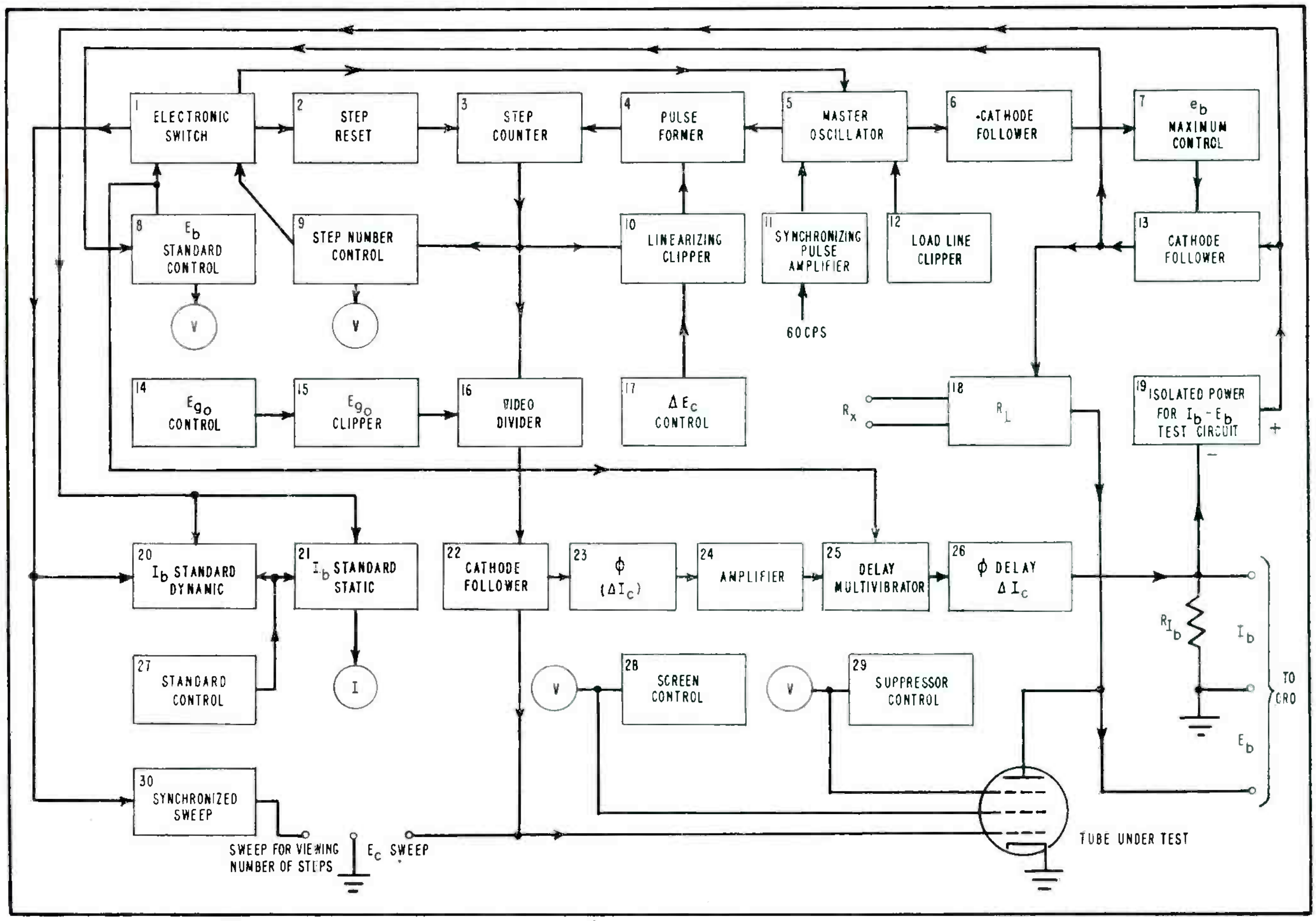


FIG. 2—Block diagram of the electronic tube curve generator. Numbers in the boxes are used for text reference

cathode follower V_{31} and the two I_b standard current tubes V_6 and V_{26}. The idling current of cathode follower V_{31} passes through R_{49}; the output current flows through R_L, thence through the plate-cathode circuit of the tube under test, and thence to E_1 power supply through R_{62}. The *IR* drop across R_{62} has special significance in that it defines the instantaneous plate current of the tube under test and the I_b standard plate current of V_{26}.

Basic Curve Generator

In order to obtain a display of the conventional $I_b - E_b$ curve on a cathode-ray oscilloscope, the *IR* drop from R_{62} is applied to the vertical deflection terminals of the oscilloscope while the plate-to-cathode drop of the tube under test is simultaneously applied to the horizontal deflection terminals. Since R_{62} must be a small resistor, considerable amplification of the vertical signal is required.

The oscilloscope must have broadband amplifiers for both deflections in order that the display will not be distorted by the oscilloscope. Furthermore, any phase-shift in these amplifiers must remain constant during the complete cycle of the family.

It is of particular interest to note that the *IR* drop across R_{62} does not produce a first-order degeneration of the maximum plate-supply signal to the tube under test. This follows from the fact that the signal to the grid of V_{31} is clipped at a constant positive crest by V_{22}, and thereby, V_{31} delivers at its cathode a signal whose positive crest is essentially constant with respect to ground. However, due to the differing demands of plate current I_b for the tube under test on each line of a family, the cathode follower V_{31} cannot deliver exactly the same crest values of E_b even though its input is clipped at a constant crest value of E_b. Furthermore, the tube under test presents a nonlinear loading of V_{31} due to the wide-range excursion of E_c (cutoff to positive grid values) usually employed.

The effect of such variable loading of V_{31} is observed in a curvature of the R_L load line dots that should appear as a straight line. Except for this distortion of the load-line locus, the degeneration of the E_b signal as it passes through V_{31} does not distort the balance of the display.

In the interest of minimizing the distortion of the R_L locus display two criteria are observed, both of which aim at minimizing the nonlinear distortion in V_{31}. First, the V_{31} stage should possess a tube having as sharp a cutoff and as high a g_m as is practical; second, R_{62} should be small, so as to limit the plate-supply degeneration to V_{31}, which also has a nonlinear degenerating effect on the output signal from V_{31}.

Linear-Step Generation

The square pulse signal from V_{18} rises to its positive peak at the time the plate-sweep voltage at V_{19} goes

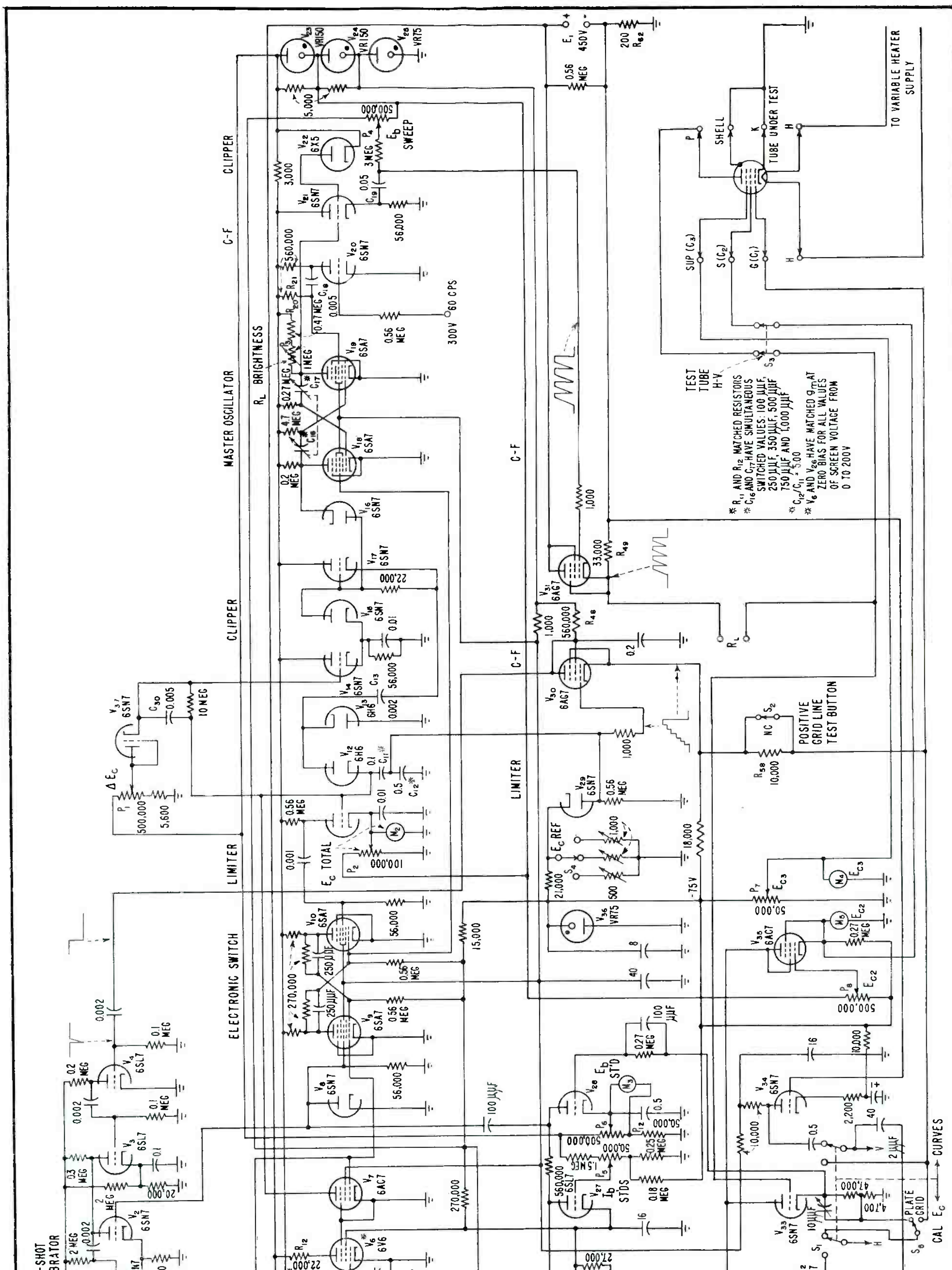


FIG. 3—Complete schematic circuit diagram of the automatic static-characteristic plotter for electron tubes

most negative. This allows the grid of cathode follower V_{17} to follow the positive pulse from V_{18} in a positive direction until the clipper V_{15} arrests it. The positive peak to which this pulse rises before it is arrested by an established voltage on the cathode of V_{15} is determined by the sum of two voltages in series; namely, the manually established potential in C_{30}, (peak derived through V_{37} from the ΔE_c control), and the previously accrued voltage across C_{11} and C_{12} in series.

As this positive pulse rises, current flows from the cathode of V_{17} through capacitor C_{13}, thence through diode V_{12} into the step-accrual capacitors C_{11} and C_{12}. Diode V_{18} serves to restore the output end of capacitor C_{13} to ground potential in the interim between positive pulses.

Neglecting the degeneration of the cathode followers in this part of the circuit, it becomes apparent that the positive crest to which the cathode of V_{17} is allowed to rise increases on each succeeding pulse by the exact amount of the previously accrued voltage at the top terminal of C_{11}. This feedback action results in a change of charge in C_{13} (during each cycle) proportional to the fixed charge in C_{30} selected by the tap on the ΔE_c control. Moreover, this measured change of charge on C_{13} remains the same for every pulse delivered from V_{17}; hence the term constant-coulomb capacitor counter used previously.

The low-impedance output of V_{17} together with the generous pulse width are more than adequate to allow C_{13} to reach the asymptote on its change of charge. The stair-step-function voltage generated in capacitors C_{11} and C_{12} is linearly reduced in amplitude by the ratio of C_{11} to C_{12}. This small-amplitude, step-function signal is fed to the grid of the tube under test through cathode follower V_{30}.

Calibrated Bias

The desired d-c bias for the grid of the tube under test is established through the application of the diode limiter V_{29} with the associated manual control of its cathode potential by the E_c reference control. The diode limiter V_{29} conducts only on the most positive step imparting the necessary bias voltage to capacitor C_{12} so that the grid of the tube under test comes up to a calibrated d-c bias level for the most positive step.

A peak-reading, vacuum-tube voltmeter was connected to the grid of the tube under test when calibrating the choice of voltages for the topmost step in terms of the value of resistors R_{45}, R_{46}, and R_{47}. These resistors of the E_c reference control were so chosen as to provide values of +1, 0, and −1 volts for the topmost step as measured at the grid of the tube under test. It is possible to select other values of voltage for the cathode of V_{29} that would result in any reasonable value of grid limiting up to at least +3 volts for the tube under test.

Frame Synchronizer

Pentagrid tubes V_9 and V_{10} with their associated components constitute a conventional electronic switch. The output control signals from the switch are taken from the No. 1 grids of these tubes. The choice of pentagrid tubes permits complete independence of the two control signals fed in through grids 3 of V_9 and V_{10}.

In an electronic switch of this nature, control grids 3 accept only negative pulses, and these negative pulses are only effective to the tube that is in the conducting state. When a negative pulse is received on grid 3 of this switch, grid 1 of the same side of the switch becomes biased beyond cutoff within a few microseconds. No signal on grid 3 can produce further effect after grid 1 becomes biased. For example, a positive pulse on grid 3 cannot make this side of the switch resume conduction since grid 1 is below cutoff voltage.

The functions controlled by this multipurpose switch will be individually described in time sequence of occurrence. During one cycle when the instrument is generating the family of curves, the electronic switch is in the state that we shall consider the ON or RUNNING position. In the ON position, V_{10} is conducting and V_9 nonconducting; grid 1 of V_{10} is at ground potential.

By interconnecting grid 1 of V_{10} with grid 3 of V_{18}, the oscillator V_{18} and V_{19} is allowed to run freely. Since V_9 of the switch is nonconducting during the ON period, its grid 1 is biased below cutoff. As this grid is directly connected to the grids of V_5, V_6, and V_7, the latter three tubes also will be nonconducting during the running time of the oscillator.

The grid-step-function limiter V_{11} generates a negative pulse at its plate when the step function in C_{11} and C_{12} has accrued to a value that overcomes the selected cathode voltage on V_{11}. When the step-function voltage applied to the grid of V_{11} is large in magnitude and when V_{11} is a sharp-cutoff tube, the manually selected cathode voltage for V_{11} is an effective measure of the a-c magnitude of the step-function signal.

Therefore, the control P_2 and its associated meter M_2 are appropriately labeled E_c TOTAL. When the step function reaches the total voltage selected for the cathode of V_{11}, a negative pulse from the plate of V_{11} passes to grid 3 of V_{10} instantaneously triggering the electronic switch to the OFF position. Immediately following the OFF state of the switch, the oscillator is stopped and held in this condition while V_5, V_6, and V_7 are rendered fully conducting.

Pentode tube V_7 presents a low-impedance discharge path for the step-accrual capacitors C_{11} and C_{12} rapidly discharging them to zero voltage. The plate current of dynamic-standard-current tube V_6 produces a pulsed IR drop in R_{62} corresponding to a calibrated value of the plate current of the tube under test. This pulsed IR drop from V_6 results in the I_b standard vertical deflection on the cathode-ray oscilloscope.

Plate-Current Calibration

The calibration of the pulsed current of V_6 is accomplished by a substitution method. A continuous current has been made equal to the peak pulsed plate current of V_6 by selecting V_{26} to match V_6, making R_{11} equal to R_{12}, and applying the same variable screen voltage to both V_6 and V_{26}.

The control grid of V_{26} is grounded while the control grid of V_6 is switched periodically to ground quite accurately by the electronic switch V_9 and V_{10}. The potential from P_5 effects variable control of the screen voltage to V_6 and V_{26} through cathode follower V_{27}. The potentiometer P_5 is appropriately labeled the I_b STANDARD CONTROL. The adjustable standard plate current to be selected is read on the I_b standard meter M_1.

Subsequent to a short rest period in the OFF position of the electronic switch, a synchronizing pulse is generated by V_{20}. An amplified and rectified 60-cycle square wave is generated at the plate of V_{20}. This signal is differentiated by R_{21} and C_{18} delivering a phase negative transient to grid 3 of the multivibrator tube V_{19}.

It will be noted that during the OFF position of the electronic switch, V_{18} of the multivibrator is held in a nonconducting state by a large negative bias on its grid 3; V_{19} of the multivibrator is in a conducting standby condition until the reception of the synchronizing signal from V_{20}.

When the signal from V_{20} rapidly biases off grid 3 of V_{19}, the plate of V_{19} delivers a single divorced plate-sweep signal. The signal is normal in every respect except that it occurs in a nonrepetitive fashion in contrast to the normal oscillations of the multivibrator. However, the divorced sweep occurs repetitively at a 60-cycle rate, and is induced directly by the synchronizing pulse from V_{20}. The single divorced sweep from V_{19} passes through the previously described path to the plate of the tube under test.

Because the tube under test is biased beyond cutoff, no plate current from it is plotted in terms of an IR drop in R_{62}. During the divorced plate sweep from V_{19}, the peak pulsed-plate current from V_6 is resting in a steady state and at a calibrated magnitude. As a result, a horizontal bar whose height above the base line directly represents the reading on M_1 (the standard I_b) is plotted on the cathode-ray oscilloscope.

Plate Voltage Calibration

The divorced sweep from V_{19} progresses until the voltage at the plate of the tube under test, which is also fed to the grid of V_{28} via V_{33}, overcomes the bias on the cathode of V_{28}. At the instant the divorced plate voltage sweep approaches the cathode bias on V_{28}, a negative pulse from the plate of V_{28} turns the electronic switch to the ON position.

As the switch goes to the ON position, the I_b standard deflection current is removed from V_6 by biasing off the tube. This results in the closing of a standard rectangle, as displayed on the oscilloscope, whose length is measured by the E_b standard meter M_3.

The potentiometer P_6 and its associated meter M_3 are appropriately labeled E_b STANDARD. Since the plate voltage sweeps are usually large and V_{28} is a sharp cutoff tube, the cathode potential of V_{28} as selected on P_6 effectively determines the voltage lengths for the standard rectangle within close limits of error.

The error is essentially a constant, equal to the cutoff bias of V_{28} subtracted from the reading on M_3. By zero-adjusting M_3 to the left of zero an amount equal to the cutoff of V_{28} or by applying a bucking potential to the ground end of M_3 equivalent to the cutoff bias of V_{28}, this error can be negligible. Errors in this part of the circuit owing to time or phase lag of the functions are negligible as compared to other errors.

The delay that occurs between the time the signal is being applied to the grid of V_{28} and the time it takes the electronic switch to operate and cutoff V_6 is not more than 2 microseconds. With a plate-voltage sweep time of approximately a millisecond, a delay of 2 microseconds will introduce only 0.2 percent error due to time lag.

Accessory Circuits

Two circuits have been included in this design that are not vitally necessary, but add conveniences and confidence in the overall operation of the instrument. Triode V_5 with its associated plate circuitry constitutes a simple servo-sweep. By direct connection of the grid of V_5 to V_9 of the frame synchronizing switch, V_5 derives its servo-timing. The sweep that V_5 generates is especially useful when viewing on the oscilloscope the step-function signal at the grid of the tube under test.

A convenient exchange of the oscilloscope connection from the normal curve-displaying connections to the grid-step function versus the servo-sweep is provided for by S_1. The step function oscilloscope display is used in setting up the E_c total and the $\triangle E_c$ controls.

Triodes V_1, V_2, V_3, and V_4 identify those curves in the family that have positive values of grid bias. Whenever the grid of the tube under test is driven positive, an abrupt increase in load occurs on cathode follower V_{30}. When this load occurs, a pulse is obtained by differentiation of the plate signal of V_{30}. The pulse from V_{30} is small since the allowable degeneration value of R_{48} is small. Therefore, the pulse is amplified by V_3 and V_4 in order to trip the single-shot multivibrator V_1 and V_2.

The multivibrator stores memory of the positive grid lines from the time of the origin of that line at zero I_b and zero E_b until the trace reaches the E_b standard deflection. At the instant the E_b standard deflection is reached, a negative pulse from V_{28} resets multivibrator V_1 and V_2 causing it to deliver a sharp marker pip. When the multivibrator is coupled very loosely into the vertical-amplifier input connection of the oscilloscope a pip appears on the positive grid lines of the family. The pip is best illustrated in the family of Fig. 1E. It appears on the top two (positive) curves of the family directly above the right-hand end of the standard rectangle.

Resistor R_{58} may be inserted in series with the grid of the tube under test by depressing the normally closed push button in shunt with R_{53}. Depressing the button results in clipping of the positive grid steps from the tube under test. On the oscilloscope display of the characteristic family, the clipping results in an obvious compression of the positive grid lines of the family. This compression is another means of identifying the positive grid lines.

Diode V_8 shunts out the positive pulses from V_{28} that occur during each flyback of the E_b sweep. These positive pulses, if they were not clipped out by V_8, would cause false triggering of the memory multivibrator V_1 and V_2. The result of the false triggering would put a pip on all the lines of the family instead of only on the positive grid lines.

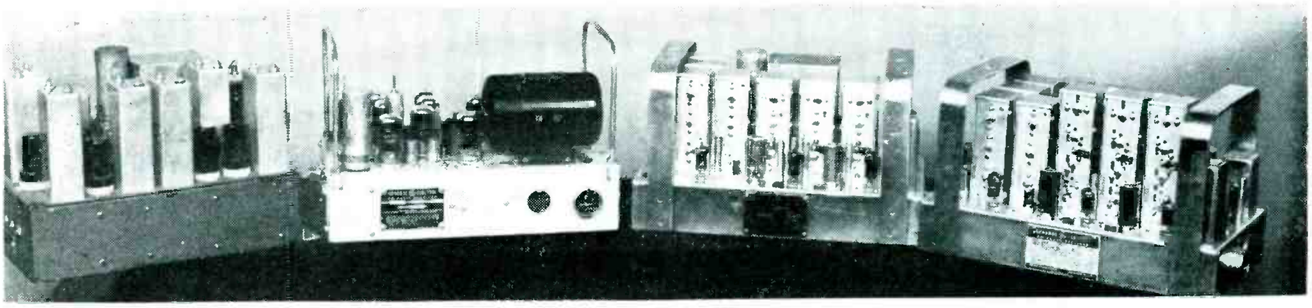


FIG. 1—Mobile f-m receivers during the past ten years (left to right, 1940, 1945, 1948 and present) have undergone considerable electrical improvement without change in physical size and little change in general appearance

Ten Years of Progress In Mobile F-M Receivers

Sensitivity has taken a back seat to selectivity in the design of mobile receiving equipment, especially in the 25 to 50-mc region. Several efficient ways of achieving increased selectivity without increasing size, cost and complexity are outlined and discussed

By A. G. MANKE and R. T. MYERS

Radio Communication Engineering Section
Commercial Equipment Division
General Electric Co.
Syracuse, New York

MOBILE RECEIVERS, for use in the 25 to 50-mc region on f-m, have undergone considerable improvement in the past ten years. This fact is illustrated graphically in the following text and illustrations. One striking point of interest is the lack of major physical design changes needed to obtain so much improvement in performance. A photograph showing first, latest and two intermediate commercial models is shown in Fig. 1.

Changing Requirements

Initially, in this field, the two major problems for the receiver were sensitivity and reliability. However, as the number of users increased, and they really increased rapidly, the receiver problems quickly changed to those primarily related to selectivity. The problems which are, to a large extent, directly related to selectivity are spurious responses, intermodulation, desensitization, oscillator drift, temperature compensation of all tuned circuits, oscillator radiation, image ratio, fidelity, and impulse response of both the low and high i-f amplifiers.

Figure 2A shows the changes in sensitivity that have taken place. The most significant fact these curves reveal is that no appreciable improvement in receiver sensitivity has been obtained since the 1945 receiver.

It is evident that the selectivity characteristics of an f-m receiver are of much importance in predicting performance. No other single characteristic has such a broad influence in determining the final field performance of the receiver and, consequently, of the communication system. The selectivity re-

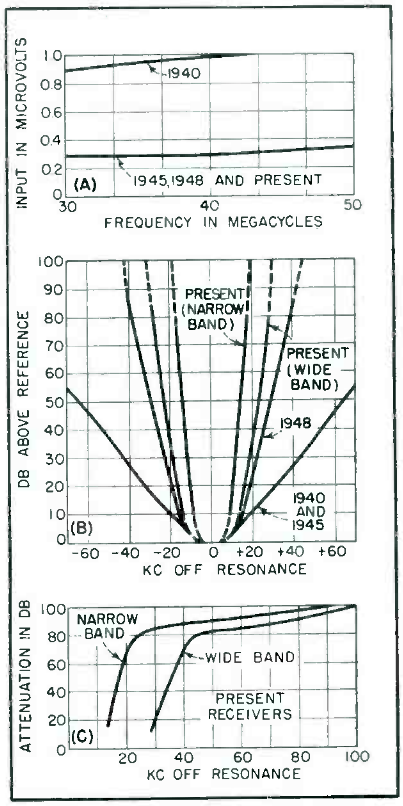


FIG. 2—No appreciable improvement in receiver sensitivity has been realized since 1945 (A) but selectivity has been increased, as shown in B and C

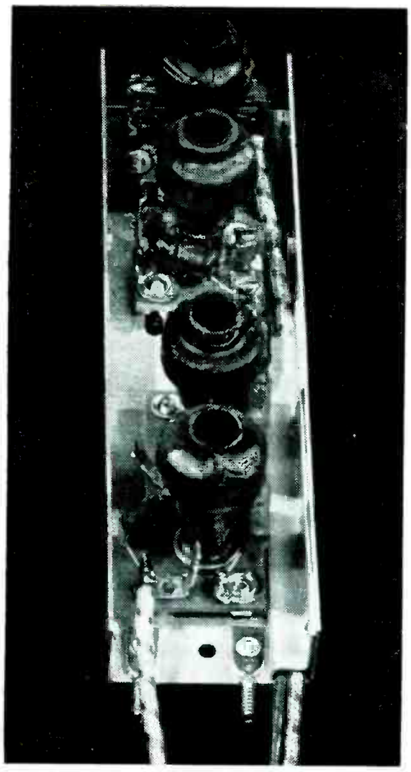


FIG. 3—Quadruple tuning of low i-f transformers provides sharper response curves

ferred to in the above characteristic is not that of the low i-f amplifier but rather the effective or two-signal selectivity.

Figure 2B shows the improvement in selectivity that has followed the evolution of the receivers shown in Fig. 1. These curves were taken by the 20-db quieting method. (Measurement of selectivity by the 20-db quieting method is made by comparing the amount of power required to give a 20-db reduction in the noise output of the receiver on and off frequency.) Dashed lines are used for attenuations above the desensitization threshold, since desensitization occurs above this level, and higher attenuation values, although indicated by the 20-db quieting selectivity curves, actually are not applicable.

Two-Signal Selectivity

The two-signal selectivity curves shown in Fig. 2C take into account all such factors entering into the selectivity question as far as the receiver is concerned. If the transmitters are reasonably free from noise and spurious signals, such a selectivity curve can be used to predict field performance, whereas the 20-db quieting curve does not show the desensitization of the receiver and is not adaptable to predicting performance at the adjacent channel and gives no information whatsoever at several channels off resonance.

In plotting the curves of Fig. 2C a weak signal equal to that required for standard RMA sensitivity is applied for the desired signal (a signal of such strength that the ratio of signal plus noise plus distortion, to noise plus distortion is equal to 12 db at two thirds of rated deviation). A second generator modulated at two-thirds maximum deviation (400 cycles) is used as the interfering generator. For each point on the selectivity curve, the interfering signal is increased until the desired signal suffers to the extent that a distortion meter shows 6 db of signal plus noise plus distortion to noise plus distortion.

Only one side of the two-signal selectivity curve is shown and this is the side having the least selectivity. By plotting the curves this way more space is available for extending the curves to cover several channels off resonance. This then enables one to read the actual selectivity directly from the two-signal selectivity curve for the adjacent channel and for frequencies far from resonance.

The 20-db quieting curve is found to be in error between 6 and 20 db in regard to predicting receiver band pass. In this region the 20-db quieting curve is often thought to represent the band pass of the receiver. This error can best be checked by putting into the receiver a signal twice the 20-db quieting level, modulating the signal at any audio frequency between 300 and 1,000 cps and increasing the swing. (This corresponds closely to maximum output.) This value of swing represents the useful band pass of the receiver, and is slightly greater for higher modulating frequencies.

This method of checking receiver bandwidth is known as the swing or modulation method and agrees with actual field operation, therefore giving realistic results. The wide difference between the 20-db quieting method of measurement of bandwidth at 6 db and the actual band pass characteristics of a receiver for an f-m signal are in part due to the limiting action of the receiver at this level.

Low I-F Amplifier

The latest receiver uses three quadruple-tuned i-f transformers in the low i-f amplifier. One of these transformers is shown in Fig. 3. All circuits are arranged so the coupling can be varied by mechanical movement of the plate and grid coils. The transformer is designed with the idea in mind of readily changing from wide to narrow band by changing a loading resistor on the plate coil, changing one coupling capacitor, and then adjusting the coil spacing as specified for narrow band.

Ceramic temperature-compensating capacitors are used to tune the coils. These capacitors are mounted on rigid terminals which also serve as coil terminals.

The iron cores used in the transformers are adjustable, but once set, a lock washer arrangement prevents further movement.

Figure 4 shows a typical selectivity curve of one of the wide-band quadruple-tuned i-f transformers. It is interesting to note that one of these transformers has several times more selectivity than the entire 1945 receiver. Although the slope of the curve of the amplifier using these transformers is great enough to give a ratio of 2 to 1 between 6 db and 100 db as measured by conventional a-m selectivity methods, this transformer shows very small ringing effects due to

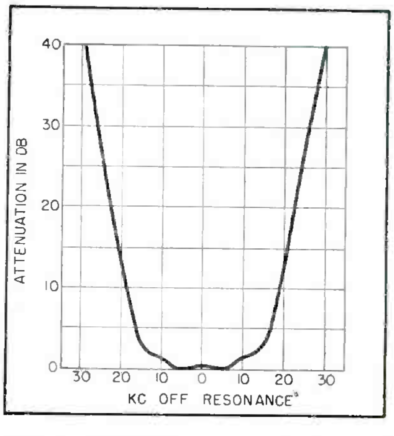


FIG. 4—Selectivity curve of four-coil low i-f transformer

impulse noise. Since each of the transformers is isolated from each other by a tube, the tendency towards ringing of the entire amplifier is held essentially to that of an individual transformer.

The quadruple-tuned transformer, when properly designed, gives a selectivity curve with an inherently wide nose as compared to that obtained in double-tuned i-f transformers. The selectivity curve (Fig. 4) has an appreciably flat portion at the bottom and then has a small shoulder at each side which adds to the broad-band effects obtainable in this selectivity characteristic. The shoulders of this selectivity curve are down only 2 db and give an overall rounding effect to the selectivity curve.

The high i-f amplifier in this receiver consists of a single stage of triple-tuned transformers. These transformers are very similar to the quadruple-tuned units in mechanical construction and also in electrical performance. A single 6BH6 pentode is used with two triple-tuned i-f transformers and this tube is operated at very low plate and screen voltage as the total gain in this amplifier is held to a minimum. It is interesting to observe the selectivity obtainable from a single stage consisting of two triple-tuned transformers and compare this to the high i-f amplifier used in the older receivers using double-tuned i-f transformers instead. The selectivity curve of this amplifier and its predecessor is shown in Fig. 5A. It will be noted that the bandwidth at 6 db is identical for both amplifiers and at 100 kc off resonance the triple-tuned amplifier is already ten times more selective than the double-tuned amplifier.

R-F Amplifier

In Fig. 5B is shown the comparison of the selectivity of the r-f amplifiers of receivers shown in Fig. 1. At one megacycle off resonance the later model receivers have 100 times more attenuation than their predecessors. This was accomplished through the use of multiple circuit transformers. The r-f transformer (Fig. 6) is triple tuned and the antenna transformer (not shown) is a two-circuit preselector. The coils used in these transformers have very high Q's and are tuned with ceramic temperature-compensating capacitors.

Figure 5C shows the comparison of the former single-tuned antenna coil with that of the present double-tuned preselector or antenna transformer. At one megacycle off resonance, the preselector has five times more selectivity than the previous single-tuned antenna coil used in the 1945 receiver. Selectivity in this part of the receiver is extremely important now that the communication band is crowded as this contributes directly to the reduction of intermodulation, except for stations located within the band pass region of the preselector, and also prevents saturation of the first tube when stations are located in close proximity. Higher front-end selectivity also contributes to lower oscillator radiation, less spurious responses and improved two-signal selectivity.

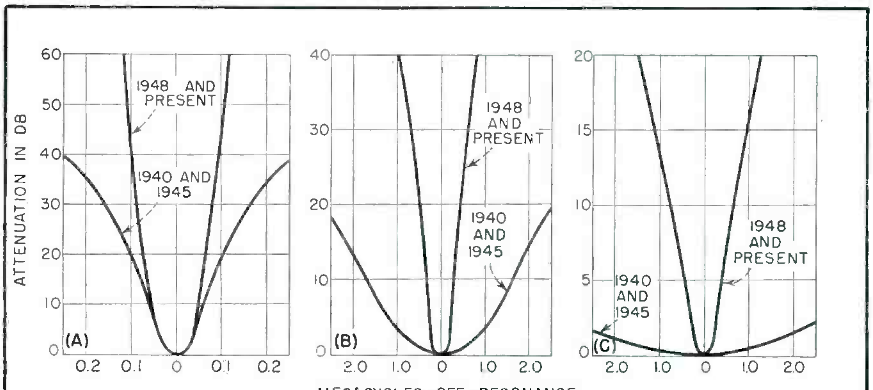


FIG. 5—High i-f (A), r-f (B) and antenna (C) circuit response curves are further evidence of improvement over earlier models

The improvement in image ratio which is largely dependent on r-f amplifier performance has increased from 1,200 to 1,000,000 or from 61 db to 120 db. Oscillator radiation has been reduced from 3,000 microvolts down to less than 20 microvolts. The two-signal selectivity at the alternate channel has been improved from 30 to 90 db. Intermodulation for stations three and six channels removed from resonance has improved from 47 to 76 db. Adjacent-channel (40-kc) desensitization has improved from 15 to 80 db and the alternate-channel (80-kc) desensitization has improved from 40 to 90 db.

Spurious response ratio has been improved from 60 to 90 db, which is due among other things to front-end selectivity, the use of a mode crystal and chassis arrangement. A far greater improvement than indicated by the ratio of 60 to 90 db has been made in the reduction of the total number of spurious responses present in the receiver. The largest selectivity increase on the later model receivers has occurred in the r-f amplifier and in view of the large number of stations in the band and the tendency towards narrow band which would further increase the number of stations in the band, it is logical that this portion of the receiver should receive the greatest percentage of performance stepup.

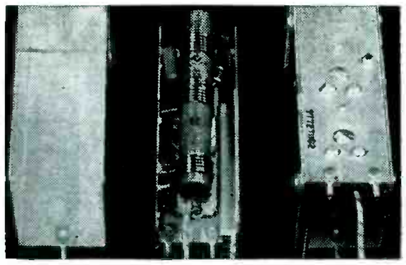


FIG. 6—Triple-tuned r-f transformer

The gain of the multiple-coil transformer is inherently high, therefore, making the receiver design very efficient from the standpoint of the number of tubes required. For instance, the latest receiver achieves its improved performance with one less tube envelope.

Measuring UHF-TV

Method combines noise-diode and signal-generator techniques to simplify manipulations and equipment over usual methods and provide greater range and versatility. Allows quick comparison of receiver noise figures and uses only standard laboratory instruments

By S. R. SCHEINER and G. W. CARTER

Television and Broadcast Receiver Division
Bendix Radio Division of Bendix Aviation Corp.
Baltimore, Maryland

NOISE FIGURE of a television receiver is usually measured with a standard noise source, such as a temperature-limited diode. A signal generator can be used instead of the noise diode, but the experimental manipulations and mathematical calculations are more cumbersome.

A method for measuring and comparing noise figure is described which combines the noise diode and signal-generator techniques. In some cases, this method results in the use of simpler manipulations and less equipment than either of the two standard methods.

This system may be applied to the measurement of a uhf converter-vhf receiver combination measurement of noise figure of a receiver beyond the usual range of a noise diode, and rapid comparisons of various receiver noise figures. Through its use receivers can be readily compared as to signal-to-noise performance by measuring gain and noise output into a fixed narrow bandwidth, which information can readily be converted to noise figure if desired.

A convenient definition of noise figure of a receiver is[1,2]

$$F = \frac{S_a/N_a}{S_o/N_o} \qquad (1)$$

where S_a/N_a = the available signal-to-noise power ratio input from the signal source and S_o/N_o = the available signal-to-noise power ratio at the output terminals of the receiver.

Equation 1 can be rewritten as

$$\left(\frac{E_o}{E_{No}}\right)^2 = \frac{E_a^2}{4KTBR_aF} \qquad (2)$$

where E_o = the signal voltage output of receiver, E_{No} = the noise voltage output of receiver, E_a = the open circuit signal voltage from the source, R_a = the impedance of the source, K = Boltzmann's constant (1.38×10^{-23} joules per degree), T = absolute temperature in degree Kelvin, and B = noise bandwidth of receiver.

From Eq. 2, the signal-to-noise output ratio of a linear receiver is a function of signal input, source impedance, noise bandwidth, absolute temperature, noise figure; and, in the case of amplitude modulation and detection, the percent modulation. If the noise bandwidth of two receivers is exactly the same, and if the applied signal is modulated by the same percentage, then it is possible to calculate readily the noise figure of the second receiver, having measured the noise figure of the first receiver (with a noise diode), and the signal input required for a convenient signal-to-noise output for each amplifier.

To compare the noise figure of amplifiers designed for the same source impedance, and having the same overall system bandwidth, then from Eq. 2

$$F = CE_{No}^2/G^2 \qquad (3)$$

where $C = 1/4KTBR_A$, a constant, and G = voltage gain of receiver $= E_o/E_a$. Also

$$F_2 = F_1\left(\frac{E_{N2}}{E_{N1}}\right)^2 \times \left(\frac{G_1}{G_2}\right)^2 \qquad (4)$$

where F_1 = noise figure of first receiver, F_2 = noise figure of second receiver, G_1 = voltage gain of first receiver, G_2 = voltage gain of second receiver, E_{N1} = noise voltage output of first receiver, and E_{N2} = noise voltage output of second receiver.

Therefore, if the noise figure of one receiver is known, the relative gains of both are known, and the relative noise outputs of both are known, the noise figure of the other receiver can be calculated.

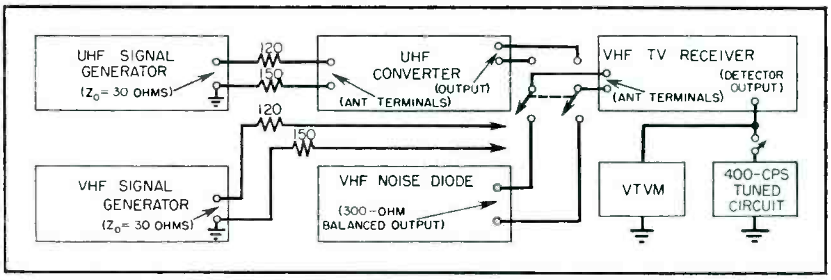
Measurement Procedure

Only one measurement with a noise diode is required on a television receiver at one frequency. It is then possible to calculate rapidly the noise figure of any other receiver at any frequency without further use of a noise diode and without calculation of noise bandwidth B.

A signal generator modulated with 400 cycles and a narrow-band voltmeter are employed in the measurement. The bandwidth of the meter is appreciably less than any of the receivers or amplifiers being compared. Hence, the overall bandwidth will be determined by the meter and will be the same for all receiver measurements as required in Eq. 4. Thus, different receivers fed from the same source impedance can be compared directly and rapidly by measurement of gain and noise output. The various noise figures can be calculated by Eq. 4.

Effectively the procedure is to evaluate the constant C in Eq. 3 by measuring noise figure, (with a noise diode) noise output and gain (with signal generator) for one receiver under one operating condition. Noise figure can then be calculated for any other receiver and any other operating conditions by measuring only noise output and gain, since C remains the same

Receiver Noise Figures



Arrangement of test instruments for measuring uhf-tv receiver noise figures

under the imposed conditions.

The noise figure of a receiver at different frequencies and different agc conditions can likewise be determined by measurement of gain and noise output. In many cases, determination of high noise figures beyond the useful range of the noise diode is possible.

Typical Case

For a practical example, it is desired to measure the noise figure of a uhf converter-vhf television receiver combination where both are designed for 300 ohms input impedance. A noise diode for uhf is not available, and, in addition, the noise figure of the combination is beyond the calibrated range of most commercial instruments.

The block diagram shows the test set-up. The first step is to measure the noise figure of the vhf receiver on the channel to be used for conversion. The usual precautions to insure detector linearity must be observed[3,4]. Using a noise diode, and with the receiver tuned to vhf channel 10, a measurement of 17 db or 50 times was obtained.

Next a c-w signal is applied to the receiver under test. A vtvm is connected to the output of the detector. The carrier input is increased until there is no further increase in noise output to insure linear operation of the detector. Further, the i-f amplifiers are biased to prevent overload in these stages and thereby insure adequate carrier-to-noise ratio at the detector. The noise voltage measured was 0.1 volt.

The signal generator is next modulated with 400 cycles. The percent modulation is sufficiently low to provide adequate carrier to 400-cycle signal voltage to again insure detector linearity. With a 400-cycle filter inserted to remove the noise, the 400-cycle output measured 0.135 volt, using approximately 10-percent modulation. The input carrier level from the signal generator was maintained constant at 80 μv on the measurements. Measurement of signal input, noise output, and 400-cycle output was repeated using a uhf signal generator connected to the uhf converter-whf receiver combination. The percent modulation used must be exactly the same.

A method of determining that the percent modulation is the same in both cases, is to apply a strong signal and reduce the gain so that the output noise is negligible, and with the same d-c voltage at the detector in both cases, measure the audio output. It should be the same if the percent modulation is the same.

With the uhf signal generator operating at 650 mc, the noise reading on the vtvm was 0.1 volt, and the 400-cycle output was 0.126 volt. The signal generator input was 350 microvolts.

Then if E_1 = 400-cycle output in first case, E_2 = 400-cycle output in second case, S_1 = signal input in first case, and S_2 = signal input in second case

$$\frac{G_1}{G_2} \text{ (Eq. 4)} = \frac{E_1 S_2}{E_2 S_1}$$

Substituting in Eq. 4

$$F_2 = F_1 \left(\frac{E_{N2}}{E_{N1}}\right)^2 \times \left(\frac{E_1 S_2}{E_2 S_1}\right)^2 \quad (5)$$

In the example mentioned F_2 = 1,100 = 30.4 db, which is the overall system noise figure.

The noise figure of the converter alone can be calculated, if its available power gain is known, as follows: $F_c = F_2 - (F_1 - 1)/W$ where W = available power gain of converter, and all other notations the same.

Indicators

The Ballantine Model 300 Voltmeter serves very well as the indicating device. The meter need not be linear as it can easily be calibrated.

The actual noise bandwidth of the overall system (which is the meter bandwidth) can be calculated by substitution of our measured values in Eq. 2. By this method B can be calculated to be 141 kc.

The measured 3-db bandwidth of the meter with its associated cable fed from a source impedance equal to the detector load impedance was measured to be 125 kc.

Measurements of noise figure for various television receivers can be made without any reference noise diode measurement if the noise bandwidth of the narrow-band meter is calculated. Having evaluated the noise figure of one receiver after this noise bandwidth has been once determined, the same meter can be employed for measurement of noise figure of any other receiver without any determination of receiver bandwidth making use of Eq. 4. As long as the same narrow-band meter is determining the system bandwidth, we are comparing receivers of equal bandwidth and Eq. 4 is applicable.

The authors wish to acknowledge the assistance of J. M. Miller, Jr., chief engineer of Broadcast Radio and Television Engineering Dept. of Bendix Radio. His suggestions and criticisms were of material help in this development.

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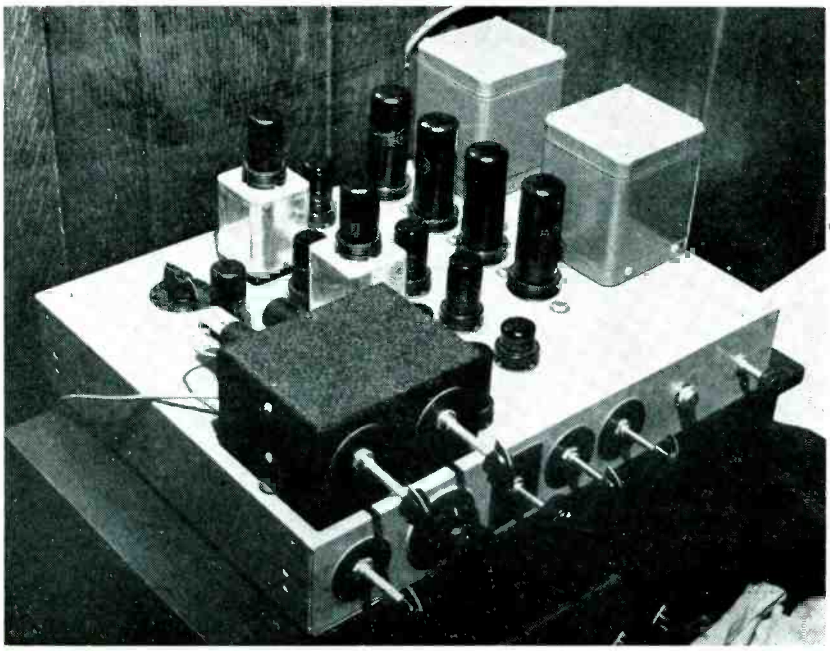
40-DB FEEDBACK

By BENJAMIN B. DRISKO
Massa Laboratories, Inc.
Hingham, Mass.

and R. D. DARRELL
New York, N. Y.



Top view of home-built Drisko power amplifier. A phonograph preamplifier and a dynamic-noise-suppressor circuit are included on the same chassis in this photograph

MAXIMUM ECONOMY together with maximum quality of reproduced music are the two criteria of the audio amplifier to be described. Five years of operation by the designer have shown it to be consistent and trouble-free. Since first emphasis was on satisfying acoustic output, horn-loaded loudspeakers were employed to achieve reductions in power-handling requirements. With such relatively efficient loudspeakers, no more than 12 watts is needed from the amplifier.

Characteristics

The amplifier design calls for effectively zero output impedance and distortion. With the extreme transient demands of symphonic music in mind, the gain-bandwidth requirements are not confined to flatness over the audible spectrum but are extended to provide slopes not steeper than about 6 db per octave down to zero gain outside that range, involving frequencies possibly as low as a fraction of one and as high as 200,000 cps.

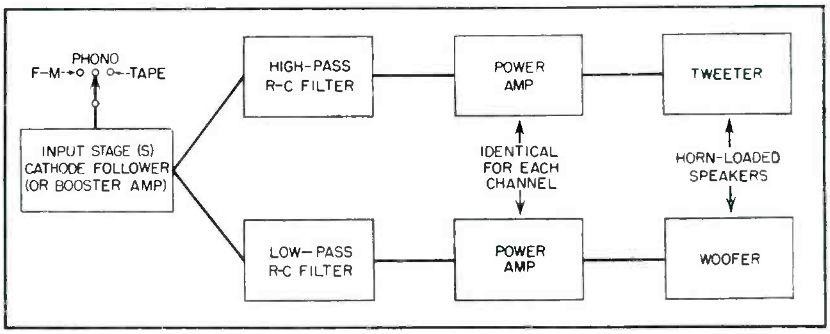


FIG. 1—Block diagram of the dual-channel system

Characteristics of the amplifier are closely shaped by those of the overall system for which it was developed. The latter is shown first in block-diagram form in Fig. 1 followed by schematic diagrams of the switching, control, input and frequency-dividing circuits, Fig. 2. The designer's own phonograph preamplifier equalization circuit is not shown as it has been described elsewhere.[1]

Particular attention should be called to the specification of horn-loaded loudspeakers, utilizing an exponential horn for the tweeter and a folded-horn enclosure for the woofer. It should be noted that the amplifier itself, identical in both channels here, is applicable to single-channel use. In this case, the quality is somewhat degraded if L-C crossover filters are employed at the inputs of multiple or coaxial speakers and the acoustic power output from a single direct radiator is markedly reduced.

Amplifier Circuit

The distinctive features of the amplifier circuit shown in Fig. 3 are: beam-power output tubes with exceptionally heavy feedback, direct-coupled over two stages only, a somewhat novel method of screen-voltage feed for the output tubes and the complete omission of screen and cathode bypass capacitors.

The principal purpose of the first feature is to achieve effectively zero output impedance. The second and third features enable the advantages of beam-power output tubes to be exploited without the high-signal-level rectification effects normally encountered unless excessive precautions are taken in power-supply regulation and in push-pull balancing. In addition, these features provide the more familiar beneficial effects of large amounts of feedback, a high degree

AUDIO AMPLIFIER

High fidelity is obtained in this audio system by using two amplifier channels, one for a horn woofer and the other for a horn tweeter. Heavy feedback gives effectively zero output impedance. Screen and cathode bypass capacitors are completely omitted

of differential balancing and notably improved transient response.

No provision is made in the circuit for the manual-balancing adjustments popular in current push-pull circuits. With ordinary care in selecting components, inherent self-balancing is provided by the common voltage-feed resistors for the paired 6SJ7 and 6L6 screens, the absence of cathode and screen bypasses and the large amount of feedback used.

Direct Feedback

Although a high-quality output transformer is specified, it is excluded from the feedback loop, which includes only the output and driver stages direct-coupled via 120,000-ohm resistors. The principal reason for this is the relative ease with which as much as 40 db of feedback can be obtained over the entire useful frequency range without running into phase-shift difficulties. Another reason is the elimination of high-frequency oscillations and distortions which are serious dangers whenever feedback is drawn from a transformer secondary.[2]

From the various popular types of phase inverters, the split-load version was chosen both for its simplicity and its operational advantages. Perhaps its only real disadvantage is the danger of heater-cathode leakage noise, which seldom proves serious and ordinarily may be avoided by judicious tube selection.

The specification of 0.5-μf coupling capacitors and 270,000-ohm grid resistors within the feedback loop and 0.01-μf, 2.2-meg combinations outside it may seem odd. Actually, the extremely large time constant of the first combination is essential to prevent steepening the 6-db-per-octave slope below the useful frequency range. The other combination is fully adequate for the lowest frequencies that can be reproduced by the overall system.

The 2.2-meg grid resistors are used because heavy feedback permits satisfactory performance from tubes operated considerably below their maximum dissipation ratings, which in turn usually results in freedom from the grid-current troubles commonly associated with high values of grid leaks.

Overload safety margin is provided by the 12-db greater signal-voltage-handling capacity of the intermediate stages over that of the output stage. With such protection and the 40-db of negative-voltage feedback, distortion of all kinds is truly negligible right up to the output stage's overload point. Just below that, an input signal of 4.6 volts rms on the phase inverter's grid delivers about 12 watts into the associated voice coil.

Amplifier output noise is negligible. With proper adjustment of the a-c heater-supply biasing controls, shown in Fig. 4, total system noise can be held to better than 90 db below full-load output.

Working-Load Considerations

The insistence on as much as 40 db of feedback to achieve effectively

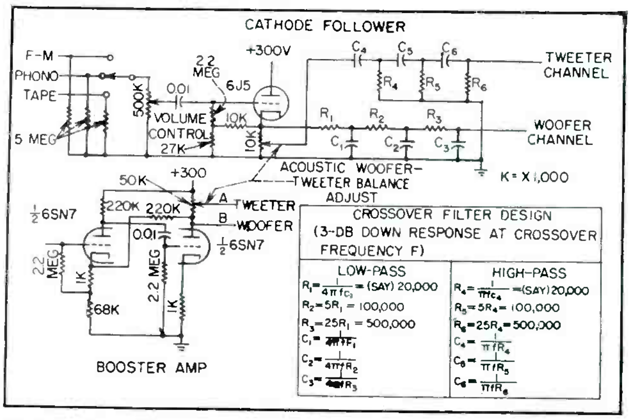


FIG. 2—Amplifier-input and dividing-network schematic. Leads A and B may be reversed if the woofer is more efficient than the tweeter

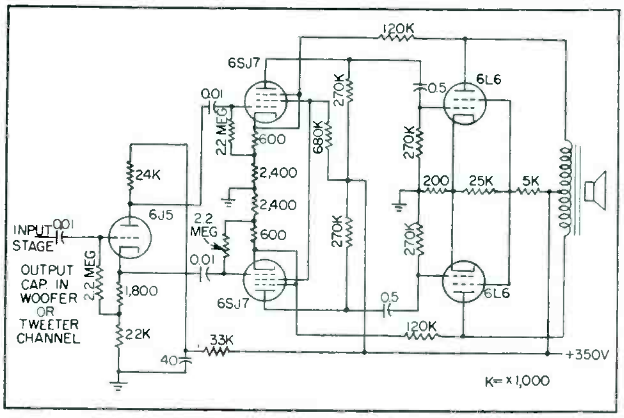


FIG. 3—Power-amplifier schematic. Output transformer may be Langevin 317-A, Peerless S-230-Q, Partridge CFB, Acrosound 20-280 or equivalent

zero output impedance hardly can be justified by the objective of maximum power output within arbitrary limits of permissible distortion. The idiosyncrasies of the actual load involve decisive design considerations, above all in determining the most effective value of amplifier-output impedance.

Efficiency of the particular loudspeaker used is a vital factor. When the working load is the loudspeaker equivalent of a four-terminal T network (consisting of one electrical and one acoustical mesh), the significance of generator impedance is determined by the nature of the coupling between these meshes. The closeness of coupling in general is related to the efficiency rating.

With loudspeakers of less than 10-percent efficiency or with voice coils of high d-c resistance, relatively slight damping can be obtained through reductions in generator impedance. With higher efficiencies and lower d-c resistances, the damping effect of source-impedance reductions becomes progressively more important. Levine[3] recently has proved that, for horn-loaded loudspeakers, critical damping cannot be obtained by normal electronic means until the efficiency reaches 50 percent, at which level the requirement is zero source impedance.

This approach also can be illustrated by shifting the objective for source-sink impedance matching from maximum-power transfer to maximum flatness of voltage response. In the former case, a resistive load is made equal to the generator impedance and the mismatching of a varying load, such as a loudspeaker, is minimized when the mean load impedance equals that of the generator. Even allowing for a mismatch ratio range of 0.4 to 2.5, the output-power variation, Fig. 5, is only one db. This discloses no apparent reason for dissatisfaction with conventional matching procedure.

A very different picture appears, Fig. 6, when the same basic data is re-examined in terms of voltage response. In this case, E_g is held constant and the load voltage is plotted as R_L varies. If the mean load resistance equals R_g, a mismatch ratio range of 0.4 to 2.5 results in an E_L variation of eight db. Even if the minimum load resistance is about 2.5 times the generator resistance, which is likely with amplifiers using triodes without feedback or beam-power tubes with moderate feedback, there still is at least a 3-db variation in E_L.

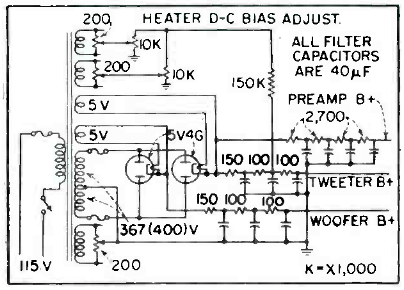


FIG. 4—Power-supply schematic. Use of filter chokes is avoided

If the goal is set as high as ±0.5-db load-voltage variation, Fig. 6 shows that the minimum value of R_L must be at least ten times R_g. This is merely another way of saying that practically constant voice-coil voltage is achieved when the power-amplifier output impedance is reduced to one-tenth the minimum impedance of its working loudspeaker load.

While there is nothing novel in this conclusion, the actual values of required negative-voltage feedback are not generally realized. When calculations are based on the minimum rather than the mean loudspeaker-load impedance to be encountered throughout the operating frequency range, from 15 to 20 db of feedback is required to approximate zero amplifier-output impedance for a triode output stage. For pentodes or beam-power tubes, this value is increased to from 35 to 40 db. The triode figures are confirmed by Williamson[4], who emphasizes that little if any audible improvement is gained by more than 20 db of feedback in his triode amplifier.

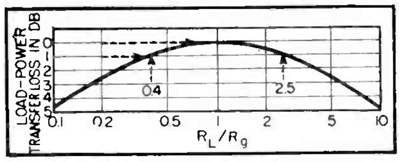


FIG. 5—Ratio of generator resistance to load resistance versus load power

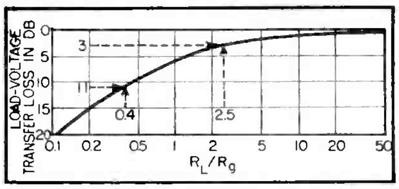


FIG. 6—Ratio of generator resistance to load resistance versus load voltage

Tube and Filter Choices

The less exorbitant feedback demand of triodes is an advantage that probably nullifies the familiar drawback of higher driving voltages. The decisive disadvantage is the seldom fully appreciated problem of high-signal-level rectification effects. In most triode output stages, a fast-acting milliammeter in the plate circuit reveals that extreme signal peaks may cause up to 50-percent rises in the plate current. These rises may cause consequent fluctuations in the supply voltage if the latter does not have effectively zero source impedance.

With pentodes or beam-power tubes, there is a more practical and decidedly cheaper solution. For any given value of load resistance, there is a critical value of screen-supply regulation that effectively eliminates plate-current changes. By feeding the output screens as shown in Fig. 3, variations in screen voltage with signal-level changes tend to hold the plate current and the proper operating point constant.

Since conventional bypassing would limit the speed of screen-voltage fluctuations, transient response considerations call for the elimination of any time constant to provide instantaneous regulation. For the same reason, cathode as well as screen bypasses are omitted, a step that has the additional advantage of markedly increasing the feedback's inherent differential balancing ability.

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Circuit Stability in Guided Missiles

Proper circuit design avoids erratic performance by controlling such factors as grid emission, variation in contact potential, heater-cathode leakage and shock and vibration dangers. End result is circuit with maximum reliability

By R. L. KELLY

Manager
Application Engineering Field Group
Tube Department
Radio Corporation of America
Harrison, New Jersey

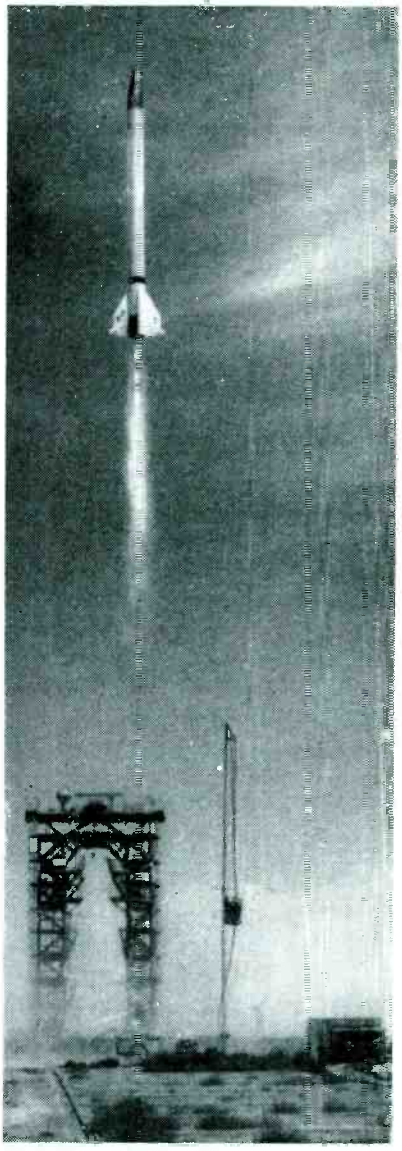
TUBE MANUFACTURERS and circuit engineers have many mutual problems.

The tube manufacturer is often asked to provide tubes that will operate with maximum reliability in circuits and under conditions for which very little information is available. The circuit engineer is asked to design circuits using any one or more of a large number of available tubes about which there is usually a great deal of published information available, but not always enough to cover the peculiarities of a particular circuit application.

The mutual problem is for the circuit engineer to tell the tube manufacturer as much as he can about a proposed application and for the tube manufacturer to tell the circuit engineer as much as he can about the use of tubes in that same application.

Electron tubes are complicated devices and new applications come about continuously. The following paragraphs will deal with recommended solutions to typical problems concerned with more reliable tube performance.

The heart of the electron tube is its cathode. It provides the electrons which are controlled and utilized by other tube electrodes. Thus, it should be expected that factors affecting the normal function of the cathode will have a marked effect on the overall performance of the tube in any particular circuit application in which the tube may be used.



U. S. Navy's Viking Rocket as it leaves the launching site for a 135-mile trip into space

Rectifier Considerations

First, consider the case of a diode. For convenience, look at a rectifier in a power supply, Fig. 1. The ratings for such a rectifier tube give a maximum value of d-c output current, peak-inverse plate voltage and peak plate current. The first two factors are easily measured in a typical circuit but the steady-state peak plate current normally must be checked by means of an oscilloscope.

Many cases of rectifier failures have been traced to the condition of excessive peak plate current, although the d-c output current and peak-inverse plate voltage were well within the manufacturer's established ratings.

How do such designs come about? Usually, the designer is trying to get the required d-c output current and voltage in the most efficient manner. He, therefore, prefers to design a power transformer having low leakage reactance and plenty of copper in order to keep the heat down. True, he winds up with a very efficient system but such designs often lead to excessive peak plate-current values in the rectifier.

The typical operating conditions for the 6x4 show that for a 4-μf input filter capacitor the minimum value of effective plate-supply impedance per plate is 150 ohms. If a larger value of input filter capacitor is used, a different value of effective plate-supply impedance will be required to limit the steady-state peak plate current to its maximum rated value. For maximum reliability, it is imperative that the value of peak plate current be kept within ratings even if it means sacrificing transformer efficiency or obtaining poorer regulation in the power supply.

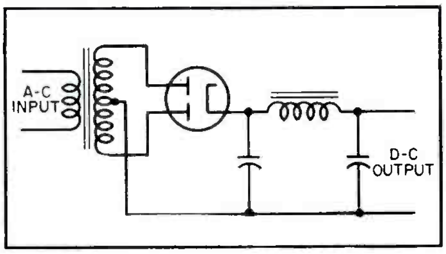


FIG. 1—Typical rectifier power supply with filter components

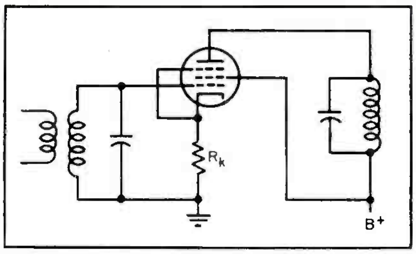


FIG. 2—Pentode circuit in a typical i-f amplifier

Contact Potential

The significance of contact potential may be described as the effect of a small battery in the grid-cathode circuit of a tube; the cathode may be considered the positive battery terminal, the grid the negative terminal. It is ever present and subject to variation due to such factors as time and temperature.

Since contact potential is a function of cathode temperature, variations in heater voltage will change its value. Let us refer to such changes as short-time changes. If performance is detrimentally affected by short-time changes in contact potential, regulation of the heater-voltage supply will reduce the short-time variations. Obviously, constant heater voltage would result in no short-time variations of contact potential. There are many applications, such as in large computers, where it is perfectly practical to use a well-regulated heater supply. In applications where it is impossible to regulate the heater supply, the design engineer must recognize that changes in heater voltage will cause changes in contact potential. This fact is inevitable.

Contact potential varies with time. This variation can be greatly minimized for high-mu tubes by the burning-in period applied to certain reliable tubes. Even so, tubes will exhibit some changes in contact potential during life.

By proper choice of circuit elements and operating voltages, the effects of contact-potential variations may be minimized. Consider, for example, the case of a pentode operating in an i-f amplifier. It is common practice to use cathode bias as shown in Fig. 2. However, the design engineer will often choose a low value of R_k in order to get high g_m, of course staying within plate and screen dissipation ratings for the tube. From the standpoint of tube life, such a design is satisfactory. However, in many cases, the resultant bias, as determined by the drop across R_k, will be 1 volt or less. Since the value of contact potential is in the same order of magnitude, the effective bias on the grid may be zero or actually positive. If the grid operates with a positive bias, grid current will flow, thus loading the input circuit and causing a loss in circuit gain.

The solution of such a problem is simple: increase the value of R_k. True, some reduction in g_m will result, but in many cases the overall circuit gain will increase due to the reduction of circuit loading. Furthermore, with a larger value of cathode-bias voltage, the effects of variations of contact potential with time and heater-voltage variations will be minimized.

Grid Emission

Consider the control-grid circuit alone. Barium evaporates from the surface of the cathode during the life of a tube. The control grid is close to the cathode and operates at a lower temperature. Barium vapor from the cathode may condense on the surface of the control grid. Since the control grid is close to the hot cathode, it absorbs heat radiated from the cathode and as a result its temperature is elevated. Sufficient barium may be deposited on the grid so that, at its operating temperature, it becomes a source of primary electrons. Since the grid is operating at a negative potential with respect to the cathode, its electron emission current will flow to the cathode and to other more positive tube electrodes. This current will return to the grid through the external grid circuit.

A typical grid circuit is shown in Fig. 3. Normal grid bias, in this case, is suppled by the drop across R_k. Since the grid is now an emitter, its current flowing through R_g results in a drop across R_g which is of opposite polarity to the drop across R_k. The resultant grid-cathode potential is the algebraic sum of the drops across R_g and R_k and is less than the drop across R_k. In other words, grid bias is lost.

The effects of loss of grid bias may cause circuit gain to change and, since the action is regenerative, plate current run-away may be caused.

Recognizing this problem, tube designers coat grids associated with large cathodes with some material to reduce the tendency of the grid to emit. However, the circuit designer can also help by reducing the value of R_g. Again, a compromise must be faced. The circuit engineer is always striving to get maximum performance from his circuits. The use of large grid resistors usually improves circuit gain. For maximum circuit reliability, however, a lower value of grid resistor should always be considered. Use as low a value as possible.

Secondary Grid Emission

There is another form of grid emission which must be recognized by the circuit engineer and that is secondary grid emission. It manifests itself in applications in which the grid is driven into the

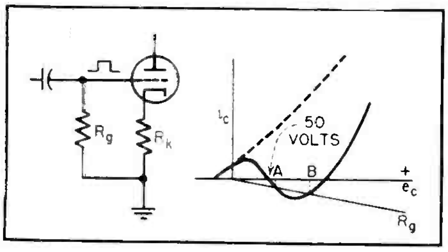


FIG. 3—Grid circuit pulsed in a positive direction

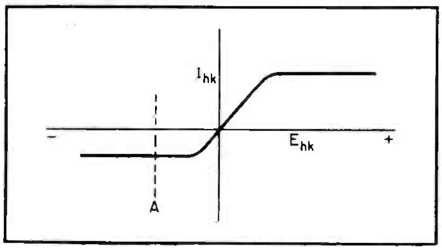


FIG. 4—Typical heater-cathode leakage characteristic

positive region. A typical example will be found in transmitter applications involving class-C operation of the tubes. In such cases, during the time the grid assumes a positive potential with respect to the cathode, electrons from the cathode will be attracted to the grid. Most materials, when bombarded by electrons, give off secondary electrons, and a grid is no exception. Some of these secondary electrons will return to the grid, but others will join the stream of electrons from the cathode and go to the plate or other more positive electrodes.

Flow of secondary electrons from the grid is in opposition to the normal flow of electrons from the cathode to the grid during positive grid operation and, therefore, the current in the grid circuit is less than it would be if there were no secondary grid emission.

Emission Effect

The effect of secondary grid emission is to make the tube easier to drive. Design engineers who provide just sufficient drive voltage to develop the required power output may find they have used tubes having secondary grid emission in their design work. However, when tubes with less active grids are used there is insufficient drive available and low power output results. In the design of such equipment, an excess of driving voltage should be always provided.

While the foregoing example might leave the impression that secondary-grid emission is always desirable, such is not the case. Consider a grid circuit pulsed in a positive direction. Figure 3 shows such a circuit and also the grid characteristic. The dotted curve is the normal diode characteristic of the grid. The solid curve shows the effect of secondary emission. In general, such a curve will cross the axis at about 40 to 50 volts. If a signal is applied which drives the grid past point *B*, the intersection of the grid load line with the curve, the tube will block at point *B*. That is, when the signal is removed, the grid will remain at the potential of point *B*.

Recognizing the desire of circuit designers to use high values of grid resistors, tube manufacturers try to keep secondary grid emission of low-power tubes to a minimum. However, the best insurance is never to drive the grid in the negative-current region.

Heater-Cathode Leakage

Another common source of trouble in the grid circuit of electron tubes is heater-cathode leakage. No problem could exist if the heater and cathode were operated at the same potential. Another method of eliminating the effect of heater-cathode leakage is to use fixed grid bias or gridleak bias. If cathode bias is required, a large bypass capacitor across the cathode resistor will reduce the effect of leakage currents. Where an unbypassed cathode resistor must be used or where the application demands extreme freedom from heater-cathode leakage effects, use of heater-cathode bias is recommended.

Figure 4 shows a typical heater-cathode leakage characteristic. If operation is at or near zero E_{hk}, any small voltage variation results in a large change in I_{hk}. However, if the operating point is moved to *A*, changes in E_{hk} result in much smaller changes in I_{hk}. This method is often used to reduce hum in high-quality high-gain amplifiers. A bias with respect to cathode of about 40 or 50 volts is recommended.

In applications which subject the tube to shock or vibration, shock excitation of the tube electrodes often results. Any motion of one electrode relative to another will result in a variation in output current.

These variations are greater for electrodes spaced close together, such as the grid and cathode. In radio-receiver parlance, this effect is referred to as microphonics.

When faced with a design in which the tube may be subjected to vibration, the designer should utilize some form of shock mounting to reduce, as much as possible, the magnitude of the vibration at the tube.

It is wise to choose a tube having wide spacings between cathode and grid. Here, again, a sacrifice of high gain per stage to obtain utmost reliability is necessary.

Another help in reducing microphonics is to utilize a damping device on the tube. This is a very old trick and has recently been used successfully in connection with the 6J6 oscillator tube in many modern television receivers.

One of the most effective means of obtaining reliability in equipment using electron tubes is often overlooked. This oversight has resulted in many instances of poor equipment reliability.

Heater Voltage

It is strongly suggested that tubes be operated at their rated heater voltage. Operate a tube with 6.3 volts at its heater terminals, if the tube is rated at 6.3 volts. The general assumption that tubes may be operated at ± 10 percent of rated heater voltage assumes that, with the tube designs centered at 6.3 volts, for instance, operation at minus 10 percent will not cause serious loss of emission or output. Conversely, if operated at plus 10 percent, the life of the tube will not be substantially shortened.

This approach was based on radio service for the entertainment field. However, in many high-power transmitting tubes, the suggested permissible range is ± 5 percent while, in some cases, adjustable heater supplies are recommended.

ONE MICROVOLT

Simple design, ease of use and reliability are features of a-c measurement system for input signal of less than one microvolt in magnitude. Complete shielding of a separate input transformer reduces pickup noise to an acceptable value

By H. C. THOMAS and C. W. HEWLETT, JR.

*Meter and Instrument Engineering Divisions
General Electric Company
Lynn, Massachusetts*

A RECENT NEED to measure a sixty-cycle signal of less than one microvolt in magnitude was not satisfactorily met with commercially available equipment. To fulfill this need, a measurement system was developed which is quite simple in design, easy to use and which has given very reliable service. The system has a full-scale sensitivity of one microvolt, with a precision of ±0.05 microvolt and an input impedance of 50 ohms at 60 cycles.

Influence of Noise

The sensitivity of a measurement system is ultimately limited by the noise level at its input terminals. On the system under discussion, the rms input noise must be less than 0.05 microvolt, preferably less than 0.01 microvolt. The basic problem of design was to attain this low noise level without unduly complicating the operation of the system.

At the 0.01-microvolt level, random noises generated in the input resistor, due to thermal agitation of electrons, and in the first tube of an electronic amplifier, due to shot effect and similar causes, may become significant. The rms value of this type noise voltage is proportional to the square root of the bandwidth of the measurement system and, to be less than 0.01 microvolt, the bandwidth must be less than 10 cycles. This requirement can be met with commercially available equipment.

A source of noise that is more difficult to reduce to acceptable values is pickup from external electromagnetic and electrostatic fields. For example, a 5-gauss (peak), 60-cycle magnetic field can induce in a single turn one centimeter in diameter about 10 microvolts rms. Very complete shielding is necessary to reduce pickup noises to an acceptable value.

Experience has shown that it is extremely difficult to shield adequately an electronic amplifier so that induced voltages, referred to its input, are less than 0.01 micro-

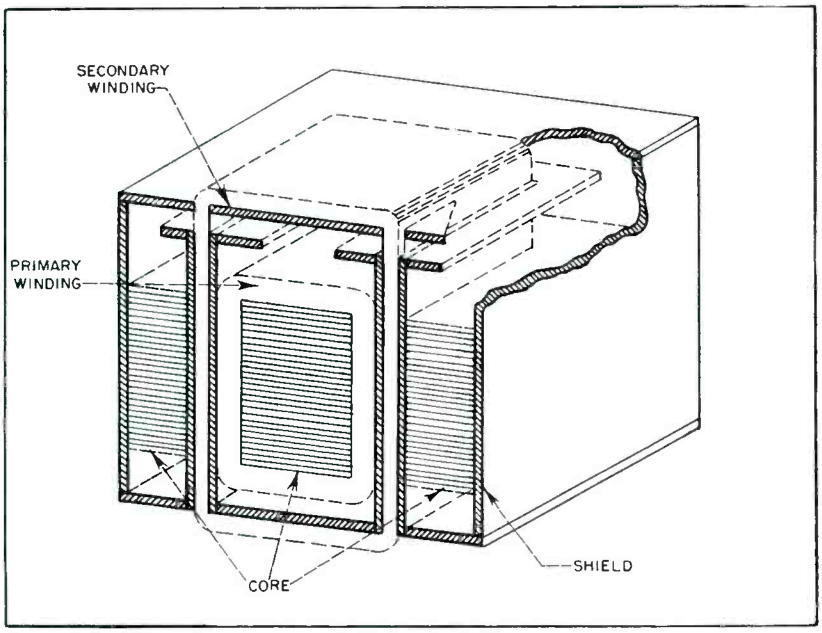


FIG. 1—Cutaway view of the electrostatic shielding used on the high-gain transformer. Transformer matches the 50-ohm input to the grid of the electronic amplifier

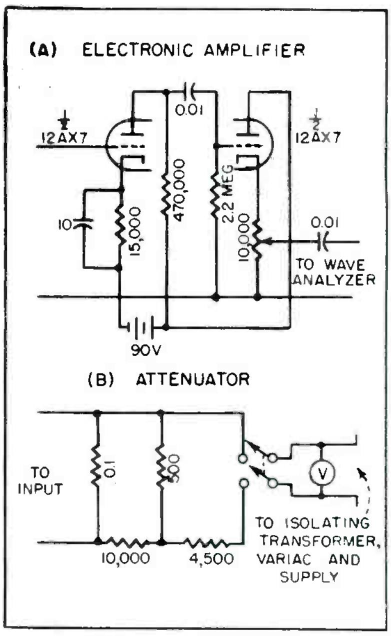
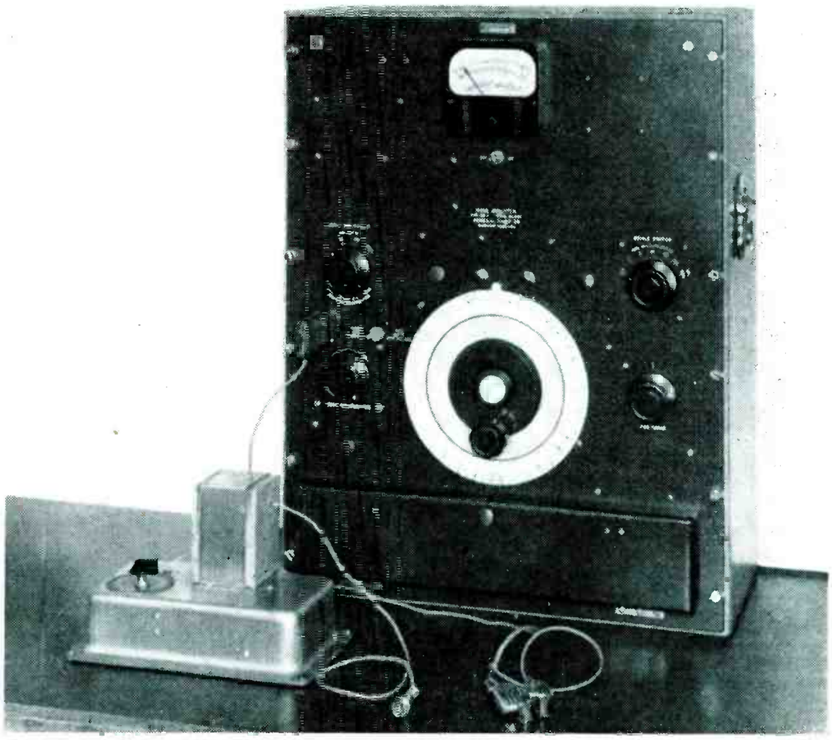


FIG. 2—Schematic diagram of electronic amplifier (A) and attenuator calibrator (B)

Shows Full Scale

volt when operated under usual laboratory conditions. It is much simpler to shield a small input transformer, designed to match the 50-ohm input to the grid of an electronic amplifier. This approach has the added advantage of providing gain prior to the electronic amplifier, thereby reducing the significance of its inherent noise and induced pickup. By this means, a measurement system has been designed which meets the specifications for sensitivity and precision and which does not require any unusual operating conditions.



System components including input transformer, amplifier and wave analyzer

Input Transformer

The heart of the system is the input transformer, Fig. 1, which provides a gain of 150, without introducing appreciable noise. The degree to which magnetic and electrostatic shielding is employed in the transformer is important. As shown in Fig. 1, the brass electrostatic shield is arranged to enclose completely the secondary winding and the outside legs of the core, without constituting any short-circuited turns. This shield effectively eliminates any capacitive coupling to the secondary winding. In addition, the transformer is completely enclosed within two concentric mu-metal shields, which provide adequate magnetic shielding.

The circuit of the two-stage electronic amplifier is shown in Fig. 2. The first stage is a voltage amplifier and is followed by a cathode-follower stage to give a low-impedance output. Triodes are used to minimize inherent noise. A maximum voltage gain of about 50 is obtained. The amplifier, including the tube and the plate-supply batteries, is totally enclosed in a shielded chassis.

The output of the amplifier is measured by a General Radio Wave Analyzer, which acts as a narrow-band filter and electronic voltmeter. The gain of the system is normally adjusted to 3,000, which results in a full-scale indication of the wave analyzer, on its 3-millivolt scale, equivalent to one-microvolt input to the system.

Calibration Means

A built-in calibration system is provided since no effort was made to design the equipment for long-time stability. The calibrating circuit provides a standard input of 50 microvolts and makes it convenient to calibrate the system frequently for any value of measured circuit impedance within the range of adjustment. The available gain is enough to provide for a measured circuit impedance as high as 50 ohms.

The connecting leads are tightly twisted pairs enclosed in braided shields. All of the system shielding is electrically connected together and is grounded at one point. The leads from the transformer secondary to the input of the electronic amplifier are made very short—about 2 inches. Other connecting leads may be several feet long without introducing pickup trouble.

The noise output, with the input shorted, is less than 0.03 microvolt. The precision of the system is estimated as ± 0.05 microvolt, based on its use in the application for which it was designed. Inputs as high as 50 microvolts can be measured, using the range switch of the wave analyzer as an attenuator. Higher inputs are limited by saturation of the electronic amplifier. The system is sufficiently immune to electrostatic and electromagnetic pickups to permit its use under laboratory conditions with usual precaution. It is important, however, to arrange connections to the measured circuit to minimize undesired pickups.

The combination of a well-shielded transformer and electronic amplifier with the wave analyzer has provided a considerable improvement in measurement sensitivity over usual laboratory technique and has made possible precise a-c measurements in the one-microvolt region.

Ferrite Applications

Small-size high-voltage tv transformer cores and ferrite rod antennas for portable receivers are two outstanding uses of ferromagnetic spinels. Wide application is promising because of high maximum permeability, high electric resistivity and low r-f losses

By B. V. VONDERSCHMITT M. J. OBERT

Tube Department

and H. B. STOTT

Home Instruments Department

Radio Corporation of America
Camden, New Jersey

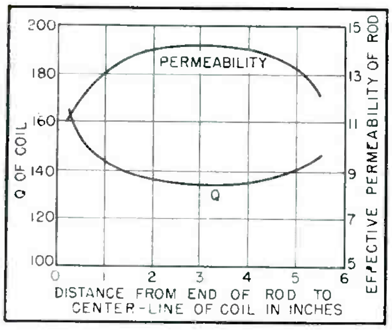


FIG. 1—Variation in Q of coil and permeability of ferrite rod with position of coil on rod

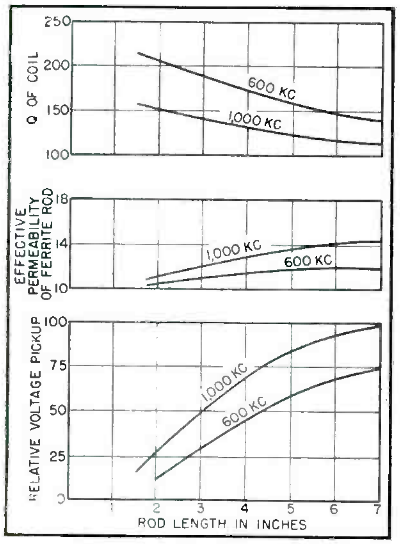


FIG. 2—Variation of Q of coil, permeability of ferrite rod and voltage pickup of antenna with rod length

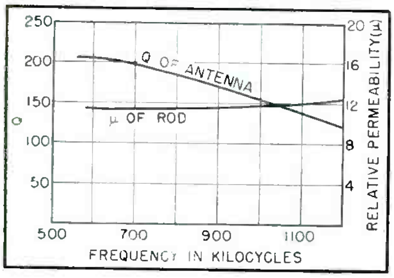


FIG. 3—Variation of Q of antenna and permeability of rod with frequency

RECENT YEARS have seen an increasing use of ferromagnetic spinels, commonly called ferrites, in electronic components to replace silicon-steel laminations, iron wire and powdered iron and to provide components having improved characteristics and reduced bulk.

Characteristics of ferrites such as high maximum permeability, high electric resistivity and low r-f losses, are of particular interest for television components such as yokes and horizontal-deflection output and high-voltage transformers. In such components, the use of ferrites has made an important contribution to increasing operating efficiency and reducing size.

Deflection Transformers

The high power required for deflection in wide-angle kinescopes necessitates the use of efficient deflection systems.

The single item used in the design of a horizontal-deflection output transformer that almost completely determines its efficiency is the magnetic material used for the core. Ferrites have been developed exhibiting characteristics that are very favorable as core material for such transformers. As a result, transformers operating from a moderate power supply with only a single high-voltage rectifier and capable of deflecting kinescopes having a 66-deg horizontal-deflection angle at anode voltages up to 18 kv, have been designed with small C-shaped ferrite cores. The total weight of the ferrite core for such a transformer is approximately 75 grams.

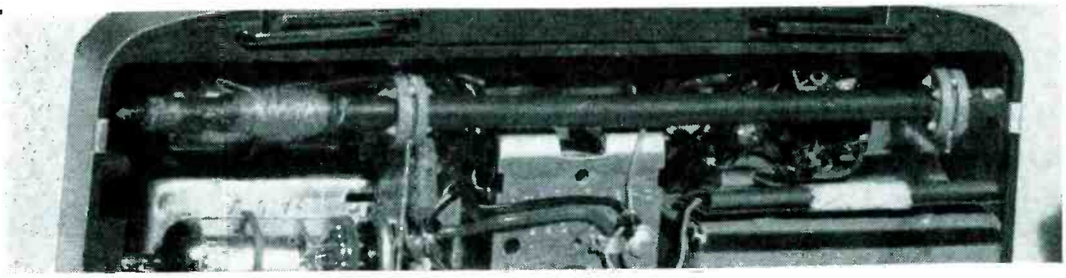
Compact ferrite cores also permit the use of compact coils having high coupling coefficients between primary and secondary windings which reduce the likelihood of Barkhausen oscillations and provide efficient performance.

Ferrites have also made an important contribution in the design and development of deflecting yokes for scanning wide-angle picture tubes. For the flux-return path in these yokes, the ferrites provide a high-permeability low-loss magnetic material which is considerably superior to early powdered-iron cores, and iron core wires.

Ferrite Rod Antenna

Another application in which the use of ferrites has resulted in improved physical and electrical characteristics is in the antenna of small personal radio receivers. Personal receivers in the past have used a flat air-core loop antenna nested within a hinged lid. For satisfactory operation it is necessary to suspend the loop in free space away from the chassis and components so that the loop Q and re-

in Electronic Components



An RCA personal portable receiver showing relative size and location of antenna near top

ceiver performance would not be greatly reduced. The inherent mechanical and breakage troubles have made this type mounting very undesirable.

The new ferrite rod antenna is shock-mounted to the receiver chassis and insulated from it by two soft rubber grommets. The supports holding the grommets have slotted holes to eliminate the shorted-turn effect of metal surrounding the rod.

This complete antenna occupies less than two square inches in area and in a confined space, as compared with the conventional loop antenna of greater than 20 square inches in free space.

For optimum performance, the small coil and the ½ by 7-in. rod should have the highest possible Q when in its mounted position. The rod must possess low-loss characteristics and high permeability. The pickup ability of the antenna and the signal-to-noise ratio of the receiver are dependent on these two basic criteria, on the resultant tuned-circuit impedance and on certain other design considerations such as the type of wire, winding and form factor of the coil on the ferrite rod.

For a given ferrite rod, there is a particular combination of size, shape and winding pitch factor that, along with the correct ratio of coil diameter to rod diameter, results in maximum pick-up voltage. These factors determine the degree of coupling to the rod and, therefore, the amount of signal flux leakage and self-inductance leakage. Eddy-current losses between adjacent turns and also the distributed capacitance of the winding are reduced by the use of the progressive universal-type winding with 15/43 E.S.S. wire.

Coil Position

The positioning of the coil on the rod is also important. Losses due to ferrous metals close to the rod reduce the Q of the complete assembly; the loss is greatest when the metals are close to the coil winding. Nonferrous metals induce less loss into the antenna but offer some shielding to magnetic pickup. In the RCA receiver, the chassis is constructed of brass, the ganged tuning capacitor has an aluminum frame and the antenna coil is located as far from surrounding components as is compatible with the need for compactness.

The coil is positioned close to one end of the rod for several reasons. First, maximum Q is obtained when the coil is in this position. Second, the effective permeability decreases as the coil approaches the end. This feature is useful in manufacture because it permits adjustment of the antenna to the correct inductance without the necessity for adjusting turns. Fig. 1 shows these effects. The average position is for the center line of the coil to be one inch from the rod end. Adjustment of the coil over the range of ± one-quarter inch represents a change in inductance of about 10 percent.

Another feature due to the smallness of the ferrite antenna is its low distributed capacitance of only two μμf as compared with 14 μμf for conventional loops. With this lower capacitance, it is possible to obtain a higher tuned-circuit impedance because a smaller capacitance range is needed in the ganged-tuning capacitor and a greater value of coil inductance may be used.

The sensitivity of the antenna increases with the number of turns making up the antenna inductance. With the ferrite antenna, the reduced capacitance requirements make possible the use of a compact tuning capacitor having increased plate spacing. The increased spacing reduces capacitor rejects in the factory and minimizes any microphonic tendencies at the higher audio levels.

Ferrite-Rod Dimensions

The length of the ferrite rod has an effect on both the Q of the antenna and the effective permeability. Figure 2 shows variation in Q with incremental increases in the length of the ferrite rod. This variation is due to the greater inherent losses in the longer rods coupled into the antenna coil. Also shown in Fig. 2 are the variations in effective permeability and the relative voltage pickup with rod length. The voltage pickup varies almost directly with rod length and approximately as the square of the rod diameter.

Figure 3 shows the variations with frequency of Q and effective permeability of an antenna having the antenna coil located with its center line one inch from the rod end, the normal operating position. The signal-to-noise ratio of the antenna is improved over that of the conventional loop due to the higher operating Q and the smaller physical size. The smaller size is significant because it reduces the electrostatic pickup.

Television Picture

Analysis of the video waveform in a single scanning line can be made using equipment feeding an oscilloscope and picture monitor. Designed primarily as a research tool, the instrument can also be used by broadcast engineers to simplify the measurement of synchronizing waveforms and aid in evaluating the resolution of television cameras

THE VIDEO WAVEFORM of any selected line, or portion of a line, occurring in a frame interval can be observed on an oscilloscope by use of the instrument to be described.

The usefulness of such an instrument is greatly enhanced if there is freedom from jitter and a simple method of identifying the particular line being observed. This equipment has been designed to satisfy these requirements and provides a reliable yardstick for the evaluation of the performance of television systems and apparatus.

Most oscilloscopes used as video monitors operate with a recurrent sweep which may be set to either 30 cycles or 7.5 kc. When operating under these conditions, the persistence of the oscilloscope phosphor and the persistence of vision stack the video voltages of each scanning line on top of each other. The resulting scope presentation is useful for determining the maximum video excursions in the black and white direction and measuring the ratio of video signal to sync signal occurring in a frame interval; however, it is impossible to analyze the video waveform in a single scanning line with such a presentation.

The television line selector utilizes a triggered sweep with a repetition rate of 30 cycles a second and a variable sweep duration having a minimum value of approximately 2 microseconds and a maximum value of several hundred microseconds. With a presentation of this type, it is possible to observe and measure the video voltage occurring during any single scanning line.

A frame repetition rate rather than a field repetition is used for two reasons. First, it is often desirable to observe the vertical synchronizing signal during the nine-line interval for either of two consecutive fields. As is well known, these signals are different, the even fields having a full line spacing between the last horizontal synchronizing pulse and the start of the equalizing pulses, while the odd fields have a half line spacing. Second, a given scanning line such as the hundredth may contain different information in odd and even fields, especially at the point of horizontal transitions.

Figure 1 shows the comparison between a video scope presentation utilizing a recurrent sweep operating at 15.75 kc and a line-selector sweep operating with a repetition rate of 30 cycles a second and a sweep duration of approximately 70 microseconds.

Equipment

This equipment has been designed to operate in conjunction with a wide-band oscilloscope such as the Tektronix Model 511, which has a triggered sweep and provision for increasing the sweep speed five times and observing any 20-percent section of the horizontal trace. Figure 2 is a block diagram of the line selector.

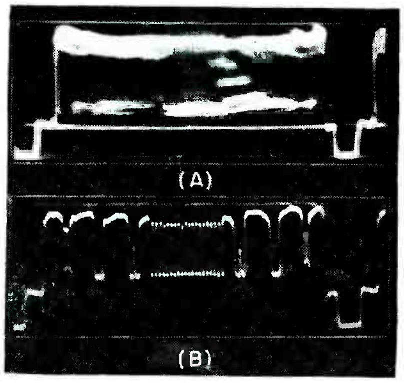


FIG. 1—Conventional scope presentation of recurrent sweep at 15.75 kc at top, and line selector sweep at a repetition rate of 30 cycles

The sync separator removes the video portion of the signal and applies vertical sync to a 30-cycle blocking oscillator which fires on every other integrated vertical sync pulse. The output of the 30-cycle blocking oscillator is a series of narrow pulses having a time separation of 33,333 microseconds (1/30 second). There is only one output pulse for every other field, since the line selector operates at a frame rate rather than a field rate.

The output of the 30-cycle blocking oscillator is used to trigger a cathode-coupled multivibrator (*CC MV* 1). The duration of the pulse produced by this multivibrator may be varied anywhere from 60 to 33,000 microseconds by means of a four-position switch and a vernier potentiometer. The rectangular pulse produced by *CCMV* 1 is differentiated and inverted so the trailing edge becomes a trigger for *CCMV* 2. The pulse duration of this second multivibrator is fixed at 60 microseconds.

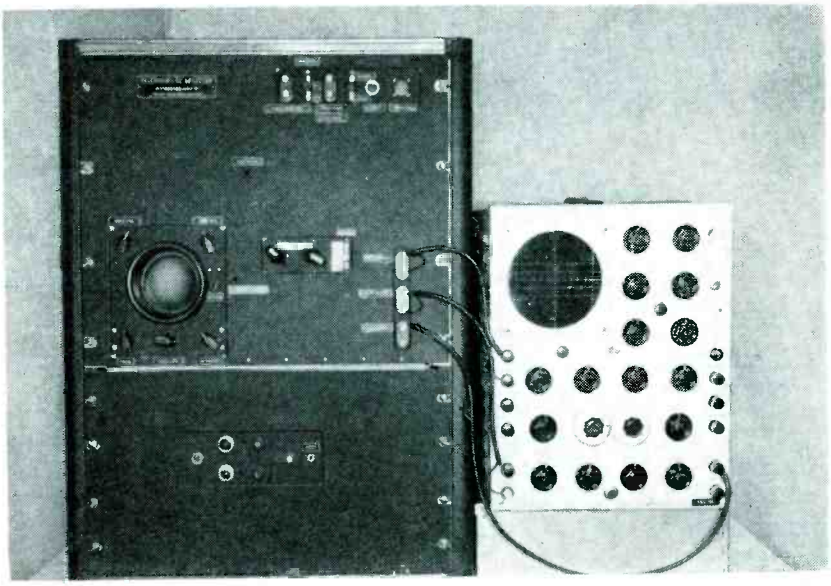
The 60-μsec pulse produced by the second multivibrator serves a double purpose; it is applied to the grid of the crt picture monitor as a horizontal identifying white line, and it is used to open a coincidence gate. Since the 30-cycle blocking oscillator is tied to vertical sync, any adjustment of *CCMV* 1 will cause the identifying horizontal white line to move up and down the picture displayed on the picture monitor.

Laboratory tests have shown that a well-designed cathode-coupled multivibrator being triggered by a stable source and producing a pulse having a duration of

LINE SELECTOR

By JOSEPH FISHER

Project Engineer
Research Division
Philco Corporation
Philadelphia, Pa.



Line selector unit at left, containing built-in picture monitor, operates in conjunction with oscilloscope at right

15,000 microseconds may have a variation of pulse duration of approximately 5 microseconds between consecutive 15,000-microsecond pulses.

If this pulse were used as a trigger, the oscilloscope display would have a 5-microsecond jitter between successive presentations. On a sweep duration of 100 microseconds, this would cause a blurring of the video waveform. If a faster sweep of 15 microseconds were used, the presentation would be definitely unusable because of jitter.

The method used in this equipment to produce a stable jitter-free presentation is to trigger the oscilloscope with a single horizontal sync pulse which precedes the line to be observed. For a line selector operating at frame rate, only one selected horizontal sync pulse is allowed to pass through a coincidence gate every 1/30th of a second. The gate circuit is so arranged that it requires coincidence between the 5-μsec horizontal sync pulse and the 60-μsec identifying pulse for a horizontal sync pulse to pass through. With operation of this type, a small amount of phase jitter is permissible in either the 30-cycle blocking oscillator or the cathode-coupled multivibrators. The phase jitter merely causes a slight relative displacement between the 60-μsec gating pulse and a single horizontal sync pulse and does not affect the stability of the scope presentation.

Selector Circuit

Figure 3 is a circuit diagram of the selector circuit. The 30-cycle blocking oscillator output and the two cathode-coupled multivibrators referred to as *CCMV* 1 and *CCMV* 2 are shown in detail in this dia-

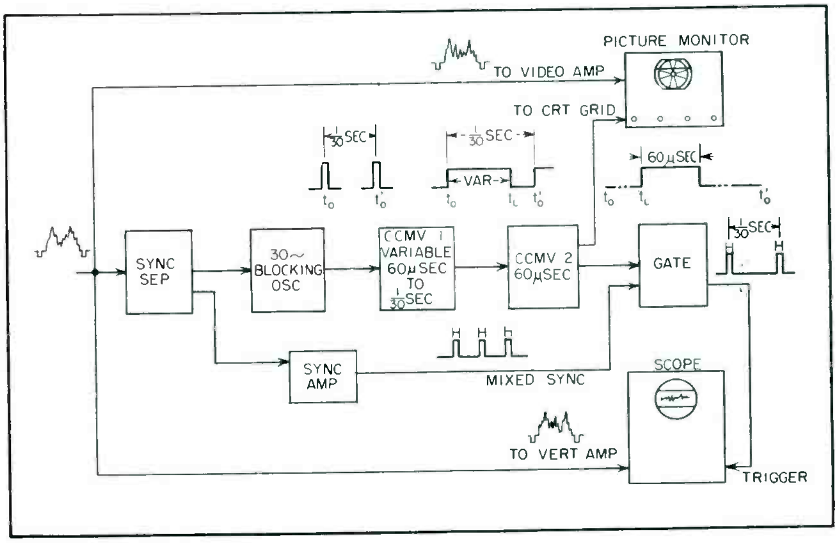


FIG. 2—Arrangement of stages of the line selector and connections to the picture monitor

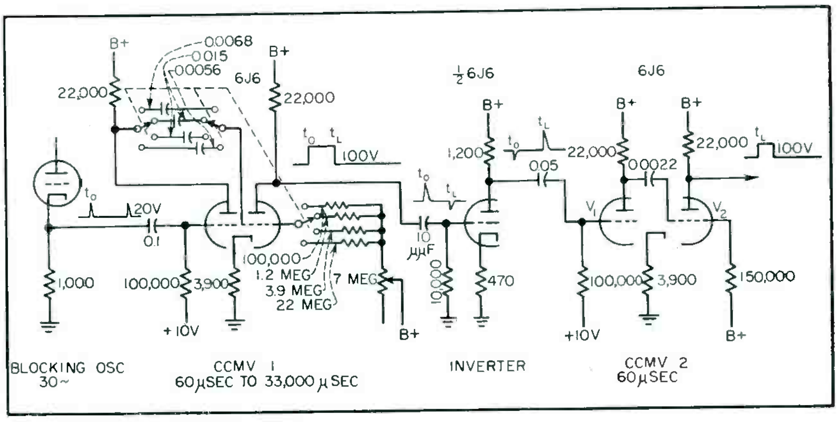


FIG. 3—Two cathode-coupled multivibrators form the selector circuit

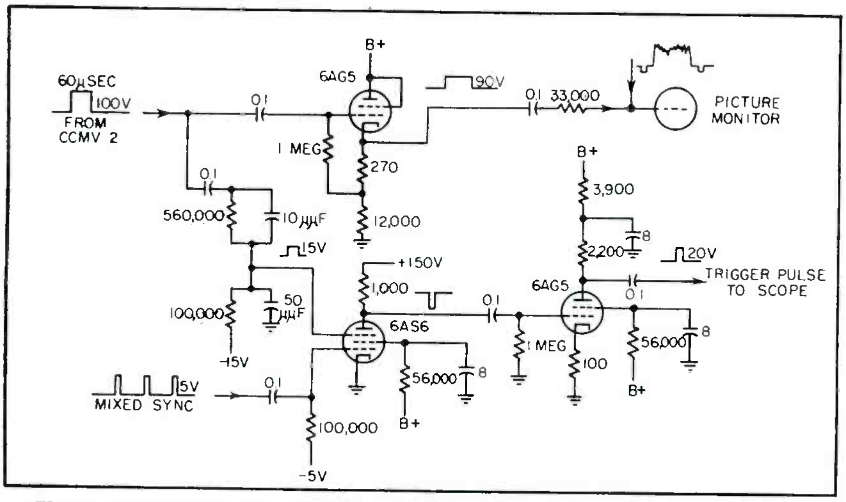


FIG. 4—Coincidence gate circuit feeding the picture tube and the oscilloscope

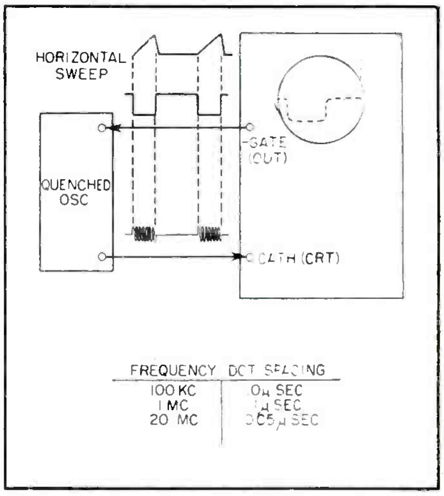


FIG. 5—Block diagram of the marker unit

gram. The performance of *CCMV* 2 is as follows. Consider a time interval before the arrival of the trigger pulse t_L. The grid leak of the right-hand triode section V_2 is connected to +250 volts d-c; the grid-to-cathode resistance will be approximately 1,000 ohms and V_2 will be operating at close to zero bias. The plate current of 7 ma will result in an instantaneous voltage on the plate of approximately 100 volts and a cathode voltage of 27 volts d-c. The high cathode voltage resulting in a net bias of 17 volts on V_1 will keep this half of the 6J6 cut off. If no trigger pulse were applied, the circuit would remain in this operating condition indefinitely.

A positive trigger pulse (t_L) of sufficient amplitude to drive V_1 to zero volts causes plate current to flow in this half of the tube, and the plate voltage of V_1 drops. Since it takes time to change the charge of the 2,200-μμf coupling capacitor, the voltage on the grid of V_2 drops, cuts this section of the tube off, and produces a positive output pulse.

When negative charge on grid of V_2 leaks off through the 150,000-ohm grid leak, V_2 goes into conduction, cutting off V_1. The start of the output pulse is coincident with the trigger applied, while the duration of the pulse depends on the time constant of the coupling capacitor and the grid leak of V_2, and to some extent on the amplitude of the trigger pulse.

The performance of *CCMV* 1 is the same; however, since the duration of this pulse must be continuously variable from 60 microseconds to 33,000 microseconds, a four-position switch is provided to change the RC time constant. After differentiation by the 10-μμf capacitor and the 10,000-ohm grid leak, the trailing pulse t_L is inverted by the 6J6 triode and applied as a trigger to V_1.

Trigger Gate Circuit

Figure 4 is a detailed circuit diagram of the coincidence gate circuit. The 100-volt 60-μsec pulse from *CCMV* 2 is applied to a 6AG5 cathode follower having close to unity gain. The output of the follower is connected through an RC network to the grid of the crt picture monitor. As previously mentioned, this pulse produces a horizontal white identifying line across the picture displayed on the monitor.

The 33,000-ohm resistor is connected directly to the grid connector on the crt socket to prevent excess capacitance degrading the picture. This resistor and the plate load of the video output tube of the monitor form a resistance divider to attenuate the 90-volt identifying pulse to approximately 10 volts at the crt grid.

The 100-volt 60-μsec pulse from *CCMV* 2 is also fed through a compensated divider to the suppressor grid of the 6AS6 gate tube at a level of 15 volts. Mixed sync which has been separated from the composite video input signal is applied to the control grid. The fixed bias on the suppressor and the control grids are adjusted so that coincidence of the 60-μsec gating pulse, which occurs only once every 1/30th of a second, and a horizontal sync pulse is required to cause plate current to flow. The pulse output voltage of the 6AS6 is then one selected horizontal sync pulse. This pulse is inverted and amplified by the 6AG5 and applied as an ex-

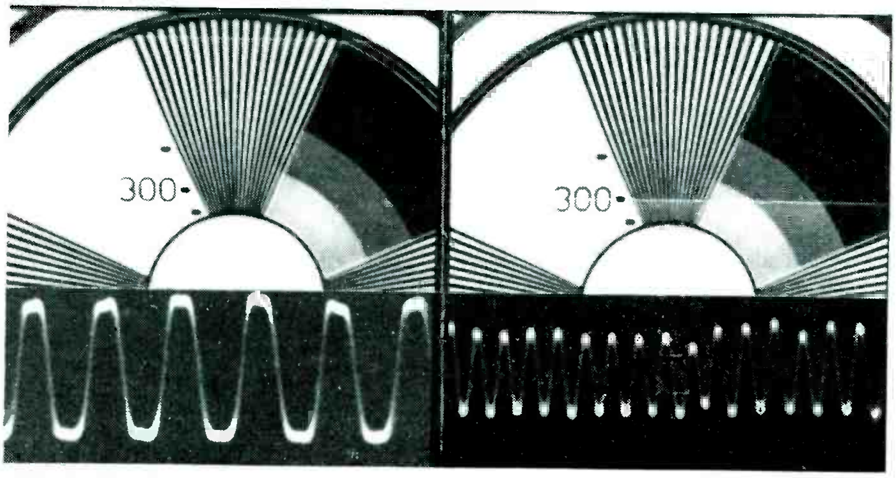


FIG. 7—The illustration at left shows the identifying line at the 100-line mark and the video waveform of this line. Similar data at right is for the 300-line mark

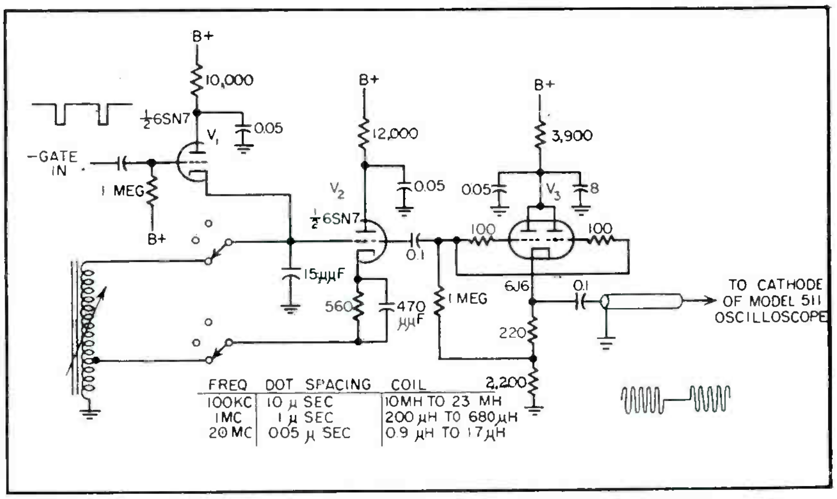


FIG. 6—Circuit for providing time marker data

ternal positive trigger to the oscilloscope.

Intensity Modulation of Trace

Measurements of the time duration of sync pulses and studies of transient responses are greatly simplified by providing time markers which modulate the trace. Figure 5 is a block diagram and Fig. 6 is a circuit diagram of the time marker unit. The performance of this circuit is best understood by omitting tube V_1, and considering V_2 as an ordinary c-w sine wave oscillator. By means of the three-position switch, either of three coils may be inserted in the circuit to produce c-w signals at either 100 kc, 1 mc or 20 mc. This signal is applied to a cathode follower which in turn feeds the cathode of the oscilloscope crt.

If V_1 is inserted and we consider a time interval before the arrival of the negative gate, V_1 is conducting heavily and damping the oscillator tuned circuit with a resistance equal to $1/G_m$ or approximately 400 ohms. This damping prevents V_2 from oscillating. The negative gate pulse from the oscilloscope, which has a time duration equal to the triggered sweep, is applied to V_1 and cuts this tube off. This removes the damping from V_2 and the circuit goes into oscillation for the duration of the sweep. Quenching the oscillator in this manner insures that the time marker dots will remain stationary. Time marker dots spaced at either 10, 1 or 0.05 microseconds are available.

Applications

A very useful application of the line selector is measuring the frequency response and transient response of television cameras and picture-generating devices such as the monoscope and flying spot scanner. Figure 7 shows a study made of the signal generated by a monoscope tube operating into a video amplifier flat to 6 megacycles. The left composite picture shows the identifying line at the 100-line mark, corresponding to a video frequency of 1.25 mc. The video voltage developed when scanning this line is shown under the test chart.

The selector was then adjusted to identify and display the voltage developed when scanning through the 300-line mark, which corresponds to a fundamental frequency of 3.75 mc. The response is down three to one because of aperture distortion (finite size of scanning spot on monoscope). To a first approximation the aperture effect causes only frequency distortion and not phase distortion, and the resolution of the monoscope was improved by adding a circuit having three-to-one peaking between 1 mc and 3.75 mc.

Since most peaking circuits have phase distortion, it was necessary to follow the peaking circuit with a phase corrector which had a flat frequency response and a phase characteristic which was the inverse of the peaking network. The resulting improvement is shown in Fig. 8.

Figure 9 illustrates the results that can be attained with the time marker unit. The top picture shows a horizontal sync pulse time dotted with 1-microsecond markers, while the bottom picture shows a single equalizing pulse intensity modulated with dots having a separation of 0.05 microsecond.

The writer acknowledges the development work done by Eric Bittmann, of Philco Research.

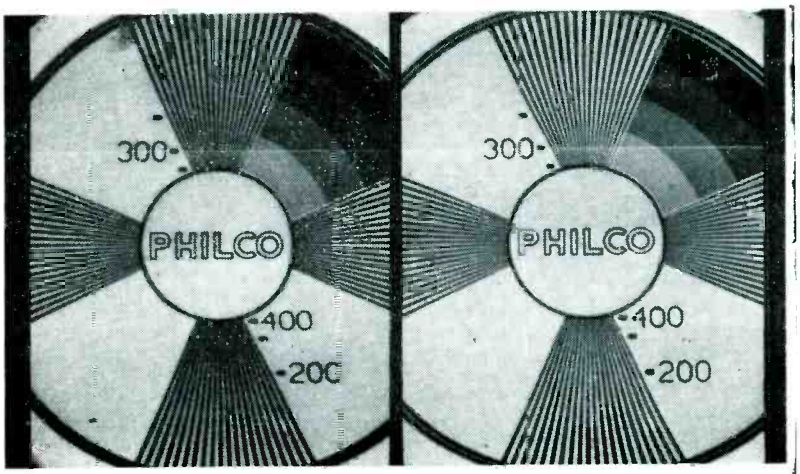


FIG. 8—Test pattern without aperture correction, left, and with aperture correction right

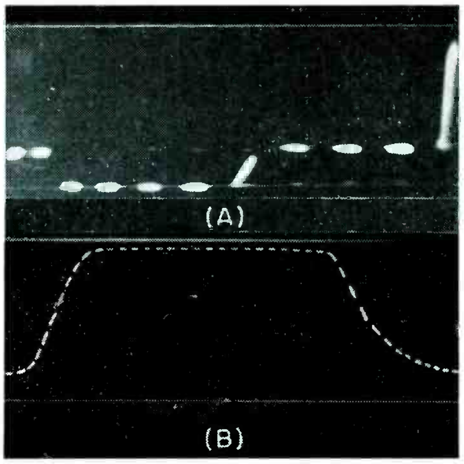


FIG. 9—Horizontal sync pulse with 1μ-sec markers (A), and time dotted equalizing pulse (B)

ANTENNA GAIN

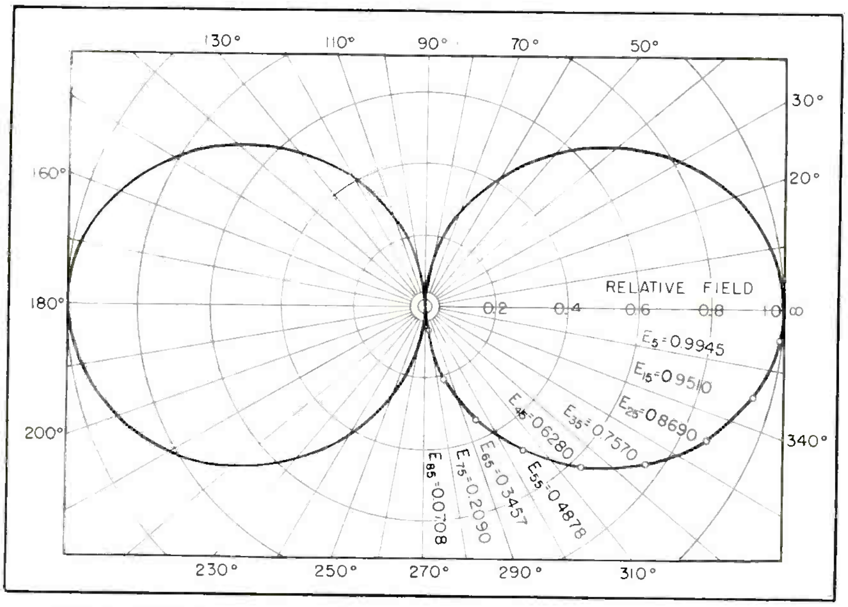


FIG. 1—Radiation from a vertical orientation of a half-wave dipole antenna

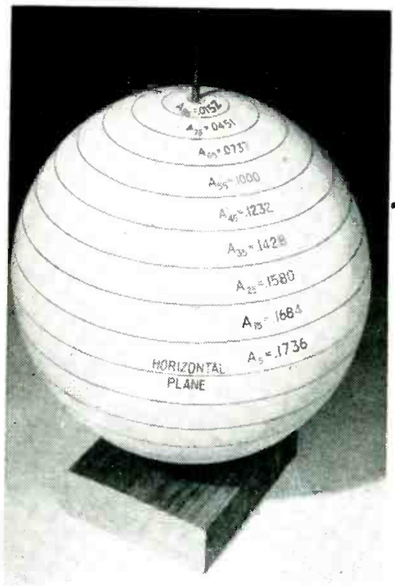


FIG. 2—Sphere marked with area zones

THE calculation of gain from a number of radiation patterns is a widely used technique. The procedure can be reduced to a reasonable limit by a method about to be described. First, it is essential that one understand the manner in which gain depends on radiation patterns.

A simple antenna example, and one for which the results can be readily verified, is the well-known standard half-wave dipole. It is most commonly regarded as a vertical antenna because with this orientation it has equal radiation in all directions in the horizontal plane. In other words, the horizontal pattern is a circle. Because of the simplicity of the dipole structure, vertical patterns are all the same and may be indicated by the curve of Fig. 1. The shape is described precisely by $E = K \cos (\pi/2 \sin \theta)/\cos \theta$, where θ is the angle from the horizontal plane.[1,2]

The reduction of the radiation as the vertical angle increases implies that the total power that is radiated into space for a given field intensity in the horizontal plane is less than would be radiated from the imaginary isotropic radiator (an antenna which radiates equally well in all directions). Conversely, there is available a greater field intensity in the horizontal plane, from this half-wave dipole antenna for a given power input, than is available from an isotropic radiator. This improvement in effectiveness is known as gain and as an IRE standard is specified in terms of power (gain means power gain). Thus the gain of a half-wave dipole antenna is the increase, over an isotropic radiator, in the power received per unit area in the plane of uniform response, when equal input power values are applied.

For this particular antenna, it is desired to find the power radiated into solid space. As indicated previously, this may be determined readily from the patterns of the antenna. Since this antenna has a circular horizontal pattern and all the patterns taken at angles above and below the horizon are circles, one need only be concerned with the manner in which the vertical pattern varies from a circle.

In an integration of the kind about to be performed, the antenna should be imagined as being placed at the center of a large sphere. Such a sphere is shown in the photograph of Fig. 2. The surface of each half has been divided into

Table I—Gain Data for Half-Wave Dipole

Zone, in deg	*Area*	*Power*	*Product*
0 to 10	0.1736	0.9890	0.1718
10 to 20	0.1684	0.9044	0.1523
20 to 30	0.1580	0.7552	0.1194
30 to 40	0.1428	0.5730	0.0818
40 to 50	0.1232	0.3944	0.0486
50 to 60	0.1000	0.2379	0.0238
60 to 70	0.0737	0.1195	0.0088
70 to 80	0.0451	0.0437	0.0020
80 to 90	0.0152	0.0050	0.0001
	1.0000		0.6086

by Graphical Means

Time-consuming computations are avoided in this simple, graphical method of obtaining antenna gain. Once radiation pattern of antenna is known, method is applicable to complex antennas and for determining acoustical gain of loudspeakers and horns

nine zones of equal latitude and each zone marked with its relative area using a subscript corresponding to the angle at the center of the zone.

To integrate the energy from the antenna in question, the power falling on each zone is determined (the area times the unit power) and then these powers are added together. The unit power in each zone is found by squaring the field values indicated in Fig. 1. The area of each zone can be found from formulas available in many handbooks, corresponding to the values shown in Fig. 2. Due to symmetry it is necessary to be concerned with only one quadrant. By correlating the curve and data of Fig. 1 with the zones of Fig. 2, the necessary quantities may be set up.

Typical Example

To demonstrate how effective such a simple integration can become, a tabulation of the results for the half-wave dipole antenna, oriented vertically, is shown in Table I.

By M. W. SCHELDORF

Director of Research
Andrew Corporation
Chicago, Illinois

Notice that if the unit power from an isotropic radiator in each of the zones of the table had been used, the power column would show 1.000 for all zones, the product column would have contained the same numerical values as the area column and the final sum would be 1.0000. Thus, for equal intensities in the horizontal plane, the numbers 1.0000 and 0.6086 correspond to the power radiated. Therefore, the gain of the half-wave dipole antenna is 1.0000 divided by 0.6086 which equals 1.643 or +2.15 db. These values compare favorably with those obtained by more exact completely mathematical means.

It is quite obvious now that to obtain the gain of any antenna having a solid of radiation which is generated by a curve rotated about its vertical axis, it is necessary only to repeat the above simple process. When the upper half and the lower half of the vertical pattern are different, as is often the case in experimental work, the integration must be done for double the number of zones and the gain becomes 2.000 divided by the summation of the products secured.

Some special graph forms have been developed which reduce the integration process to a minimum and permit better accuracy because the incremental zones are reduced to zero width. Refer to the graph paper forms illustrated in Fig. 3, 4 and 5. In effect, power values corresponding to discreet vertical angular positions are plotted linearly as ordinates on each of these papers.

The angular positions are so distributed in the abscissa that they provide the area function, in the products for summation. Thus to find the relative radiated power, from the vertical pattern, the area under a curve plotted on these papers is measured. The area for an isotropic radiator is the area under the horizontal line of ordinate value 1.000. A previous dis-

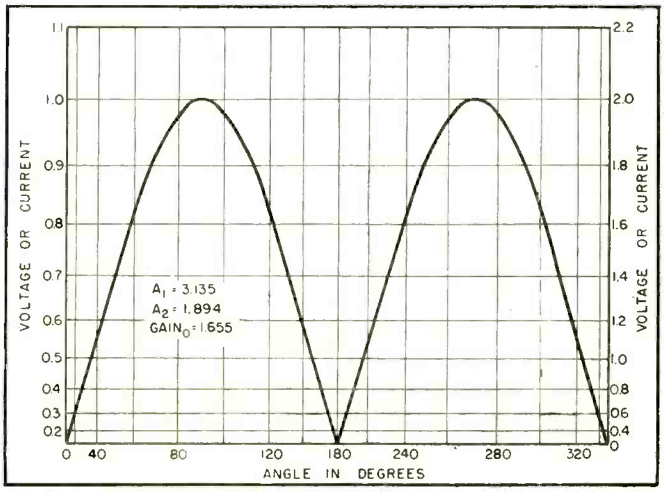


FIG. 3—Gain computation chart for half-wave dipole antenna

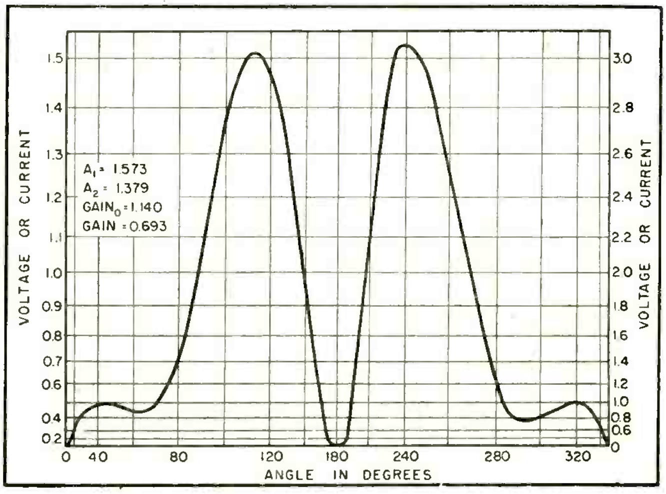


FIG. 4—Gain computation chart for ground-plane antenna

cussion of the general idea for graphical integration is described by Fiet[8].

To obtain the gain of a half-wave dipole antenna, the vertical pattern shown in Fig. 3 was plotted. By means of a polar planimeter, the area under this curve was measured to be 1.894 units and the area for reference as 3.135 units. The power gain is therefore 1.655. The error is less than 1 percent compared with the usual standard of 1.645. Note that in plotting the vertical pattern or beam section on the chart paper, the positions of 90 and 270 deg along the abscissa must be used for the horizontal radiation values of the pattern.

In many cases, especially with experimental data, it is necessary to consider horizontal patterns which are not circular. Also there will be variations in the beam sections. This necessitates the use of more than one integration, one for each beam section.

Suppose first that the horizontal pattern is perfectly circular or near enough so that any deviation may be neglected. Then beam sections equally spaced in the azimuth are used and the gain determined from the average of the individual values of gain. Next, suppose that the horizontal pattern differs considerably from a circle and that the vertical patterns are not alike. Then it is necessary to weigh each vertical pattern in accordance with its importance.

Let curve *A* of Fig. 6 represent the measured horizontal pattern. The magnitude of all the points is increased until the average value corresponds to unity on the scale, as shown in curve *B*. Suppose that there are available vertical patterns for the sections 0 to 180 deg, 45 to 225 deg, 90 to 270 deg and 135 to 315 deg. as shown by the radial lines; then there are two ways of obtaining the gain. One method is to plot each vertical pattern on the special chart paper so that the 90 and 270-deg values agree with the magnitudes on the corrected horizontal pattern B and then take the average of the gain values obtained. A second method is to plot each vertical pattern on the special chart paper so that the 90 and 270-deg values are unity. Then modify each gain value in proportion to the corresponding values on the horizontal pattern B and average.

When making the magnitude corrections with experimental data, it is often necessary to use some arbitrary methods to adjust the values. Many times the horizontal pattern is not in agreement with the corresponding values of power in the vertical patterns. In this case it will be found satisfactory to compare the mean values in the horizontal pattern with the mean values in the vertical pattern and make the adjustment on this basis.

It should be noted also that the gain value obtained by the method described is the average gain in the horizontal plane. The gain in any specific direction is obtained by multiplying the average gain value by the magnitude of the corrected horizontal pattern in that direction.

In many experiments, vertical patterns will be obtained which do not give a maximum power in the horizontal plane. For instance, stub radiators over odd-sized ground planes give a beam which is considerably bent up or down. When such a curve is to be plotted on the special paper such as shown in Fig. 3, the ordinates given on the left-hand margin are not satisfactory.

Since the divisions are not uniform, the scale cannot be readily changed and still keep the curve well up on the paper. A second scale on the right-hand margin has been provided and to permit better proportions for all cases, intermediate scales as shown in Fig. 4 have been provided, one on each margin. In Fig. 4, the kind of off-beam pattern that may be encountered has been plotted. In this case, the area under the curve can easily be more than the area under the curve for a half-wave dipole antenna and hence the gain compared with it is less than unity.

An advantage in the use of the

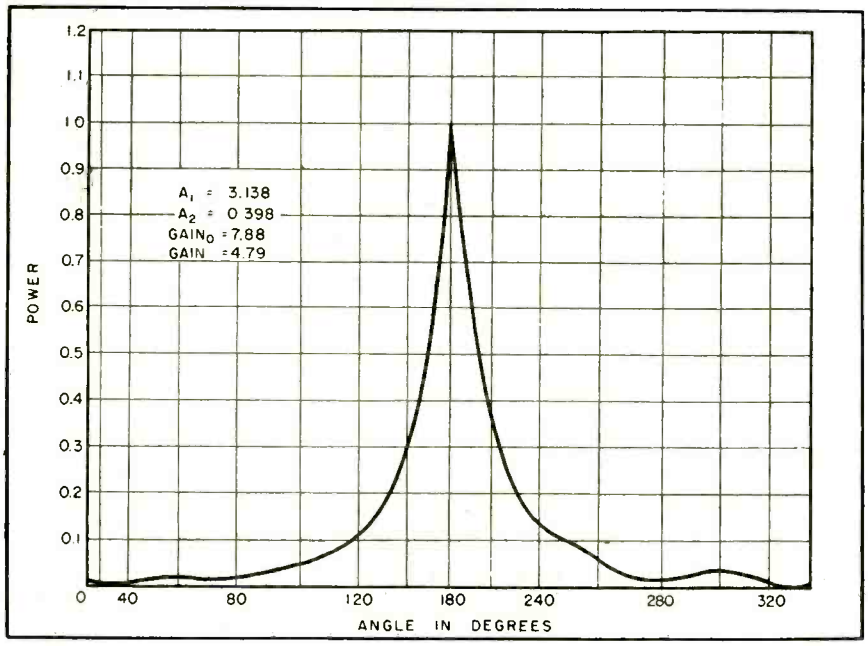


FIG. 5—Gain computation chart for corner-reflector antenna

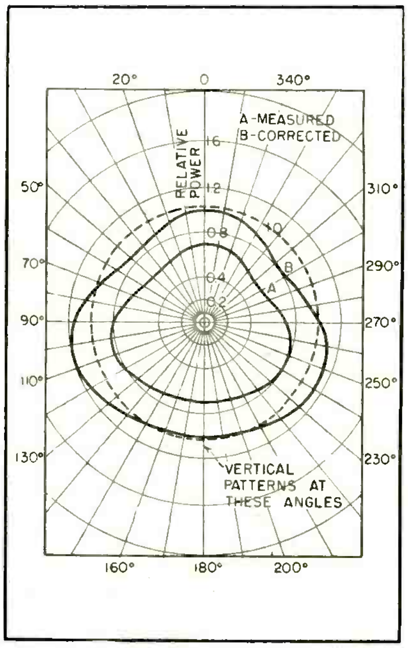


FIG. 6—Horizontal radiation pattern

chart paper becomes obvious at once. The importance of side lobes and unbalanced or off-side beams is made clear by the area that these characteristics contribute to the total area. Conversely, it can be easily observed how unimportant side lobes become when they are present at high elevation angles.

Vertical patterns calculated in terms of power and those measured with square-law detectors may be plotted on chart paper having a uniform distribution of the ordinate values. This is shown in Fig. 5. In this case, it is convenient to use any scale desired, the right-hand margin has been left blank for this purpose.

Gain of Beam Antennas

The discussion up to this point has been restricted to the kind of antennas most commonly used in broadcast services. The solid of radiation approaches a pancake with most of the energy concentrated in a ring in the horizontal plane. There are, in addition, many services that employ beam antennas, in which case the chart paper is used in a slightly different manner.

For simplicity, start with a beam that is uniform in transverse cross-section, that is, the E-plane and H-plane patterns are alike. Assume that the beam is horizontal. Then the spherical surface imagined as surrounding the antenna must be divided into zones as shown in Fig. 7. Note that whereas the high-energy level for the horizontally omnidirectional antenna is projected onto relatively large areas, here the high-energy level is projected onto relatively small areas. The use of the chart becomes clear at once.

Instead of plotting the beam section so that the maximums of radiation occur at 90 and 270 deg, the main beam is plotted at 180 deg and the back radiation at 0 deg. (For a bidirectional beam there will be a peak at both 180 and 0 deg). An example is shown in Fig. 5. It is obvious at once how much more important side lobes become with this type of radiator. It becomes easier to understand why experimental gain values fall below anticipated values with the presence of seemingly insignificant side lobes or back radiation.

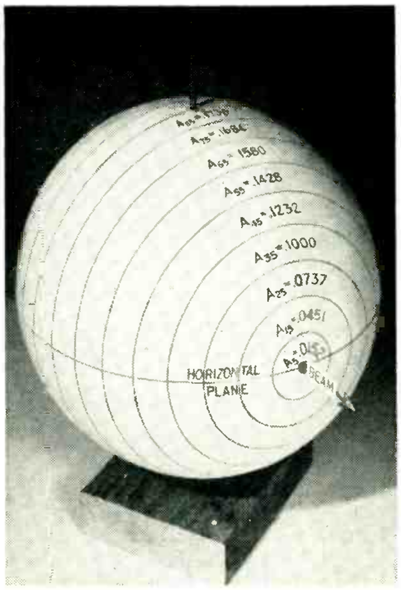


FIG. 7—Sphere for beam antenna

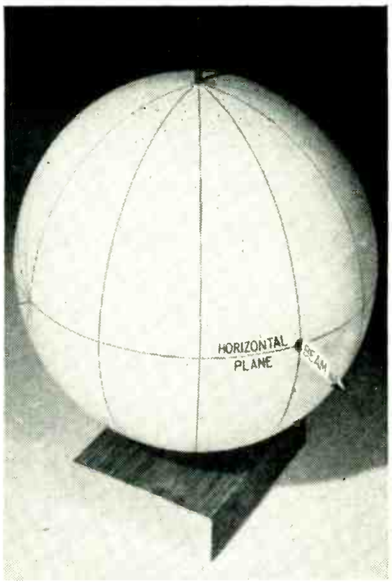


FIG. 8 Sphere for shaped-beam

Shaped Beams

The modern trend toward shaped beams requires a consideration of gain computation suited to them. For a simple regular and minor deviation from a constant cross-section beam, it will suffice to obtain a separate pattern in the E-plane and the H-plane and use the gain obtained from the average value.

When more than two patterns of the beam are required in order to define the shape of the radiation solid sufficiently well, an extension of the above scheme is unsatisfactory, particularly from a polarization standpoint. For both the E-plane and H-plane patterns the polarization may be held fixed but with intermediate patterns, the polarization must vary with the elevation angle. This is both difficult to calculate and difficult to measure experimentally.

The most direct solution is to take additional patterns in the vertical axis of the antenna, at different azimuth angles. The gain is obtained from the average of the individual values, with no consideration to an integration in the horizontal plane. The sections for the patterns are shown in the photograph of Fig. 8. Note that each pattern must be either plotted to its appropriate scale magnitude, without correction, or be plotted to full scale and the integration modified, as done for the noncircular pattern omnidirectional antenna. Note that in this plan for multiple sections, the integration is done along spherical areas known as lunes, such that the effective area of integration to be considered varies the same as for the omnidirectional antenna. The maximum area occurs in the horizontal plane. Hence the antenna power, or field, in the horizontal plane is plotted at 90 and 270 deg on the chart paper. For sharp beams, it is possible to arrange for many sections through the beam and only a few remote from the beam, as long as each integration is weighted in proportion to the width of the section that it represents.

When integrating the patterns of exceptionally sharp beams, it may become necessary to plot the pattern with several scales, in order to obtain the required accuracy. In the extreme case where the number of determinations warrants, it is entirely practical to set up two separate graphical forms, one for the main beam and one for the side lobes, with overlapping angular scales so that these forms will cover a range of beam width.

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(1) M. W. Scheldorf, A New Studio-To-Transmitter Antenna, *Proc. IRE*, p 108, Feb. 1945.

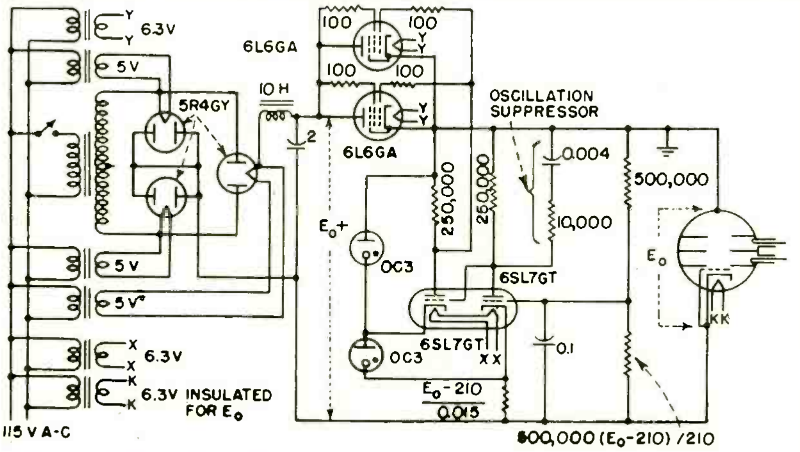
(2) Reference Data for Radio Engineers, Federal Telephone & Radio Corp., First Edition, p 143, 1943.

(3) O. O. Fiet, Measured Characteristics of the Pylon Antenna, *Broadcast News*, p 14, Dec. 1947.

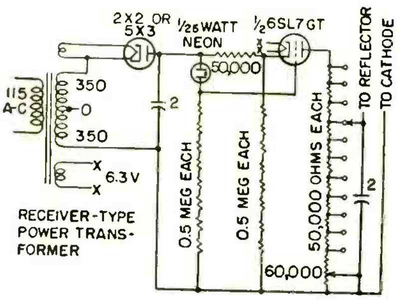
KLYSTRON CIRCUITS

Most-used versions presented for convenient reference, including three regulated power supply circuits, klystron frequency standard, afc for reflex klystron local oscillator, resonant cavity control and phase modulator

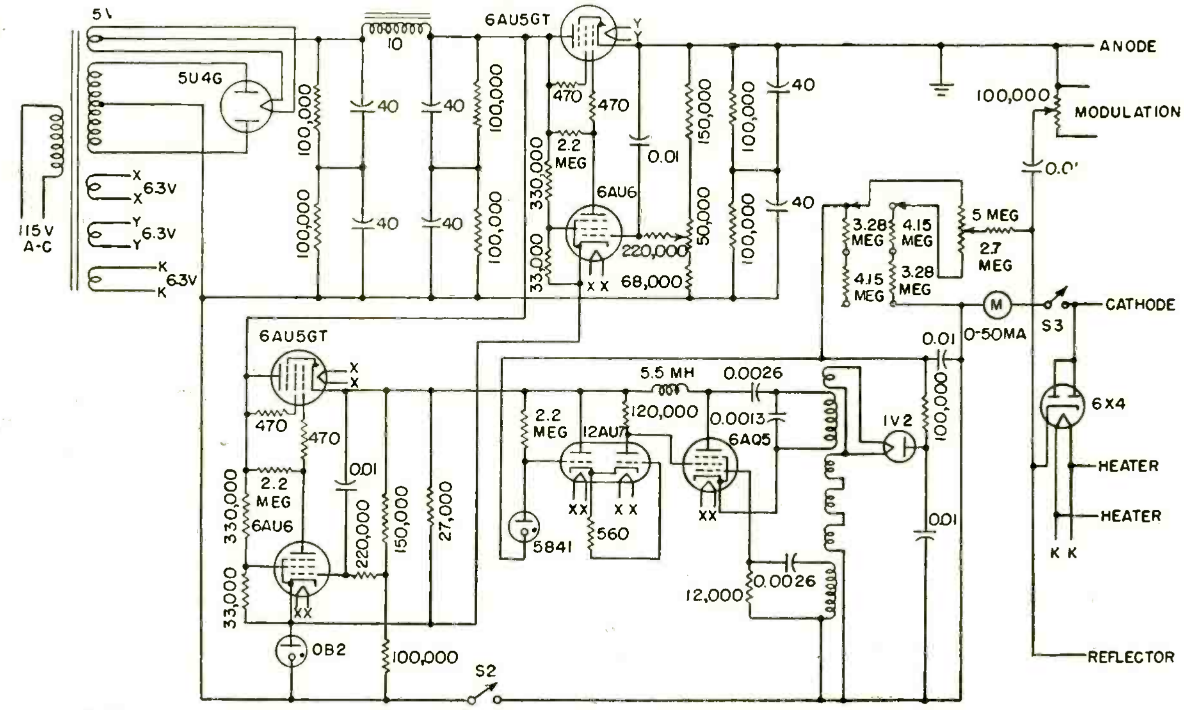
By A. E. HARRISON *Assoc. Prof. of Electrical Engineering, University of Washington, Seattle*



BRIDGE-TYPE POWER SUPPLY—Gives any desired value of beam voltage by changing the two resistors specified in terms of beam voltage E_0, provided input voltage is also changed



HALF-WAVE POWER SUPPLY—Conventional half-wave rectifier is alternative method of obtaining 500 volts for reflector voltage supply. A μ-bridge regulator circuit is particularly applicable because it operates in the negative lead



POWER SUPPLY—Simplified version of Hewlett-Packard Model 715-A klystron power supply circuit illustrates design problems for reflex klystrons. Reflector voltage, which requires no power and often operates above ground potential, is supplied by an r-f supply. The r-f oscillator voltage is supplied by an electronically regulated source. An additional feedback circuit from the rectified output voltage improves voltage stability. Reflector voltage is adjustable between 10 and 900 volts. Diode between cathode and reflector leads prevents reflector voltage from becoming positive. Regulated beam voltage is variable from 250 to 400 volts. Single VR tube acts as voltage reference. Switches delay application of beam voltage

(Continued on p 150)

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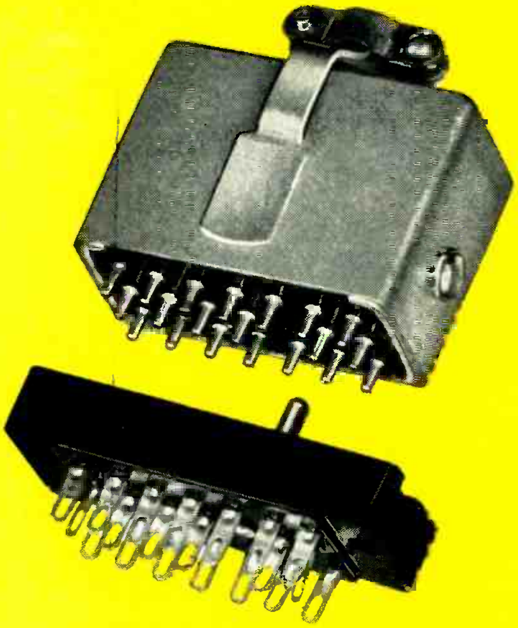

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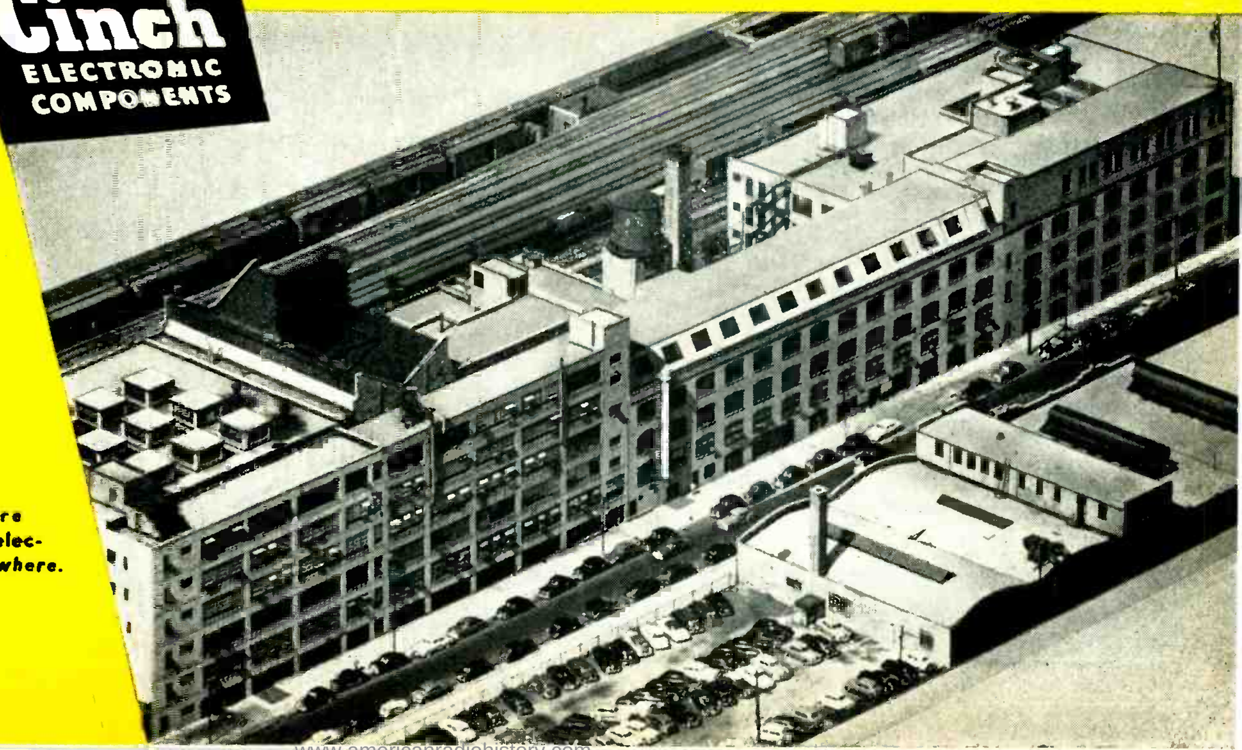

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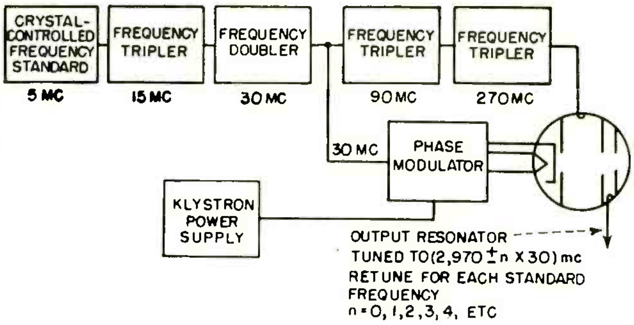
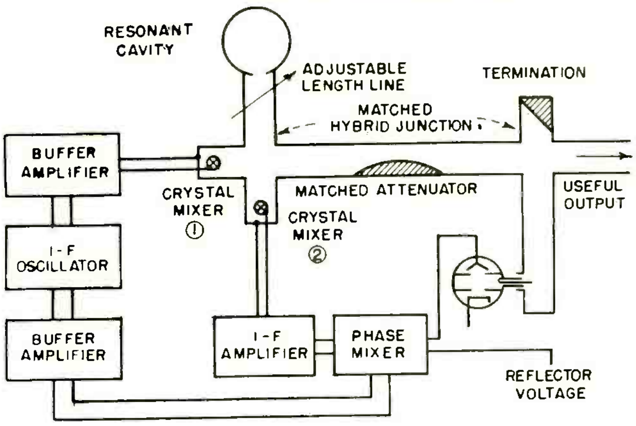
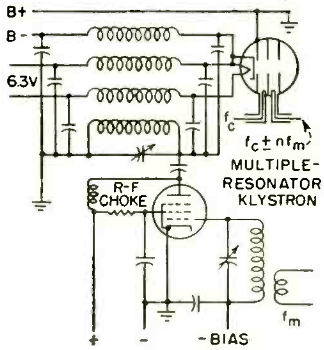
KLYSTRON CIRCUITS (continued from page 148)



FREQUENCY STANDARD—A phase-modulated signal derived from the same source as the input signal for a klystron frequency multiplier can be used to generate standard frequencies in the microwave region. Modulator unit is similar to that shown for phase-modulation of a klystron amplifier. The klystron multiplication factor is 11. The choice of 270-mc input frequency and 30-mc modulation frequency requires only four sidebands to cover the frequency spectrum between harmonics. For example, the next standard frequency above 2,970 + 120 mc is a sideband of the 12th harmonic of the input frequency, or 3,240 — 120 mc

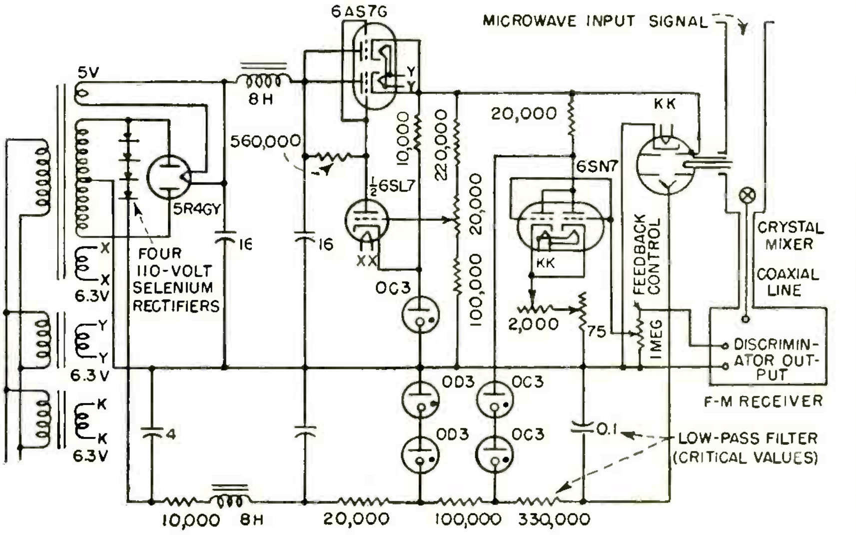
RESONANT CAVITY CONTROL OF REFLEX OSCILLATOR—Frequency stabilization of a reflex klystron oscillator can be obtained by locking the oscillator to a resonant cavity. A block diagram of a method developed by R. V. Pound is illustrated. One hybrid junction (magic tee) provides a sample of the output of the reflex klystron oscillator. When the oscillator frequency coincides with the resonant frequency of the cavity there is no r-f signal at mixer crystal No. 1 and no i-f signal at mixer No. 2. A shift in frequency produces an r-f signal at the first crystal mixer which becomes modulated at the intermediate frequency and reflected to the second mixer where it is demodulated to produce an i-f signal. The phase and amplitude of the demodulated i-f signal are determined by the relation between the klystron frequency and the cavity frequency. The phase mixer compares the demodulated i-f with the original source and produces a signal which corrects the klystron frequency



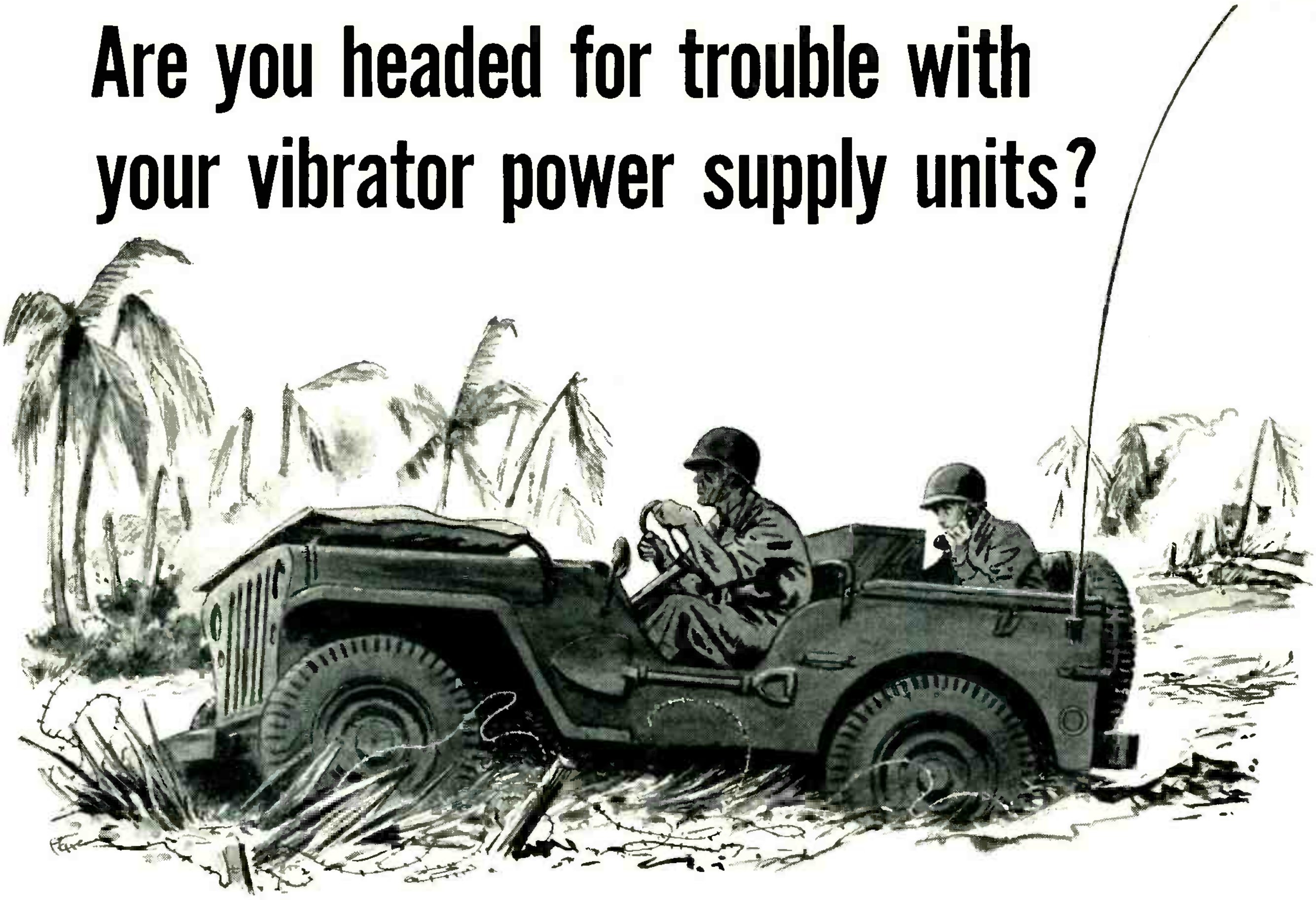


PHASE MODULATION OF KLYSTRON AMPLIFIER—Some microwave transmitter systems can advantageously use phase modulation, either as a device for modulating a klystron amplifier or as a means of producing two signals with a fixed frequency difference. In most cases the modulation frequency f_m is made high enough so that a sideband can be separated from the carrier frequency f_c by the selectivity of the high-Q output resonator. The problem is to vary the entire electron gun structure, which is at a high d-c voltage above ground, at an r-f rate. Since r-f chokes for the heater leads are not too practical, the scheme illustrated for including the three klystron leads as part of the plate tank circuit has been devised. The klystron leads are wound with the same number of turns as an integral part of the tank coil but insulated adequately for the cathode voltage on the klystron. The r-f circuit must be kept close to the klystron socket

AFC—Reflex klystron oscillators are ideally suited to automatic frequency control in f-m systems because the d-c output of the discriminator can be applied to the reflector electrode to control the frequency of the local oscillator. The reflector voltage supply in this circuit is obtained from a selenium rectifier so that a common grounded lead can be connected to the cathode of a type 723 A/B or similar reflex klystron local oscillator. Two VR-tube regulators in series give adequate voltage stability for this application. The output of the f-m discriminator is connected to the grid of a d-c amplifier which controls the reflector voltage. The 2,000-ohm and 75-ohm variable resistors in the cathode lead act as rough and fine controls of the average reflector voltage



Are you headed for trouble with your vibrator power supply units?



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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

Facsimile-Scanner Function Generator

By James C. Barnes
Assistant Professor
Electrical Engineering Department
University of Minnesota
Minneapolis, Minnesota

In the solution of certain problems by electrical analog methods it may be necessary to employ a relation between two variables which is specified graphically. In others, although an analytical expression is available, the analytical relation may require rather elaborate arrangements to provide an electrical analog. Hence a convenient means of obtaining an electrical representation of a graphed function is of value.

To allow using a graph rather than a profile (as used by Sunstein, Electronics, p 100, Feb. 1949), the possible use of facsimile techniques was investigated, since graphs are suitable subject copy for transmission by facsimile systems. If a graph is scanned with the scanning lines parallel to the vertical axis, there is a pulse in the scanner output each time the scanning spot passes over the curve. The result is a pulse-time-modulated signal, the timing of the pulses representing the height, or ordinate, of the curve.

To demonstrate the proposed method, a drum-type facsimile scanner was adapted to generate an electrical signal from a graphed function. In the particular scanner used, the drum on which the copy is scanned is 6 in. in circumference and $4\frac{5}{8}$ in. long. The drum is rotated at 300 rpm by a synchronous motor, so that the graph is scanned at a rate of five lines per second. The exact speed is not important, but it is essential for the speed to be constant. By means of an optical system, light reflected from a small area of the graph sheet is directed to a phototube. The optical system is stationary and the drum, as it rotates, feeds axially past the optical system at the rate of 1/200th in. per drum revolution.

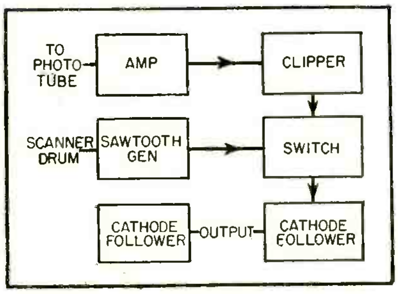


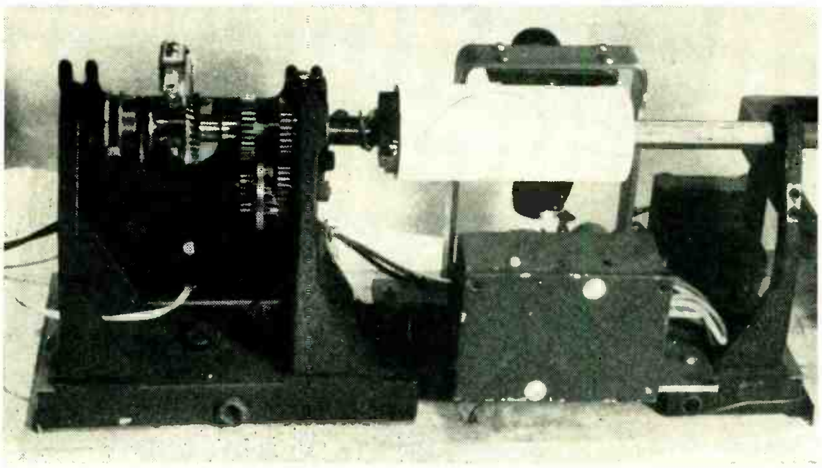
FIG. 1—Block diagram of the function generator

The time required to complete the scanning is 160 seconds. This is inconveniently long but has no adverse effect on the results with an analog computer of the Reac type. A higher scanning speed and wider line spacing would be desirable to reduce this time. Also, a larger drum would be preferable since errors in drawing on larger paper would be less important in percentage. However, facsimile equipment having these desirable features was not available for the tests.

Figure 1 is a block diagram of the circuit employed, and Figure 2 shows the waveforms at various points as indicated. For purposes of illustration, the variations in the pulse spacing are exaggerated on Fig. 2.

Referring to the figures, the cam-operated contact triggers a sawtooth generator each revolution of the drum. The output of the sawtooth generator is fed through a cathode follower to an electronic switch, so that the input to the switch is a sawtooth voltage at low impedance.

The switch, normally nonconducting, is actuated by amplified pulses from the phototube output so that it conducts momentarily when the curve passes the scanning spot. When the switch is thus caused to conduct, it charges a capacitor to the voltage of the sawtooth input at that instant, the time constant of the charging circuit being short. This capacitor then remains



View of the experimental model of the function generator

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With the type 202-D Signal Generator, you can quickly and accurately test, analyze and evaluate the performance of telemetering receivers and associated equipment. Note that the frequency coverage of the instrument is provided in a single range between 175-250 mc.

SPECIFICATIONS:

RF RANGE: 175-250 megacycles in one range, accurate to ± 0.5%. Main frequency dial also calibrated in 24 equal divisions for use with vernier frequency dial.

VERNIER FREQUENCY DIAL: This dial is divided into approximately 100 equal scale divisions and is coupled to the main frequency dial by a 24:1 gear train. The approximate frequency change per vernier division is 35 kc.

FREQUENCY MODULATION (DEVIATION): The FM deviation is continuously variable from zero to 240 kc. The modulation meter is calibrated in three FM ranges (1) 0-24 kc., (2) 0-80 kc., and (3) 0-240 kc. deviation.

AMPLITUDE MODULATION: Utilizing the internal audio oscillator amplitude modulation may be obtained over the range of 0-50% with meter calibration points of 30% and 50%. By means of an external audio oscillator the RF carrier may be amplitude modulated to substantially 100%. A front panel jack is provided which permits direct connection of an external modulating voltage source to the final stage for pulse and square wave modulation. Under these conditions the rise time of the modulated carrier is less than 0.25 microseconds and the decay time less than 0.8 microseconds.

MODULATION CONTROLS: Separate potentiometers are provided for continuous control of FM and AM levels.

MODULATING OSCILLATOR: The internal AF oscillator may be switched to provide either frequency or amplitude modulation. It may also be switched off. Eight fixed frequencies between 50 cycles and 15 kilocycles are available, any one of which may be selected by a rotary type switch.

RF OUTPUT VOLTAGE: The RF output voltage is continuously variable over a range from 0.1 microvolt to 0.2 volts at the terminals of the output cable. The impedance of the RF output jack, looking into the instrument, is 53 ohms resistive.

DISTORTION: FM: The overall FM distortion at 75 kc. is less than 2% and at 240 kc. less than 10%.

AM: The distortion present at the RF output for 30% amplitude modulation is less than 3% and for 50% AM less than 6.5. At 100% the distortion is 12% to 15% depending upon the modulating frequency.

SPURIOUS RF OUTPUT: All spurious RF output voltages are at least 25 db. below the desired fundamental. Total RMS spurious FM from the 60 cycles power source is down more than 50 db., with 75 kc. deviation as a reference level.

EXTERNAL MODULATION REQUIREMENTS:

Frequency Modulation: The deviation sensitivity is 50 kc. per volt. For external FM the input impedance is 1500 ohms.

Amplitude Modulation: Approximately 45 volts are required for 50% modulation and 100 volts for 100% modulation. For external AM the input impedance is 7500 ohms.

Audio Voltage for External Use: There is available at the FM external oscillator binding posts about 5 volts a.c. maximum and at the AM external oscillator binding posts, 50 volts maximum.

DIMENSIONS AND WEIGHT: Outside cabinet dimensions: 17" high, 13½" wide, 11½" deep. Weight: 35 pounds.

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charged at this voltage, except for leakage, until the next switch operation when the curve passes the scanning spot again. Accordingly, if a linear sawtooth is assumed, the voltage on the capacitor is proportional to the time between the start of the sawtooth and the occurrence of the pulse, except for an additive constant. This, in turn, is proportional to the height of the curve, again with an additive constant.

It is essential that only pulses produced by scanning the curve actuate the switch. However, the phototube output contains fluctuations due to cross-section lines and paper irregularities in addition to the useful pulses. The amplitude of these fluctuations is relatively small, provided that the cross-section lines are light. Cross-section paper having light green cross-section lines met this requirement.

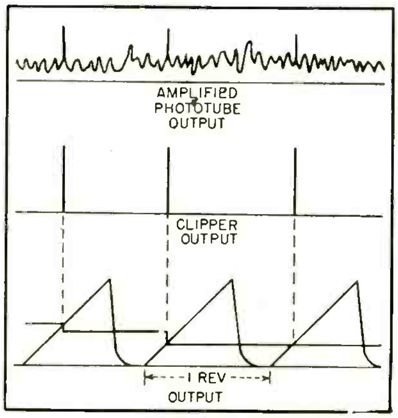


FIG. 2—Exaggerated view of the variations in pulse spacing

The amplified output of the phototube is clipped to remove the unwanted fluctuations, leaving the pulses as required.

The capacitor charged by the electronic switch is connected to a cathode follower. The output is taken between the cathode of this tube and the cathode of another cathode follower whose grid voltage is adjustable. This adjustment permits setting for zero output when the zero reference mark is scanned. A second adjustment controls the period of the sawtooth generator. This effectively is a control on the vertical scale factor, or signal volts per unit distance on the vertical scale of the graph. It is set when the reference mark at the scale maximum is scanned.

Industrial Electronic Fly-Ash Recorder

MARCEL GROBTUCH
Melbourne, Australia

AN ELECTRONIC fly-ash recorder to be used for examination of dust output from boilers has been designed and constructed in Australia. Performance and usefulness exceed that of any other piece of similar equipment known to the writer.

The idea was first examined when the Australian Paper Manufacturers Ltd. found it necessary to meter the relatively large particles of dust as apart from the smoke in the flue gases issuing from the stack of one of its several mills. The stack in question is common to three boilers, each being metered independently and recorded on a multipoint strip-chart recorder.

A six-in. diameter sampling tube was fitted across the induced draft fan and inspection ports of 1¼-in. inside diameter tubing mounted on the sampling tube. These ports were left open to enable the air to be drawn continuously into the tube as a result of the negative pressure inside. An attempt to use windows was made in the early stages of experiments but invariably they became fogged after only a short period of operation and efforts to create drafts across the surfaces of the glasses were unsuccessful.

A phototube is situated on one side of the inspection port with a low-voltage d-c light source opposite. A slit of light is focused at the center of the sampling tube and passes through to the phototube. A pulsating direct current flows in the cathode resistor of the tube. The frequency of the a-c component depends upon the number of shadows per second affecting the cell due to the light absorbed by the dust particles.

The a-c component is amplified through a three-stage amplifier and applied to a direct-reading frequency meter. The current through the 6H6, Fig. 1, is directly proportional to the frequency at which the dust particles pass the inspection point.

The movement of a chopper-bar-type of multipoint recorder is in

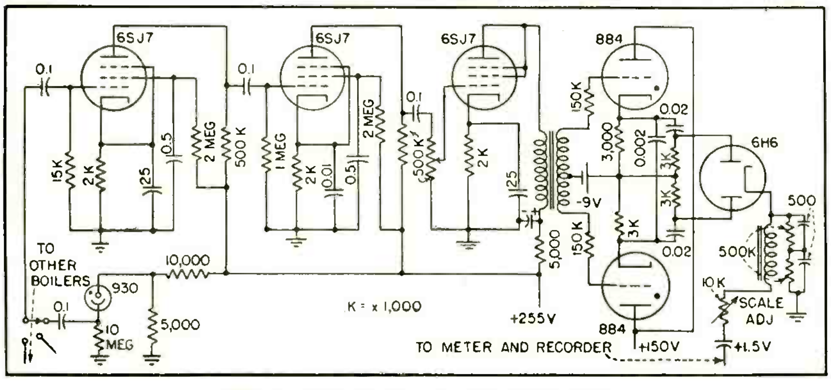
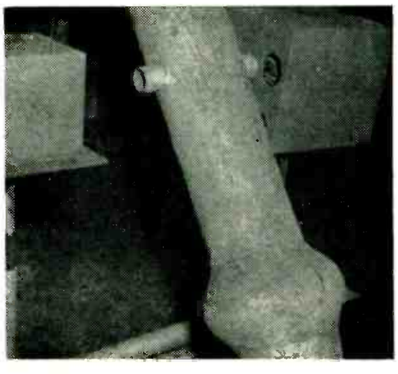
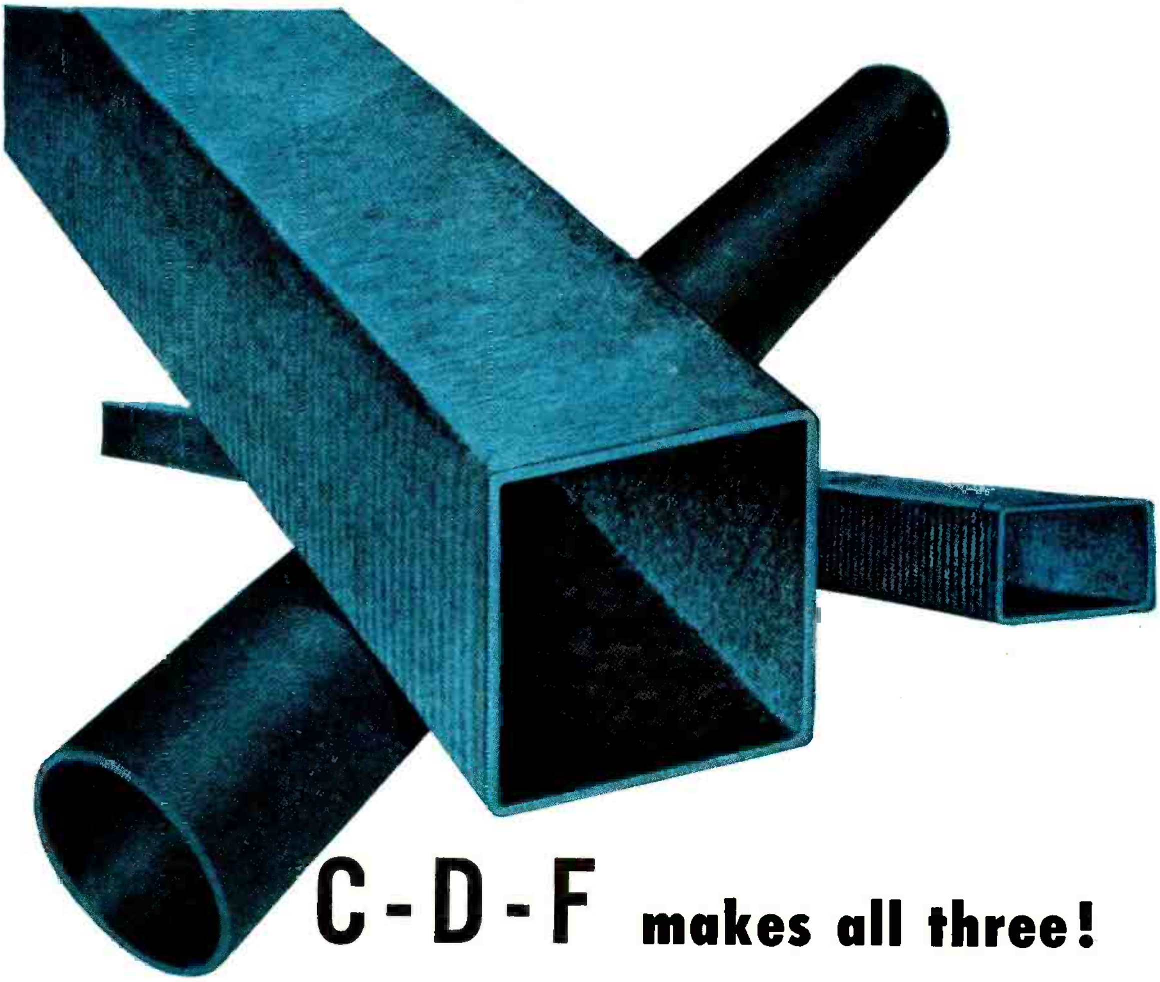


FIG. 1—Fly-ash recorder circuit diagram



Installation of the recorder on a pipe



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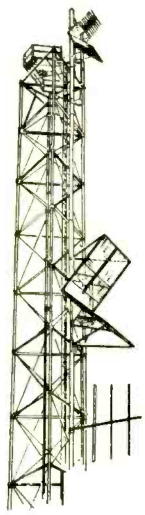
series with the microammeter in the diode cathode circuit. As the rate of fluctuation is extremely high, it was found necessary to introduce a long time constant in the 6H6 cathode so as to record only an average.

The purpose of the recorder is not to measure the absolute number of particles above a certain size. It is intended to indicate trends in the quantity of ash passing into the atmosphere. The minimum size of particle counted is easily governed by the setting of the gain control. The instrument, however, is not affected by a relatively constant background of the smoke comprising much smaller particles.

The instrument has an added advantage in its ability not to ignore slow ambient light-intensity changes. The reading is not affected by the slight fogging of the phototube by dust or by small changes in light intensity due to the fact that the frequency meter used is insensitive to changes in amplitude of the applied waveform.

The input to the amplifier is successively switched to the three boilers by a selector switch in the recorder so that any individual offending boiler may be easily discovered and the cause rectified.

THE FRONT COVER



A SYSTEM of high-powered vhf and uhf radio transmitters has been installed by National Bureau of Standards engineers G. R. Chambers and J. H. Chisholm on Cheyenne Mountain, Colorado, for radio-propagation research. The transmitters are crystal controlled and radiate unmodulated signals. Two vhf transmitters, generating 3 kw at 100 and 200 mc, feed antennas on the tower together with a 4-kw uhf transmitter operating at 1,047 mc. Two other vhf transmitters operate at a level 1,500 ft lower.

Preliminary measurements of radio fields at distances 100 to 300 miles beyond the 82-mile radio horizon have indicated considerably stronger fields than those prescribed by standard diffraction theory. A new theory has been evolved for the propagation of vhf radio waves beyond the horizon by Dr. J. Feinstein of the NBS staff.

Television Pattern Generator

CIRCUIT TECHNIQUES like those in a tv transmitter sync generator are utilized in the Hickok Videometer, a pattern generator for receiver testing. The instrument contains a crystal-controlled oscillator at 315 kc, from which accurately timed signals are divided down to 15,750, 900 and 60 cycles.

Combinations of these frequencies provide a choice of video outputs for a dot pattern, a crosshatch pattern, horizontal lines plus framing frequency, vertical lines plus framing frequency, and framing frequency with blank raster. The video output can also be used to modulate low or high-band oscillators in the unit. The bar-dot pattern consists of 15 horizontal bars (14 normally visible), 20 vertical bars, or 300 dots.

The crystal-controlled frequency of 315 kc is divided down by relaxation oscillators. Four shaping circuits are employed. The various frequencies taken from the timer are shaped and fed to the mixers in proper polarity and amplitude.

The output of the mixers is fed into a plate-cathode phase inverter providing outputs of either positive or negative polarity. These are fed to the amplifier and cathode follower, and are available at the video output and are also used to modulate the r-f channel oscillators.

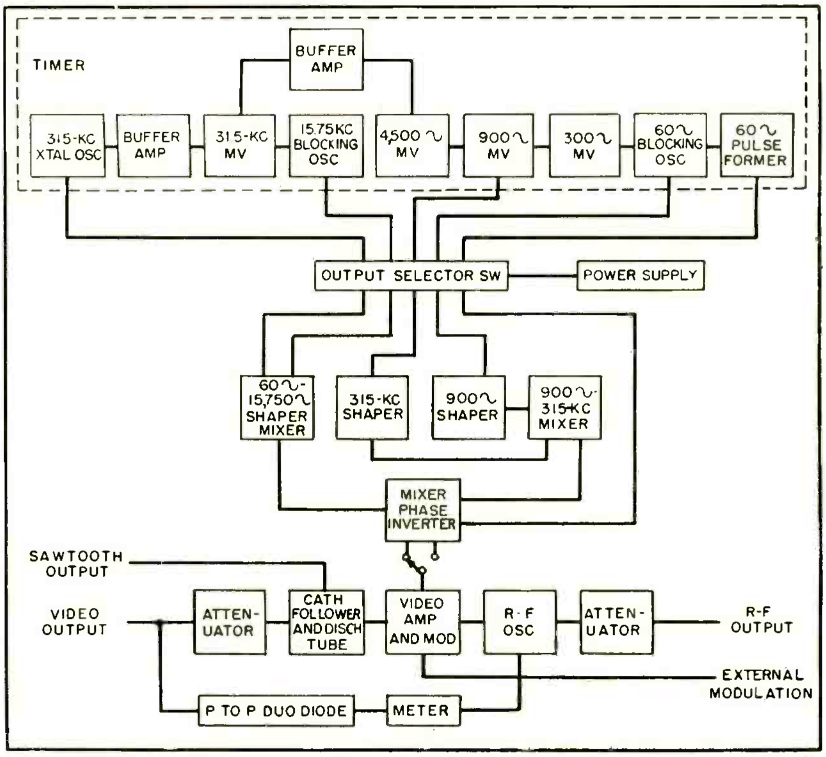
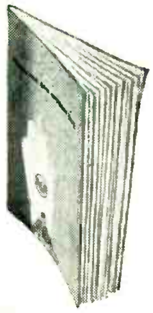


FIG. 1—Arrangement of stages of the Hickok Videometer, a bar and dot pattern generator

Output of the phase inverter is connected to a video amplifier and amplified without appreciable loss to the higher frequency components. The video amplifier is also utilized

Help to Engineers



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The television pattern generator

as a modulator for the r-f channel oscillators.

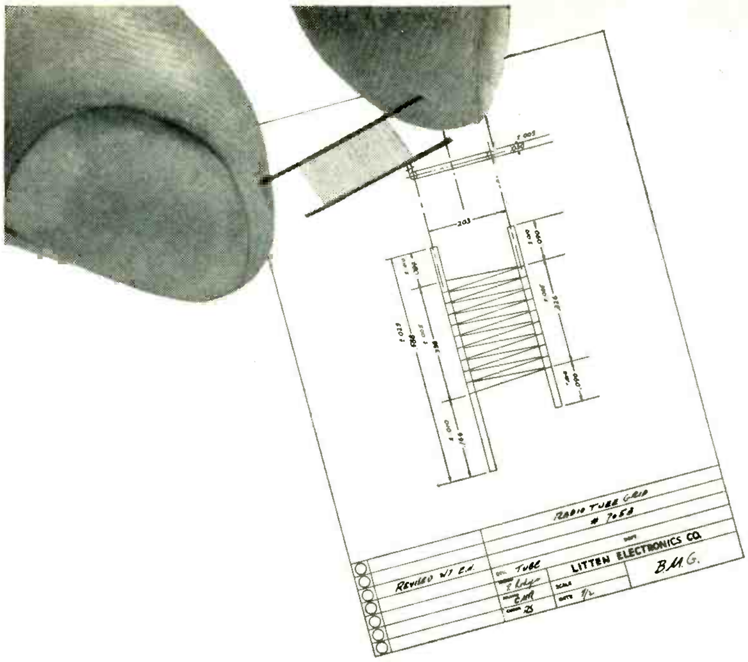
One duo-triode tube, tied in parallel, is utilized as both cathode follower and discharge tube. With the waveform selector in the video output ON position, the plate is heavily bypassed and the tube operates as a cathode follower with the output taken from the cathode. With the waveform selector set to either 60 or 15,750-cycle sawtooth output, the cathode is grounded and a resistor and discharge capacitor are switched into the plate circuit. The sawtooth output is formed and taken from the plate and the tube acts as a discharge tube.

R-F Output

Two independent Colpitts oscillators are employed, one for the low channels and one for the high channels. These oscillators are plate-modulated through an RC and L network from the plate of the modulator. Both oscillators are continuously tuned and calibrated in channel numbers. The percentage of modulation is variable.

Video output is taken directly from the video attenuator of the cathode follower and fed into a peak-to-peak duo-diode. Direct current from this rectifier is fed into a meter which is calibrated in peak-to-peak volts.

With the instrument, problems involving isolation or nonlinearity in sweep circuits, phase distortion, hum, frequency response and adjustment of hold controls can be solved. In this connection, it is interesting to note that since the television test pattern does not



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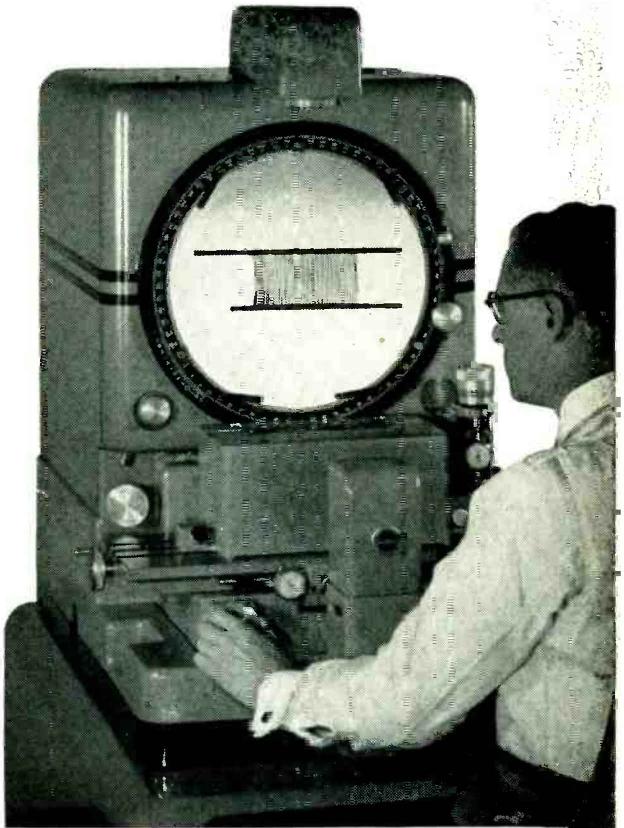
If you need optical gaging for rapid routine inspection rather than for measurements, the stripped-down Model 3 is your choice. A fixture designed for maximum efficiency in handling your particular part goes on the stage. Over the screen goes a chart-gage keyed to the fixture and carrying all tolerances. Even an inexperienced operator can either pass a part or see at once which of many dimensions are off and by how much. To inspect an entirely different kind of part means only slipping in a different fixture with its corresponding chart-gage.

In your area there's an engineer with wide experience in both aspects of optical gaging technique. It will cost you nothing to discuss with him the details pertinent to your own particular requirements. To get in touch with him, write Eastman Kodak Company, Industrial Optical Sales Division, Rochester 4, N. Y.



the KODAK CONTOUR PROJECTOR

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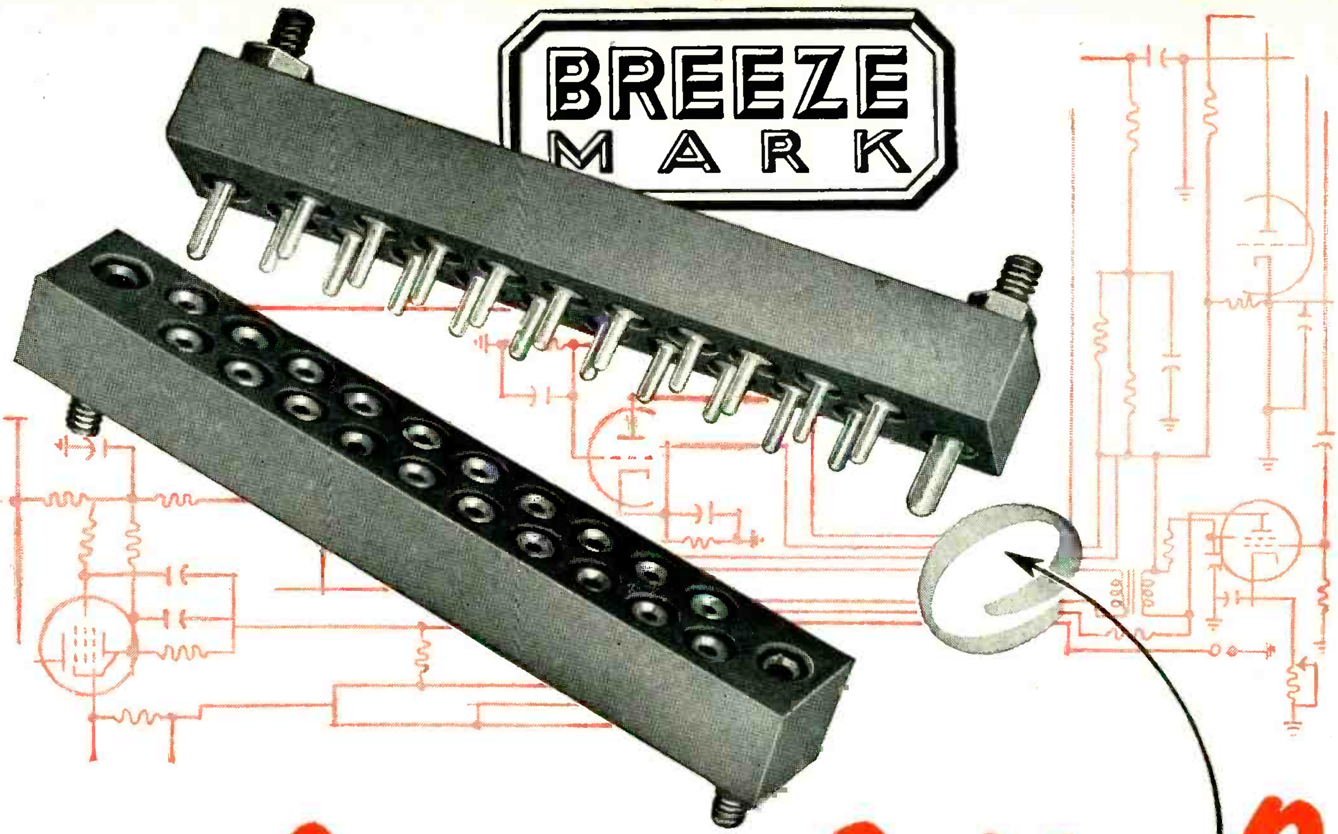

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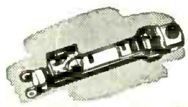

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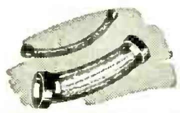

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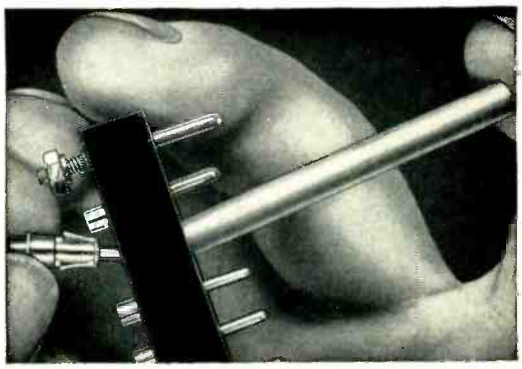

Removable pins in Breeze connectors speed soldering, save time, trouble. Pins snap back into block.

normally have equally spaced horizontal lines, a misalignment of both vertical linearity and ion trap would not be noticed with a station test pattern, because the error in vertical linearity would be compensated by misalignment of the ion trap. The bar pattern from the Videometer would show up this defect on the screen of the picture tube, however.

Since the pattern generator is calibrated in terms of microvolts of output, the sensitivity of the receiver can readily be determined.

High-Speed Recorder

By Leo Rosen
Department of Defense
Washington, D. C.

THIS ARTICLE describes two essentially similar recorders for printing hard copy, one printing numbers only, the other printing 36 symbols.

The recorder consists of a multiple selection and printing mechanism and a paper-feed mechanism. The printing mechanism accepts and prints 40 characters in parallel, the printing being accomplished without stopping the print wheel. The paper remains stationary during printing. The paper-feed mechanism is controlled independently from the printing mechanism and causes the paper to advance approximately ¼ of an inch.

The entire cycle of printing and paper advance is completed in 0.068 sec and therefore the recorder is capable of printing either continuously or intermittently at the rate of 15 lines per second with 40 characters to each line.

The theory of one method of

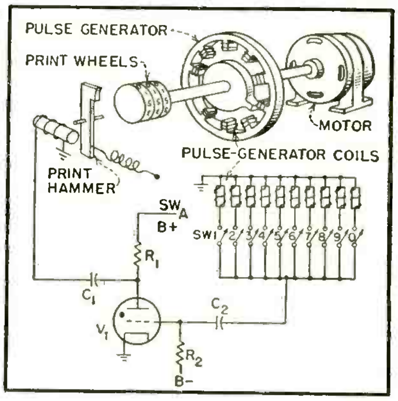

FIG. 1—Circuit using individual circuit closures

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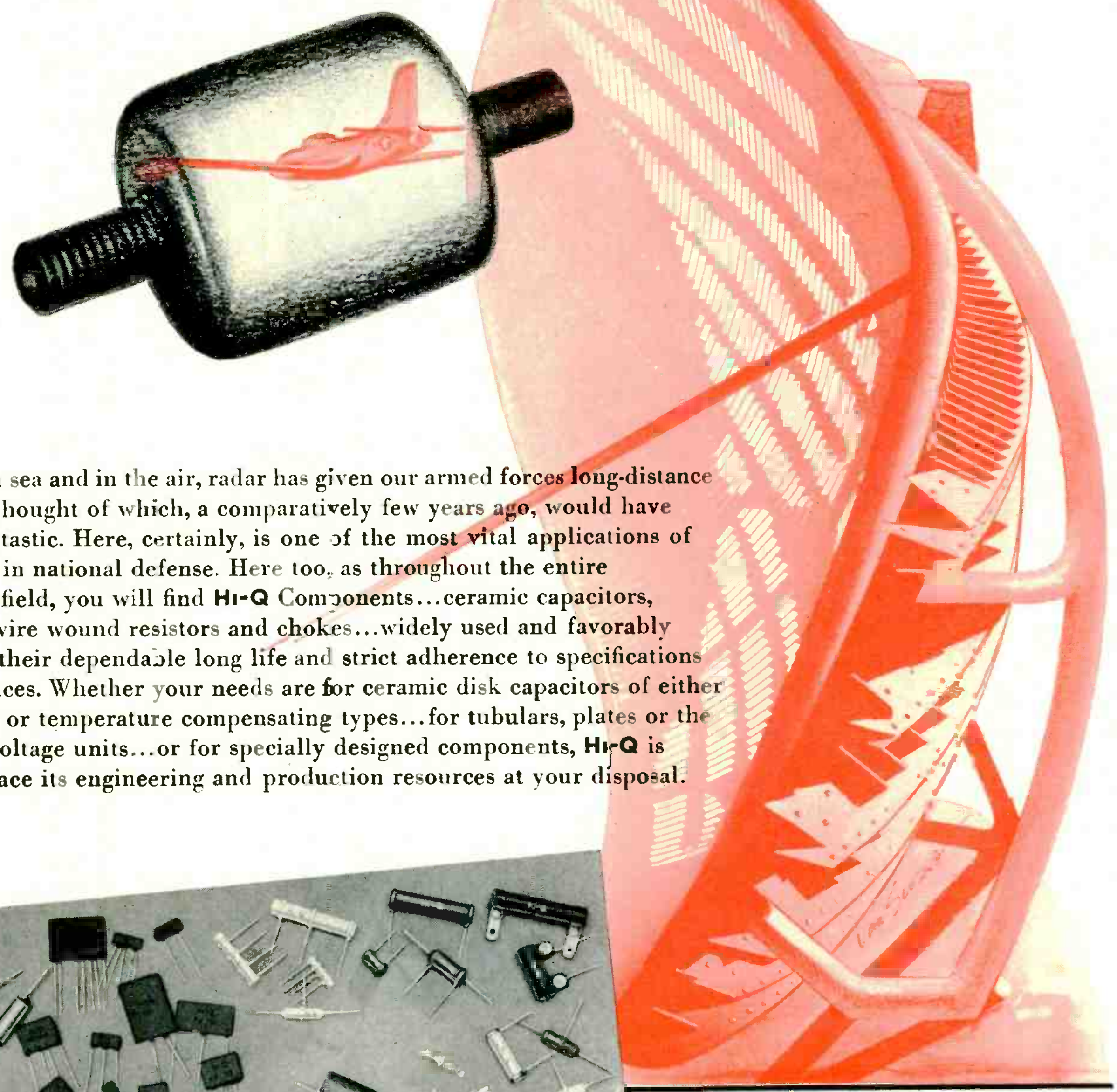

On land, on sea and in the air, radar has given our armed forces long-distance vision the thought of which, a comparatively few years ago, would have seemed fantastic. Here, certainly, is one of the most vital applications of electronics in national defense. Here too, as throughout the entire electronics field, you will find **HI-Q** Components...ceramic capacitors, trimmers, wire wound resistors and chokes...widely used and favorably known for their dependable long life and strict adherence to specifications and tolerances. Whether your needs are for ceramic disk capacitors of either the by-pass or temperature compensating types...for tubulars, plates or the new high voltage units...or for specially designed components, **HI-Q** is ready to place its engineering and production resources at your disposal.

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View of the recorder with the mechanism tilted out for inspection

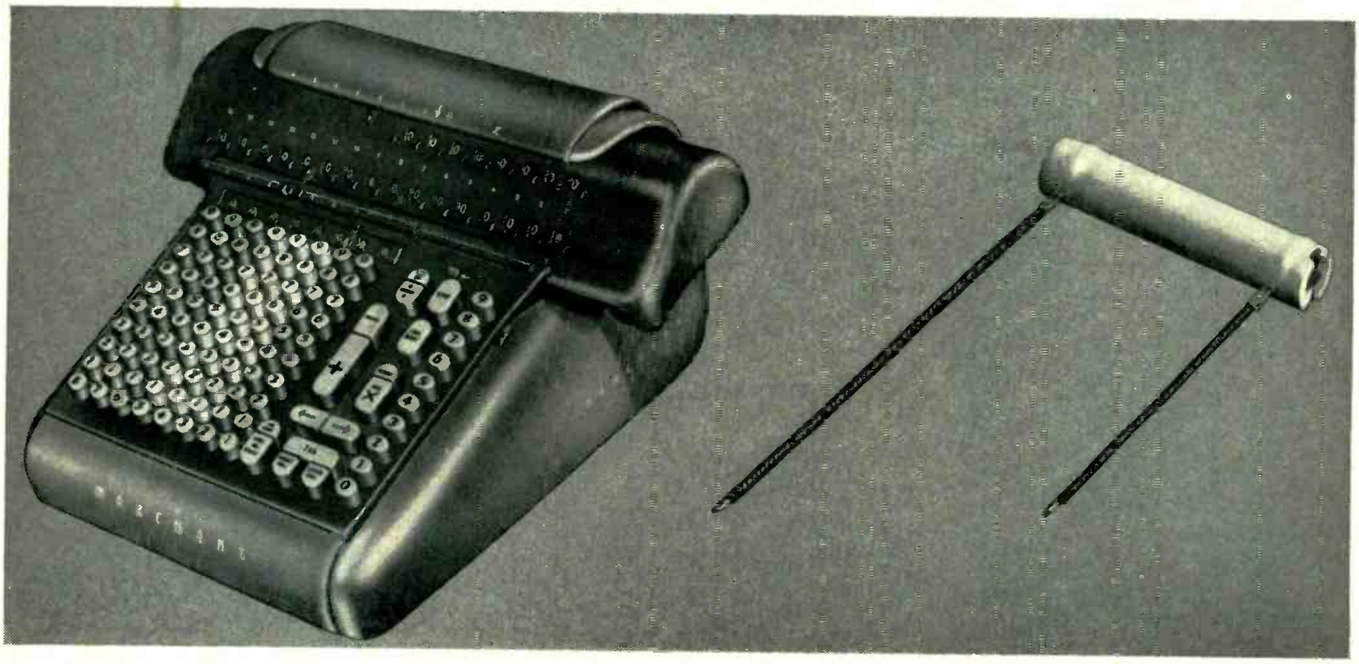
operation is shown in Fig. 1. The motor drives the print wheels and the pulse generator rotor continuously at about 1,750 rpm. As the rotor passes each pole of the pulse-generator stator a pulse is generated in the coils. (The coils are shown for clarity both in their physical location and as circuit elements.) The character to be printed is selected by closing one of the switches SW_1, to SW_0. Capacitor C_1 is charged before printing. If SW_3 had been closed, when the pulse-generator rotor reaches L_3 a pulse is transmitted to thyratron V_1, the thyratron fires and discharges capacitor C_1 through the print hammer magnet, actuating the hammer to print when a "3" is opposite the printing point. Corrections in phasing are made either electronically by means of adjustable delay circuits or by rotating the pulse-generator stator. One set of pulse-generator coils serves all the thyratrons, there being one thyratron for each print wheel and hammer. Switch SW_A is opened to prevent repeated printing.

Another method of operation is illustrated in Fig. 2. Here all of the pulse-generator coils are tied together and furnish a sequence of pulses to the gate which is normally open. The electronic counter associated with each print wheel is set for the value to be printed, either by actual counting, or by a transfer from some other counter. Switch SW_B is now closed, when a pulse is received from the start-pulse generator the gate is closed. The counter receives pulses from

Marchant Calculating Machine Company

"They make no mistake in figuring resistor costs"

says L. F. Church, L. F. Church Company, San Francisco, representative for Ward Leonard Electric Company



It's *cost in terms of performance* that counts with the makers of Marchant calculators.

A lot of arithmetic would be delayed if resistors failed to work in these push-button multiplication calculators. That's why Marchant insists upon quality resistors, rather than taking a chance with bargains.

How do you *tell* a quality resistor?

It's true that most resistors look alike. A resistor is a simple piece of equipment—really nothing more than a piece of ceramic tubing . . . a couple of terminals . . . a piece of resistance wire . . . and a protective coating.

But there the similarity ends, because in the *important* things that really count, resistors are miles apart! And the biggest difference is that all of the resistor is actually *made* by the company that sells it.

The only way to be sure that all components will react the same to changes in temperature is to balance their thermal characteristics.

Take the tube. Companies like Marchant are depending on that high-density, non-porous, high-dielectric strength, perfectly cylindrical Ward Leonard ceramic core, with smooth surface and straight ends.

They also know the terminals are made of the right alloy to permit proper expansion . . . and that they're securely, rigidly, clamped to the core.

They know the wire is drawn especially for their type of resistor . . . is capable of withstanding great overloads . . . has uniformly low coefficient of resistivity. They also know the coating provides a complete hermetic seal, highly resistant to thermal shock and to high humidity, acids, alkalies, electrolysis.

You can be sure of quality, by buying your resistors from the *one* manufacturer who manufactures, not just assembles, all the components that go into resistors. Play it safe and sound—insist upon VITROHM resistors.

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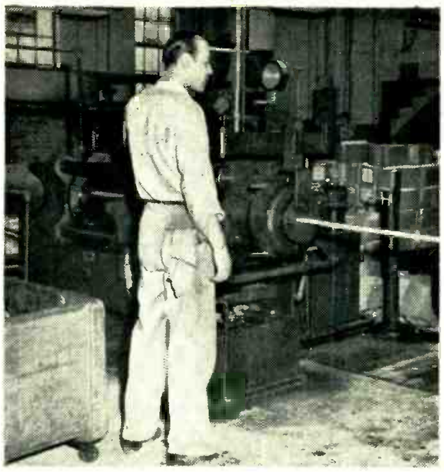

CERAMIC CORES are made by extruding refractory material from hydraulic presses such as this in Ward Leonard's plant.

RESISTANCE WIRE sample is being processed in the combustion furnace to insure accuracy of alloy formula.

VITREOUS ENAMEL for coating is fritted, then ground to exact fineness in these revolving "ball mills."

VITROHM vitreous enamel is measured by interferometer for coefficient of thermal expansion, melting and annealing points.

Uniform Quality—Matched Thermal Characteristics—Long Service Life of VITROHM Resistors—Result From Unified Manufacture

All components of a VITROHM resistor are made by Ward Leonard, the only manufacturer who *makes,* not just assembles, all parts.

Vitreous enamel coating and ceramic cores are formulated and made by Ward Leonard—wire is drawn to their specifications.

This means that all parts are uniform in quality, balanced in respect to thermal coefficient of expansion.

There's no loosening, no failure, due to unbalance of thermal characteristics, heat affects all parts the same way, which in turn means longer life.

VITROHM resistors will stay on the job under the most adverse operating conditions where a less carefully made resistor would break down. Thermal shock, vibration, corrosive atmosphere, overloads, even prolonged exposure to humidity and electrolysis will not affect their performance.

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the pulse generator. When the counter carries, the thyratron is fired and printing occurs. For example, to print "3", the counter is preset to "3". After 7 pulses the thyratron fires and the hammer strikes when "3" is at the printing station. (The print wheels are engraved so that the numbers run in reverse sequence to the direction of rotation.)

Paper movement is controlled by means of a separate circuit which is triggered after all the characters for one line have been printed. Thus data appearing in one line need not be printed at the same time.

The numeric printer has a ten-pole pulse generator and ten-character type wheels, while the alpha-

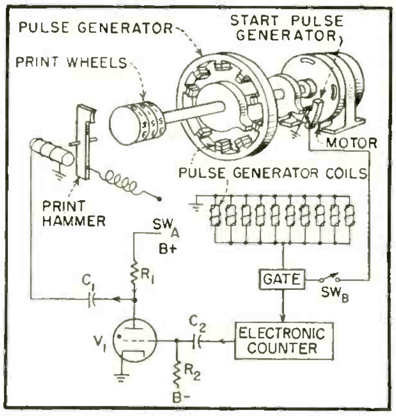

FIG. 2—Circuit using electronic counters for control

numeric printer has a 36-pole pulse generator and 36-character type wheels. The principle of operation and the remaining construction are substantially the same.

Auxiliary Circuits

Practically any type of electronic counter including decade counting or binary with feedback for decade counting can be used to drive the printer.

Circuits are available for converting a voltage into a decimal number and thus the output of a strain gage or other varying voltage can be recorded directly.

Some of the print wheel positions can be reserved for a serial number, while other positions can be reserved to indicate the actual time a reading is taken to a degree of accuracy limited only by the time standard available.

The application of the described

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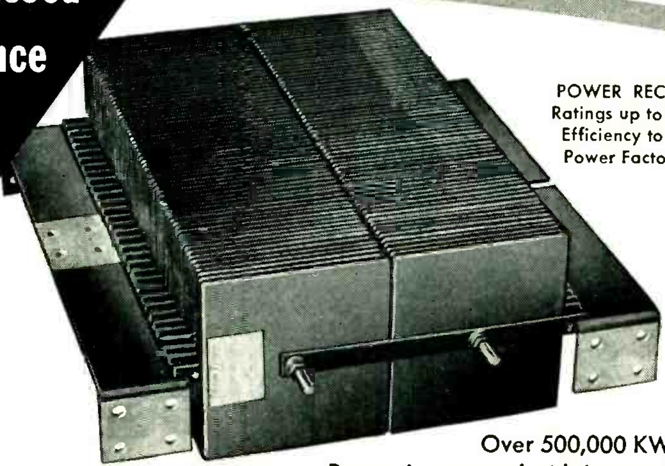

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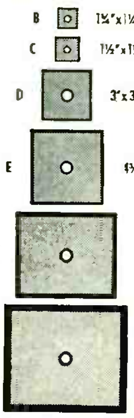

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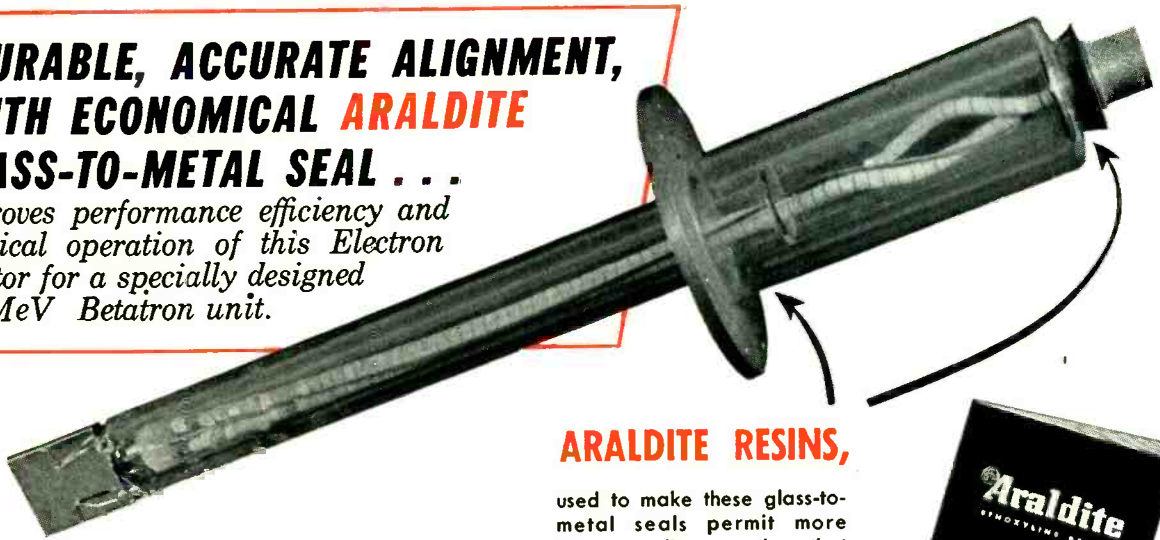

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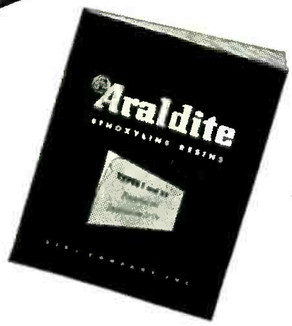

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recorder as an output device for digital or analog computers is obvious. In programs where the recording time is small compared to computation time, the recorder consolidates the data into adjacent lines. In programs where computation is rapidly accomplished, the recorder is capable of printing up to 600 characters per second.

Through the use of appropriate converters, data such as strain-gage readings, which might otherwise have to be recorded on an oscillograph, can be printed directly. A great saving in man hours of oscillograph chart interpretation may be effected by this means. The exact time of the record is also recordable by devoting the proper number of print wheels to this function. Because the paper-feed mechanism is controlled independently, two readings from one gage can be taken on one line. For example, it is possible to record using two significant figures per gage, the output of 20 gages every 0.068 millisecond or the output of 10 gages every 0.034 millisecond.

Application to communications or telemetering with up to 600 characters per second are possible. The described recorder may also be used to print from punched cards and perforated or magnetic tape. For example, in preparing address labels or accounting data.

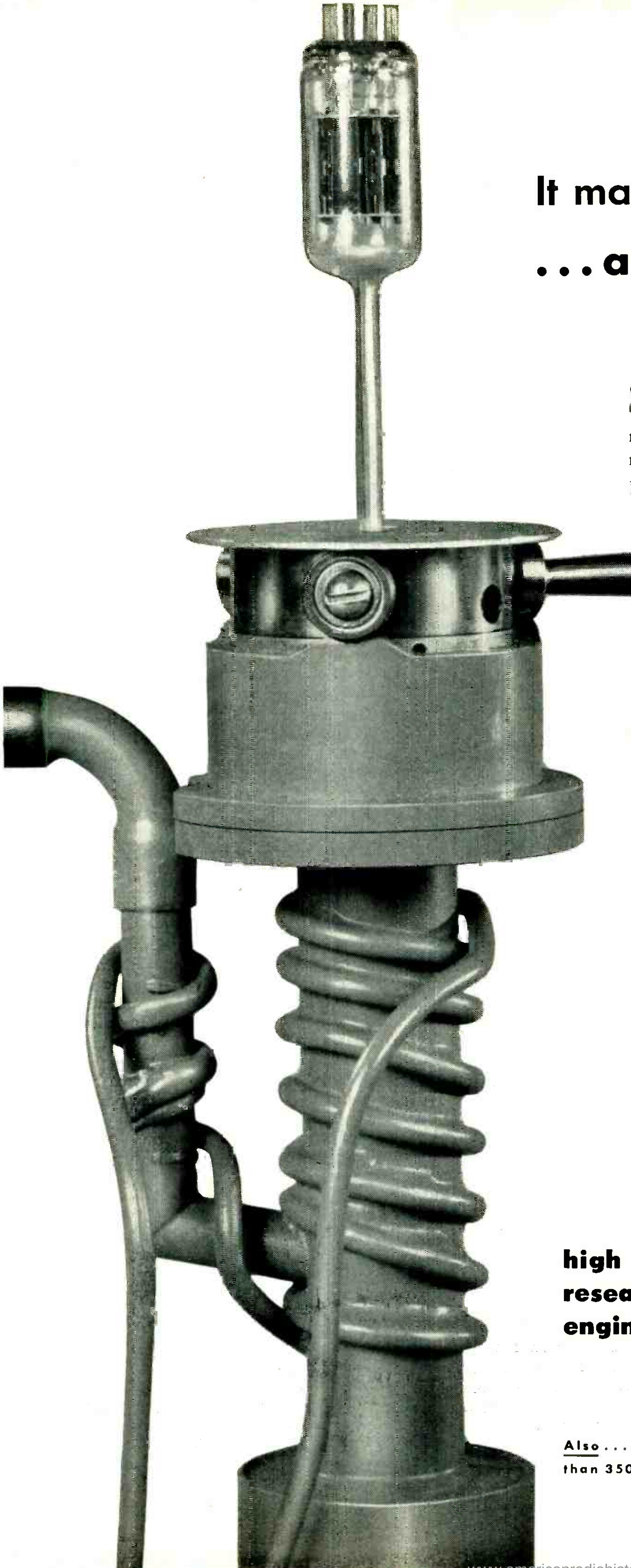
The author wishes to acknowledge the contributions of H. C. Barlow and R. Bowman of the Department of Defense, and the Anderson-Nichols Company of Boston in the development of the recorders described.

Economical Selective Calling Circuits

By Fred M. Berry
Engineering Consultant
Electronics Department
University of Kansas Medical Center
Kansas City, Kansas

The basic method to be described is not claimed to be original by the author and is believed to have been used for ship-to-shore signaling and also in two-way dialing equipment over land lines. The actual circuitry described, however, is believed to have merit on a cost and reliability basis.

The basic method is shown in



It makes tubes more reliable ... at less cost

SHOWN here, almost natural size, is DPi's new MB-10 Booster Diffusion Pump combined with a new port-and-valve unit. It's compact enough for any rotary exhaust machine, and it gives a big boost in performance—two ways.

1. This pump gives you a vacuum higher than 0.1 micron Hg at the tubulation before getter flash and in less time than other diffusion pumps of comparable size. Results: less residual gas to be gettered, less getter required, less getter deposited to affect operating characteristics, less gas that can be released from the getter to shorten tube life.

2. Despite the high ultimate vacuum, the pump tolerates high enough forepressure so that it can be installed in almost any rotary machine without extensive changes in slide valve and sweeps. For larger tubes, the port-and-valve can be adapted to permit rough pumping independently of the diffusion pump.

The unit is designed for easy installation of a leak detector to check bad seals or machine leaks. Valving is done mechanically, requiring no electrical circuits. The pump jet is specially designed for easy cleaning.

For complete engineering data, write to ***Distillation Products Industries,*** Vacuum Equipment Department, 727 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).

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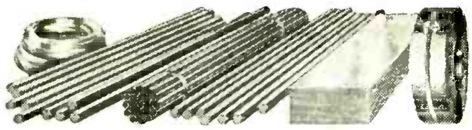

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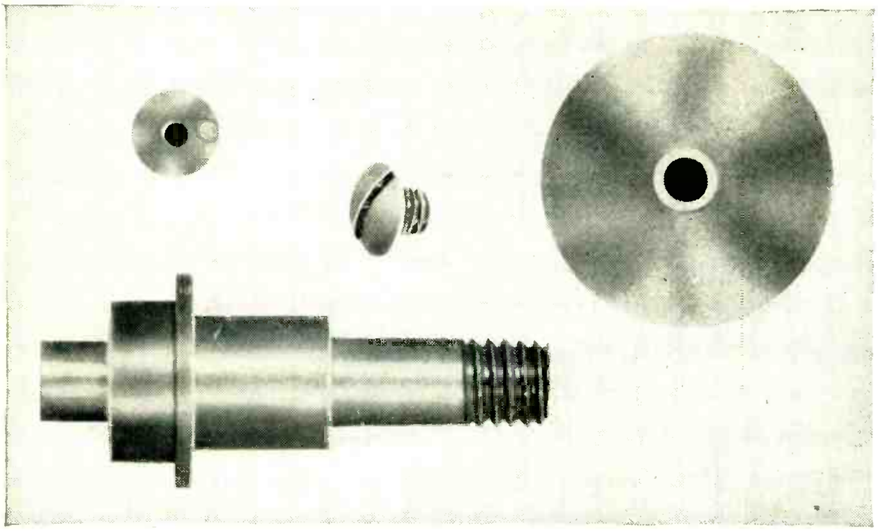


Four examples of short-run jobs turned out in screw machines at costs below "tool-room" methods. Free-turning brass rod was used—Courtesy Parsons Screw Products Co., Naugatuck, Conn. (Mag. 2x)

Cost of Short Run Jobs Cut Through Use of Screw Machines

Manufacturing in the fields of electronics, instruments and servo-mechanisms generally involves small runs. At the same time, various parts are often very small and intricate, calling for extreme accuracy.

Many concerns have produced these parts by "tool-room" methods. However, there has been a decided trend in the past few years for some screw machine shops to specialize on runs of only 100 to 1000 parts. Results have shown that the cost of setting up a screw machine and running these small lots is considerably below that of the tool-room procedure.

0.0265 Hole Drilled

A good example of this is seen in the enlarged illustration. This part is only 0.090 in. long and the largest diameter is .140. The drilled hole is 0.0265 with a plus .0000, minus 0.0005, tolerance. When produced by a toolmaker, only two or three were completed in a day. Not only is this method costly, but exceedingly slow. In a screw machine this is less than a day's production and even with the cost of cams, tools and setup considered, the end cost of the parts is far below that of the tool room.

Another factor in the production of this part is that there are parallel flats on the .140 diameter with a 3/32 dimension. Rather than milling these flats on such a small piece, it proved worthwhile from the viewpoint of both cost and accuracy to have the wire drawn to shape by the brass mill. Although the print calls for a plus-minus 0.005 tolerance on these flats, greater accuracy was found in the drawn rod.

Stud Turned on Piece

The part on the left of the large illustration, made of free machining brass rod, has a stud only 3/64 in diameter close to the edge of the 7/32 main diameter. It would have proved a difficult problem to drill a small hole so close to the edge and then assemble a stud either by staking, or some other method of joining. This was also a small-run job.

After the part was turned, drilled for the center hole and cut off, it was hand fed into chuck with an off-center hole, and then the stud was turned. Since the stud was ⅛ long and the 7/32 diameter finished to a thickness of only 3/64, it was necessary to use both a rough and finishing tool.

Assembly Problem Eliminated

As a result of using screw machines not only was the price cut on the part but also on the assembly, and greater strength and accuracy was obtained in the stud.

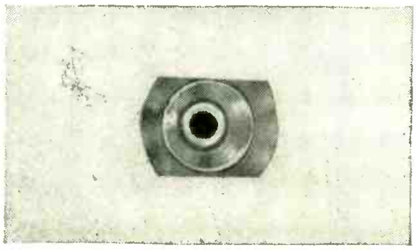
The largest part in the illustration has five outside diameters, a trepanning of the second largest diameter and an external thread. There are two inside diameters, including an internal thread on the smaller. Extreme accuracy was required on the large hole diameter as well as the depth. This was completed in a primary and one secondary operation.

The disc in the center of the illustration with the internally threaded hub has an 11/32 diameter with a thickness of 0.010. This part was completed in the primary operation and involved less than 1000 pieces. Although the leaded free-cutting brass rod had considerable temper, it was still necessary to use extreme care in the tooling to prevent bending of this thin section.

Less Than Two Threads Cut

The screw is interesting from the standpoint that although the work was done in a screw machine, the thread is less than two threads and had to come tight to the head. A self-opening diehead was used. The screw was slotted on the same machine.

For information on the choice of brass, bronze and copper for your product, consult with our laboratory as to composition, temper and form. Write to our nearest district office or to Bridgeport directly. (7863)



Brass part only 0.090 in. long with two flats on the largest diameter (0.040). Milling was eliminated by purchasing rod with flats drawn—Courtesy Parsons Screw Products Co., Naugatuck, Connecticut. (Mag. 5x)

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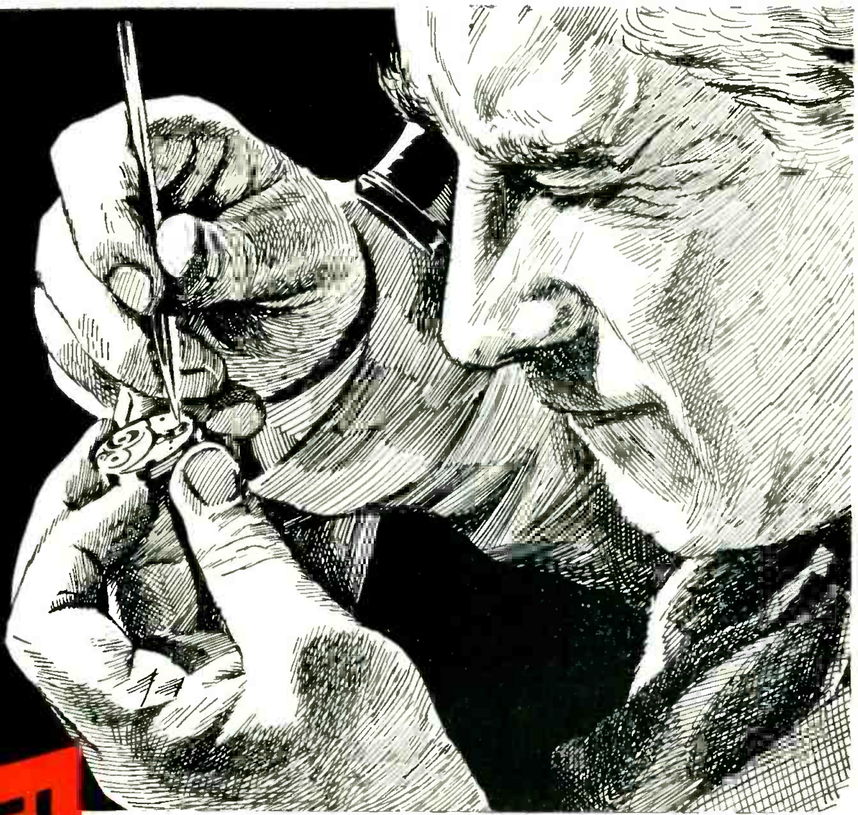

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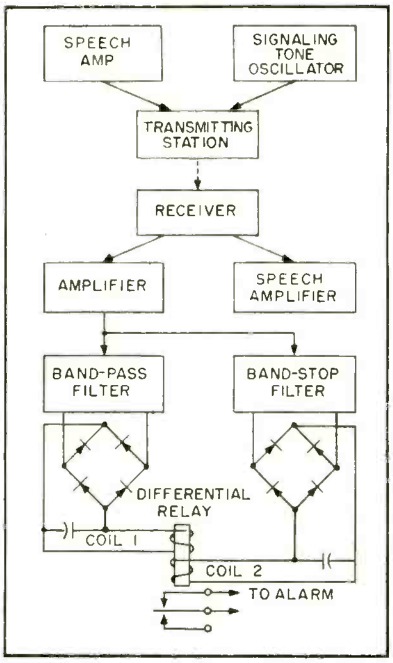

FIG. 1—Block diagram of differential-relay selective signaling system

Fig. 1. A pure tone is transmitted from the calling station. At the receiving station the tone enters the band-pass filter, is rectified and applied across coil 1 of the differential relay. The tone also is applied to the band-stop filter. If the tone is of correct frequency no current will pass and coil 2 receives no current. The relay will actuate toward contact 1 and operate the signaling device.

If voice frequencies or noise are present, the band-stop filter will pass all frequencies except the narrow band centering over the signaling tone. Since the pass filter will pass only the frequencies centering over the tone frequency, the result is that coil 2 will receive the larger current and the relay will be pulled toward contact 2 and signaling will be prevented. Thus, differential action is secured and the operation of the signaling device depends largely on the signal to "noise and speech" ratio.

If proper time delay is provided, false operation can be almost entirely prevented. The only chance for false operation is that in some voices almost pure tones lasting up to a second or more will occur. If a time delay is provided up to about two seconds this probability of false operation can be reduced greatly. One system having a time delay of from 1 to 1½ seconds has

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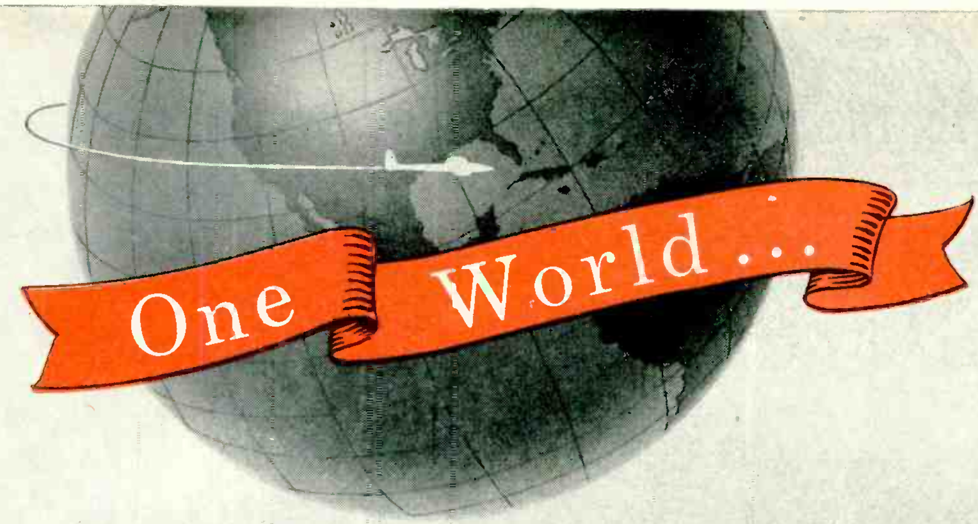

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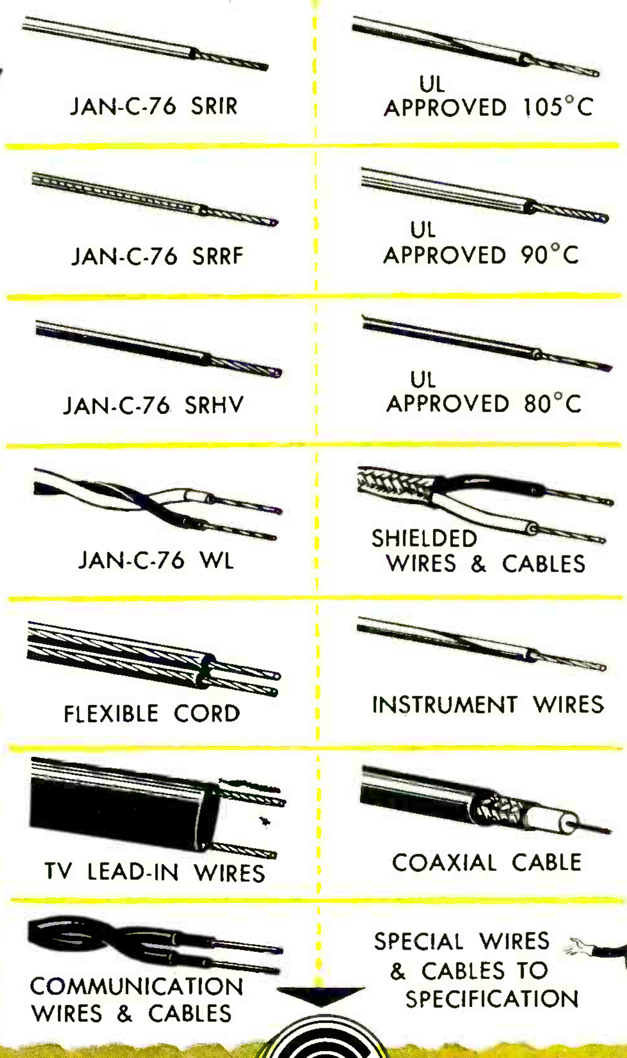

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Several signaling functions can be provided by using several tones. While the operation of the basic circuit of Fig. 1 is quite satisfactory, the cost of the two filters and the differential relay made it desirable to investigate other possible circuits.

Figure 2 is another possible circuit arrangement. Tuned circuit *LC* is supplied by speech and signal frequencies through Z_1. At the signaling frequency the tuned circuit *LC* is in antiresonance and has an effective parallel impedance of several times that of Z_1. At frequencies off resonance the impedance of *LC* drops to be equal to or less than that of Z_1. Diodes D_1 and D_2 rectify the voltage drops occurring across Z_1 and *LC* respectively. These two resultant d-c voltages are in series as indicated by the plus and minus signs of Fig. 2 and thus the difference of the two voltage drops are applied to relay tube V_1. If noise or speech is the larger component of the incoming signal, a negative voltage is the result at grid of V_1, while if a signaling tone predominates, the voltage will be positive and relay will be actuated. Capacitors C_2 and C_3 and resistors R_1 and R_2 also provide desirable time constants from the two diodes so that sustained speech tones will not actuate the relay.

The circuit of Fig. 3 retains the more selective advantage of Fig. 1 at only a slight increase in components. Referring to Fig. 3, the speech channel with tone frequencies are applied to primary of T_1. Output winding of T_1 is center-tapped and is part of a hybrid or

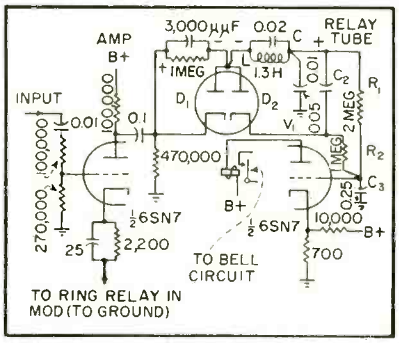
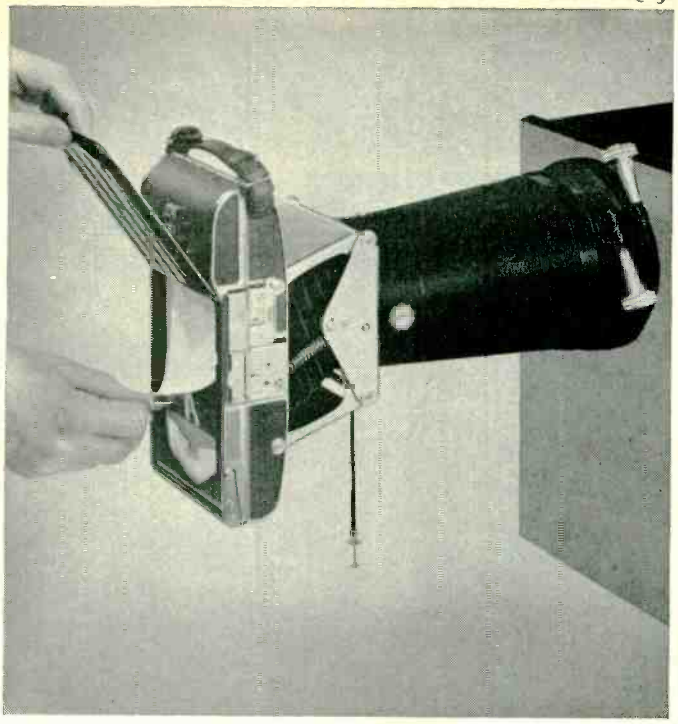
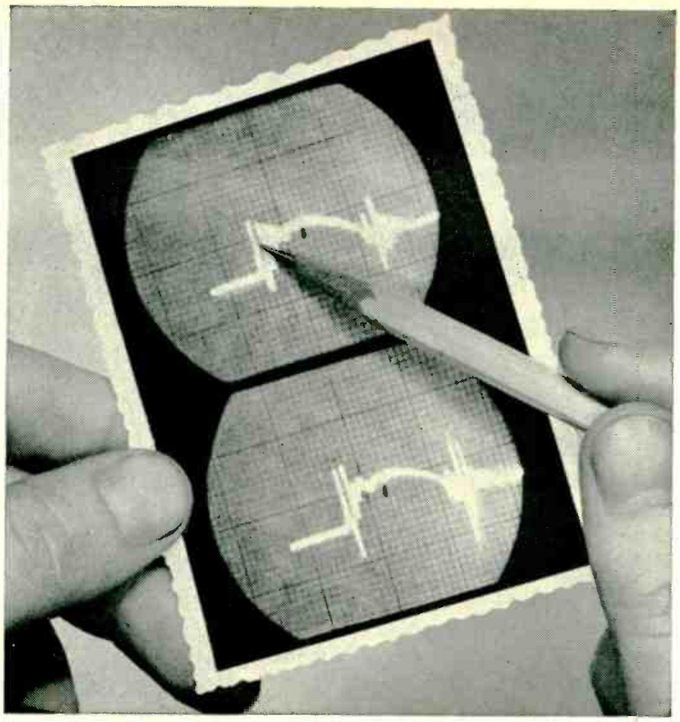


FIG. 2—Simplified differential system has advantages for single-frequency operation





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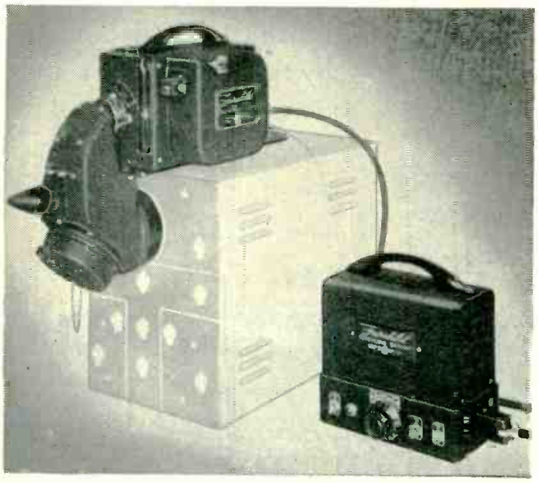

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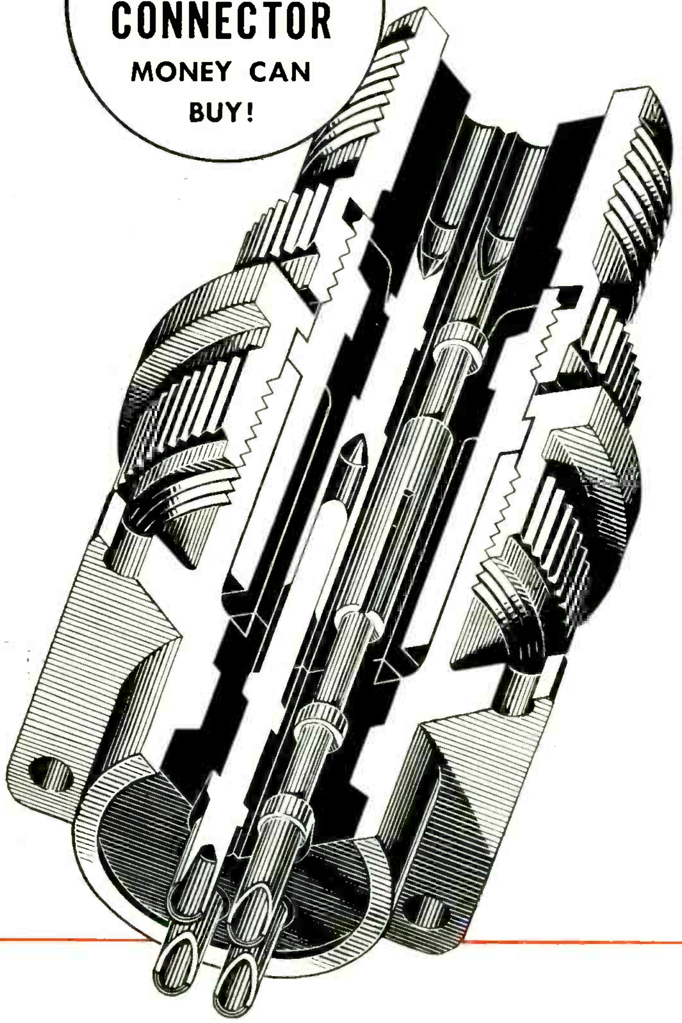

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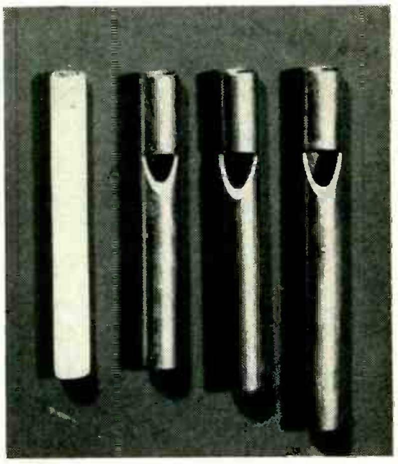
Within the pass band of the filter the hybrid network is balanced and no voltage appears between points A and B. Filter Z_1 freely passes these frequencies and diode D_2 rectifies and a positive voltage is delivered to grid of V_1. At frequencies out of pass band of Z_1 the input impedance of Z_1 is reactive and of lower impedance. Current passing



Specially-designed whistles are operated near microphone at calling station and actuate signaling equipment at selected receiving location

through Z_1 is reduced and since the hybrid network is unbalanced a voltage appears at points A and B. This voltage is rectified by D_1 which supplies a negative voltage in series with the output of D_2 and on to the grid of V_1.

This circuit allows greater tolerance to signaling tone stability. Positive signaling action is secured if the signaling tone lies within the pass band of Z_1, and noise, speech or off-frequency tones will not give false operation regardless of signal level.

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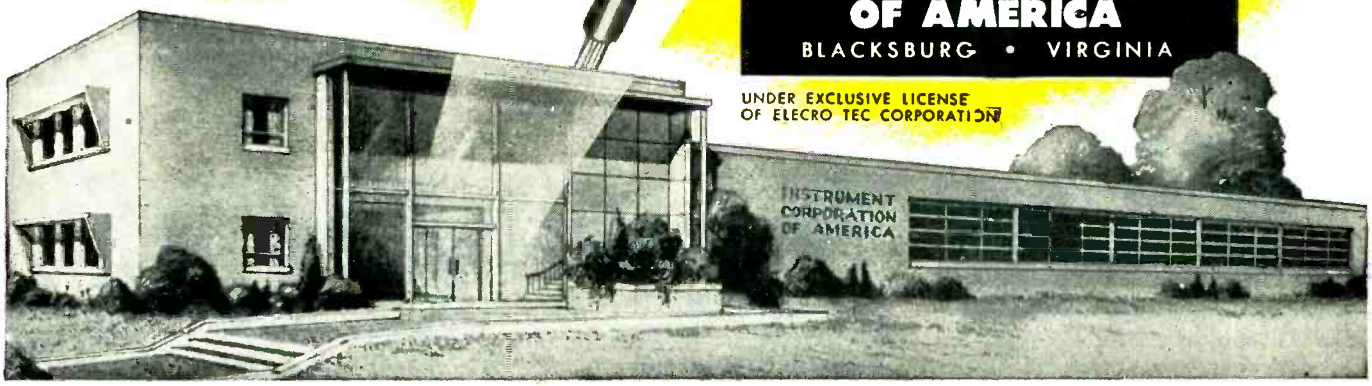

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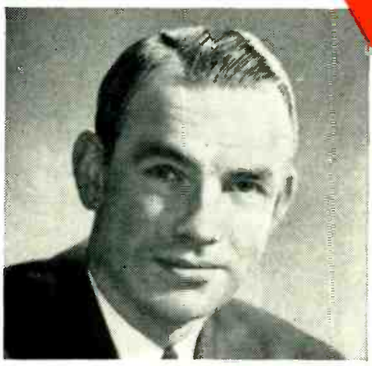

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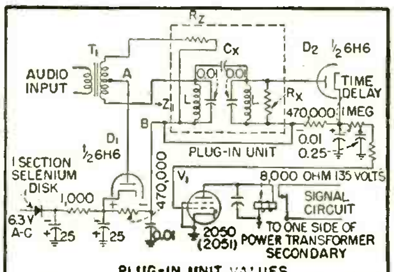

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FIG. 3—Circuit of selective filter arrangement that is actuated by mouth-operated whistles

eral Electric f-m equipment. Four of the fixed stations are located at power-generating plants operated by personnel having other duties. The ambient noise is very high and speakers were not satisfactory.

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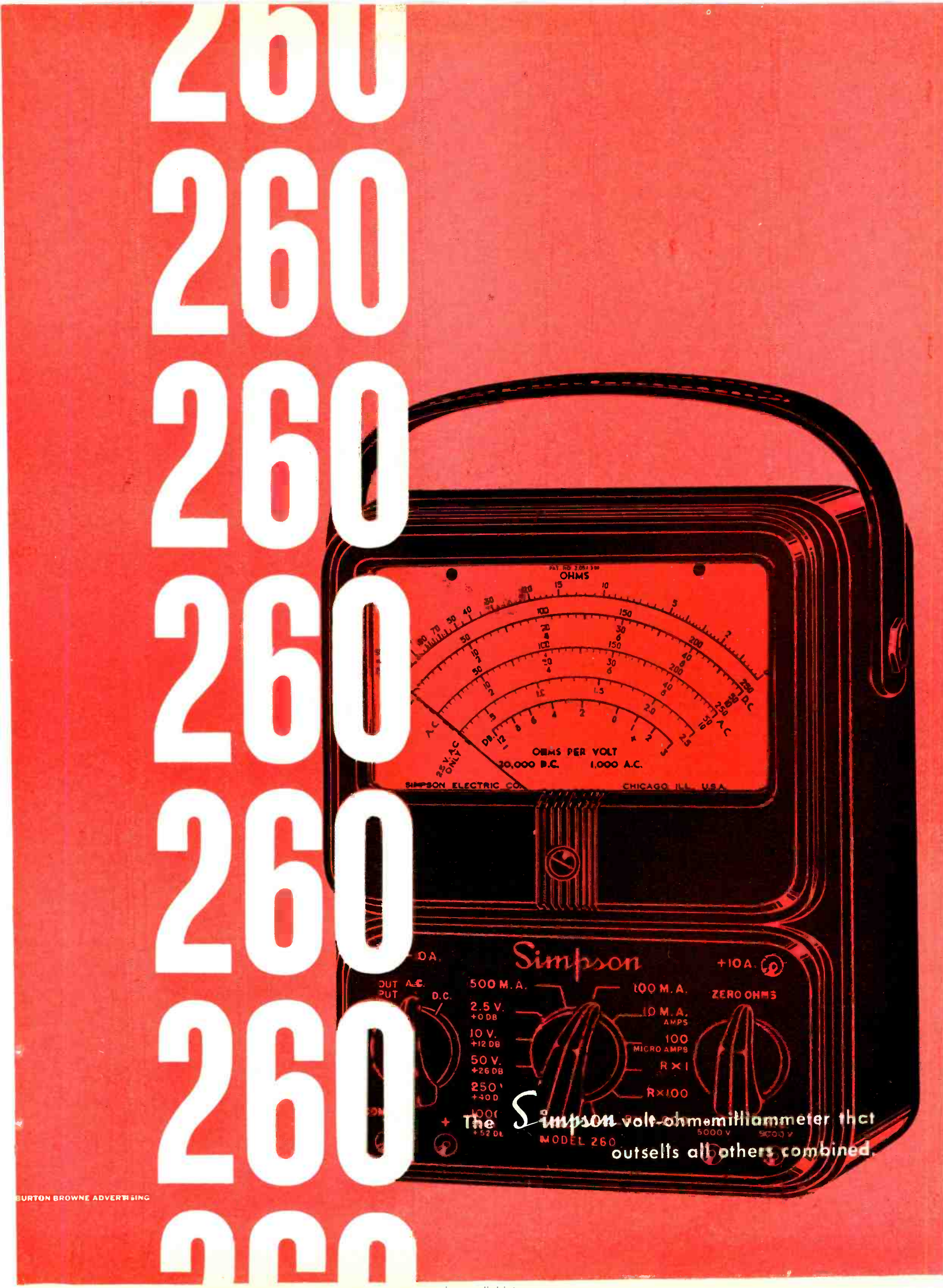
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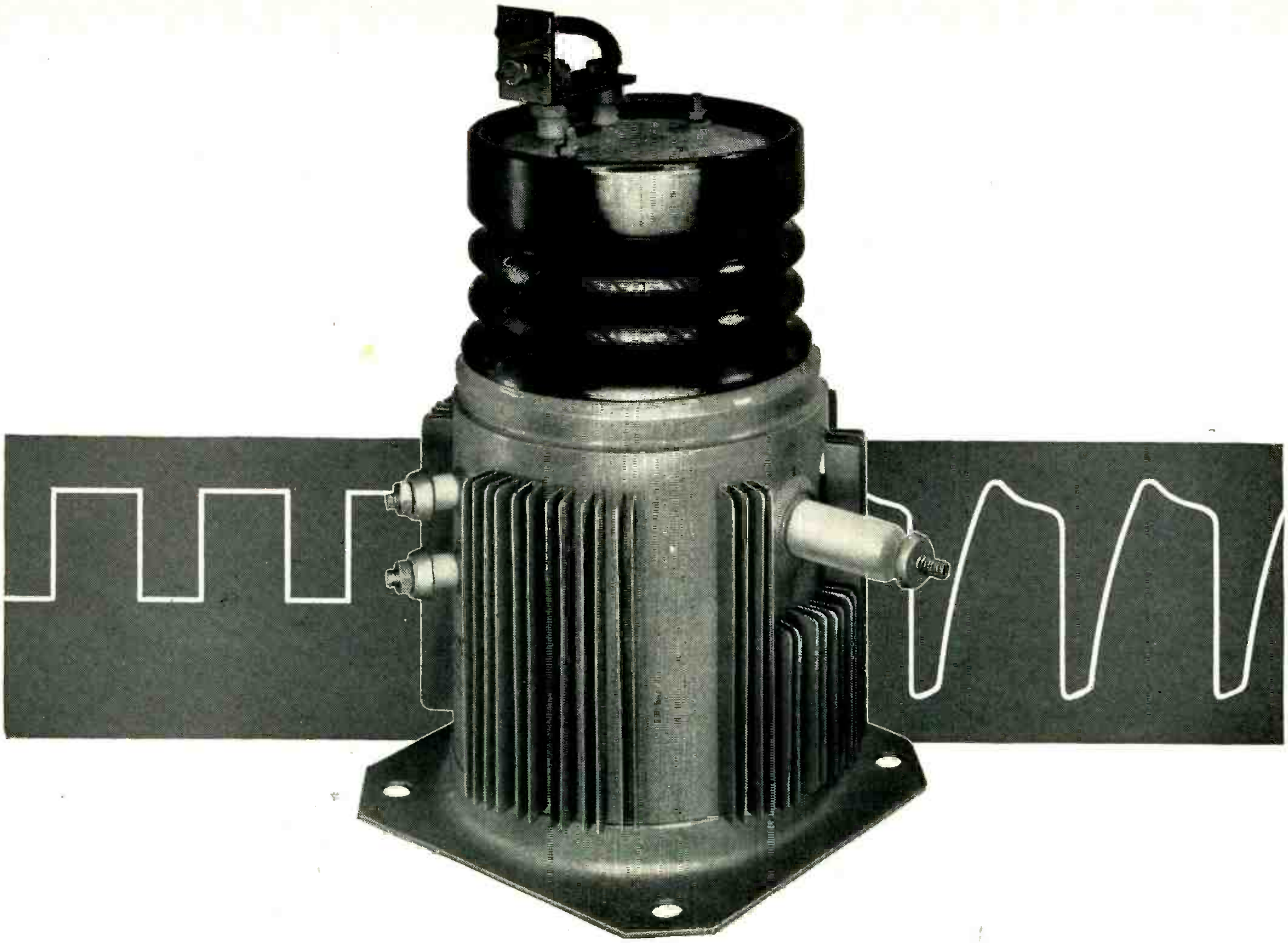

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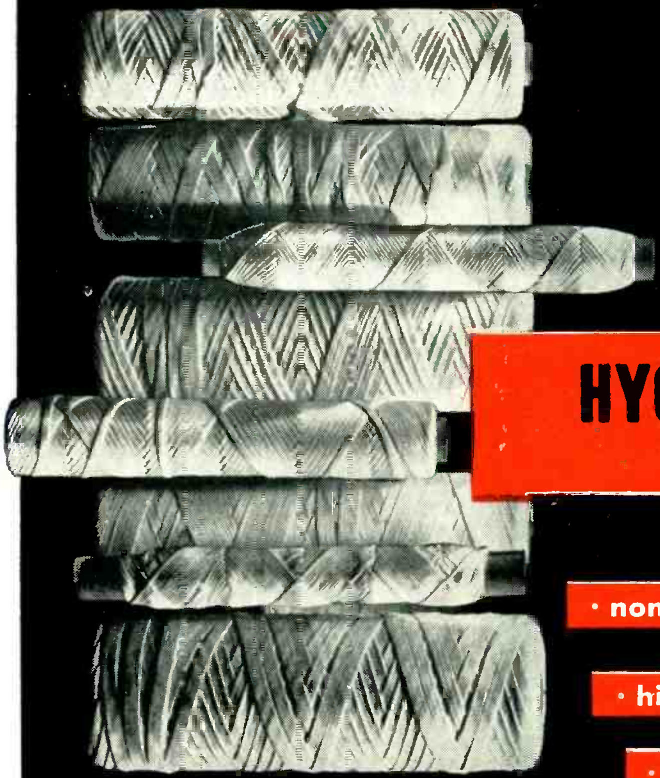

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. . . are single braided, heavy wall sleevings. Their characteristics are similar to the DBLE-WALL types except that they are coarser in appearance and lower in price. They provide a mechanically strong sleeving for applications where the Underwriters' Laboratories specify a 1/32" wall sleeving.

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This design has performed very well and has been in service about two years. Operation is reliable down to signal-to-noise ratios of 10 db and no report has been made of false operation.

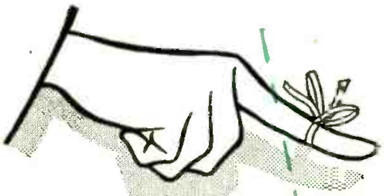
The author wishes to acknowledge the contributions of Earl Dreyer and James Allen of Missouri Public Service Company for the suggestion of the use of mouth-operated whistles and assistance during the many field tests. Dick and Ray Gredell of Radio Industries Inc. are responsible for the mechanical design of the whistle.

Voltage Regulator for Telescribers

BY EDWARD F. CAHOON
Chief Engineer
Telautograph Corp.
New York, N. Y.

THE TELESCRIBER is an instrument which electrically transmits handwritten messages or graphic characters over wire. It consists of two basic units; a transmitter and a receiver. The telescriber transceiver, Fig. 1, is a unit containing both a transmitter and receiver. The telescriber receiver alone, Fig. 2, is for reception of messages only,

FIG. 1—Transceiver unit containing both a transmitter and receiver



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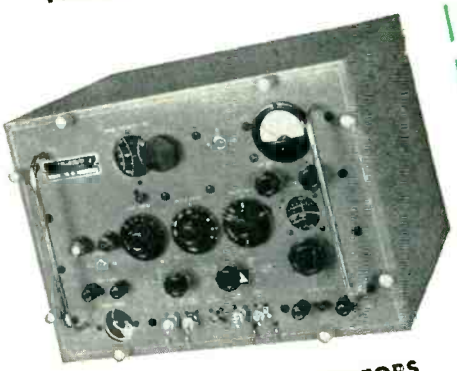

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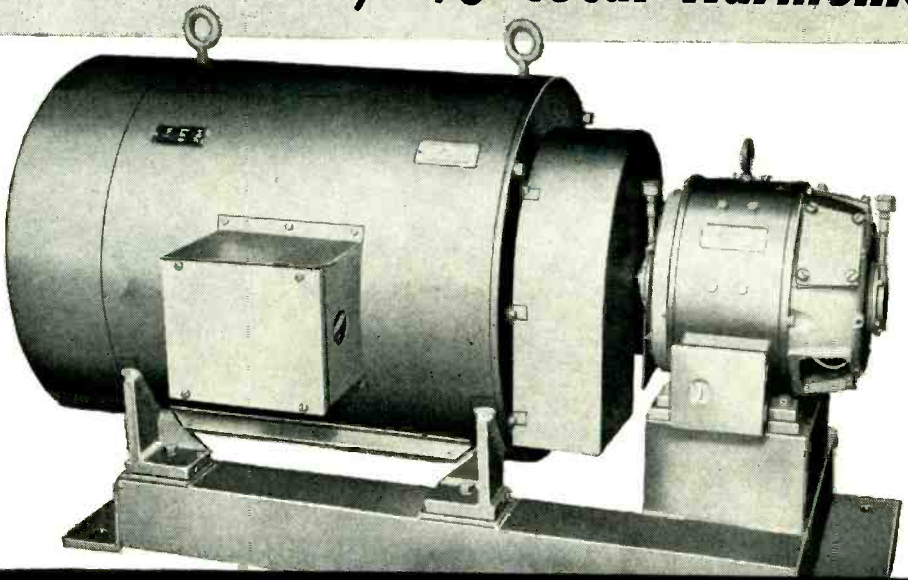

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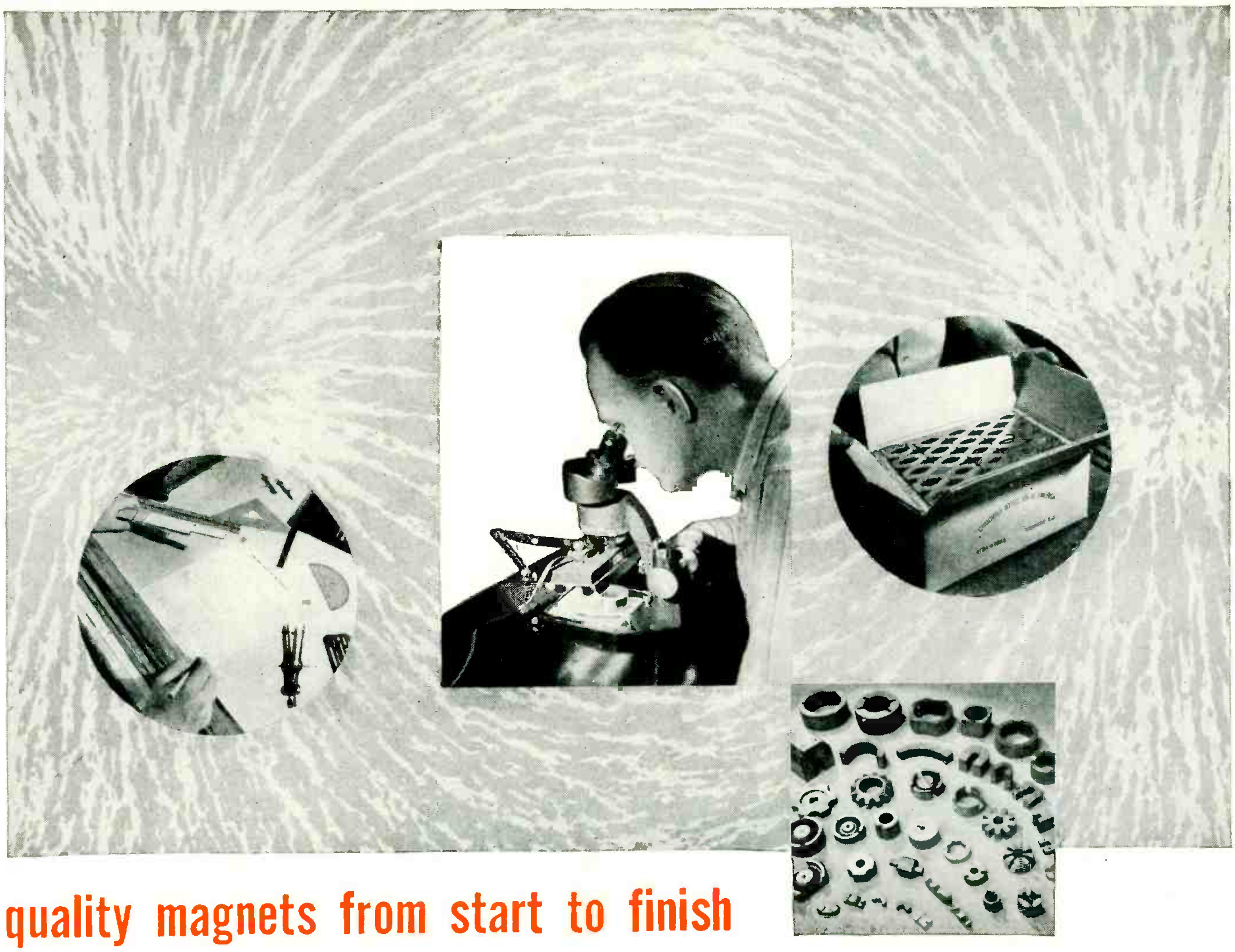

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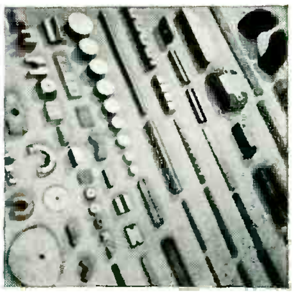

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N. Y. C. MARCH 3-6, 1952

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FIG. 2—Receiver unit

no transmission is possible.

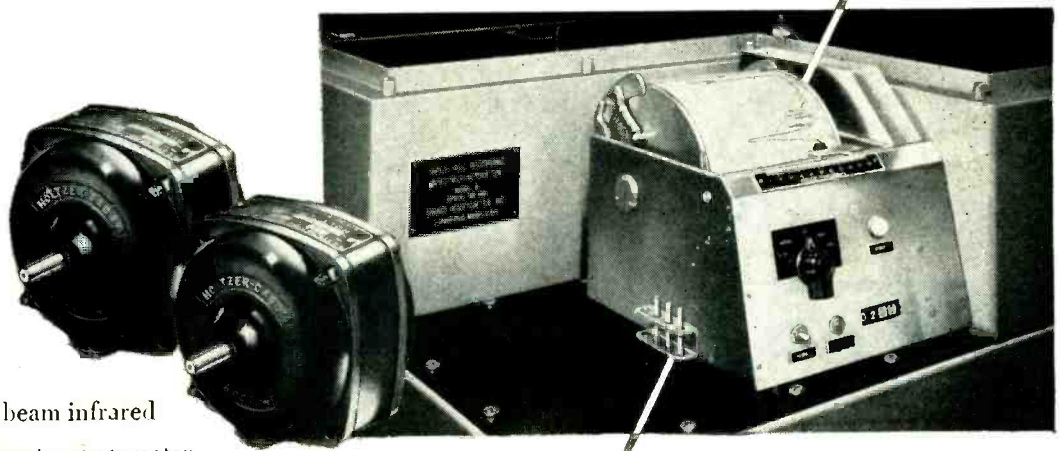
The transmitter converts the position of the manually operated writing stylus into two electrical quantities. This is accomplished by attaching a linkage system to the stylus. In amplitude-controlled models, the change of stylus position causes the linkage system to rotate potentiometer contacting members. There is a fixed voltage supplied to the potentiometers and for each position of the stylus two definite potentials are developed at the transmitter.

The receiver converts electrical information received from the transmitter into a position of the writing pen. This is accomplished by two pen-motors which are attached to a linkage system which is identical to that in the transmitter. The pen-motor, Fig. 3, is similar to a d-c voltmeter movement with a moving coil in a fixed magnetic field. The field is supplied by a permanent magnet. The angular displacement of this unit is essentially linear with respect to current through its moving coil.

In the latest Telescriber, power for moving the pen at the receiver is supplied from the transmitter. The writing circuits of this instrument are controlled by direct current. However, alternating current is its prime source of power. It is necessary to rectify, therefore, in order to obtain the direct current necessary for operation of these circuits. A dry-disc rectifier located in the terminating box is employed for this rectification.

This communication instrument, as has been described is an amplitude-controlled device. This means that the magnitude of the a-c supply (as well as the stylus position) determines the pen position at the

Holtzer-Cabot motors help the Spectrophotometer record "signatures" on a beam of light!



The double beam infrared recording Spectrophotometer developed and manufactured by Baird Associates of Cambridge, Mass., is an ingenious instrument which has proven itself invaluable in quickly and surely identifying and defining complex chemical compositions.

The Spectrophotometer analyzes organic samples by passing an infrared beam through them. The resulting vibration and energy absorption of the sample's molecules form a pattern on the Spectrophotometer's recording drum chart. Comparison of the sample's recorded characteristics with those of known elements reveals the sample's identity and composition.

Rigid specifications were laid down for the motors to operate the variable speed drive used in the Spectrophotometer. Some of the requirements:

- two winding, two speed
- synchronous operation at one speed
- smooth transition between speeds
- all speeds must be reversible
- low vibration and magnetic leakage fields
- small size—low power
- completed design must be applicable to *all* previous models

Holtzer-Cabot engineers, working closely with Baird Associates, developed two different adaptations of the H-C R-25, which met specifications perfectly. These motors are now standard components of the Spectrophotometer and are giving satisfactory, dependable service.

This is but another example of Holtzer-Cabot's ability to meet the most exacting specifications in small-motor applications. Holtzer-Cabot motors range from 1/2000 up through 1½ H.P., from 24,000 RPM to 1 revolution per day!

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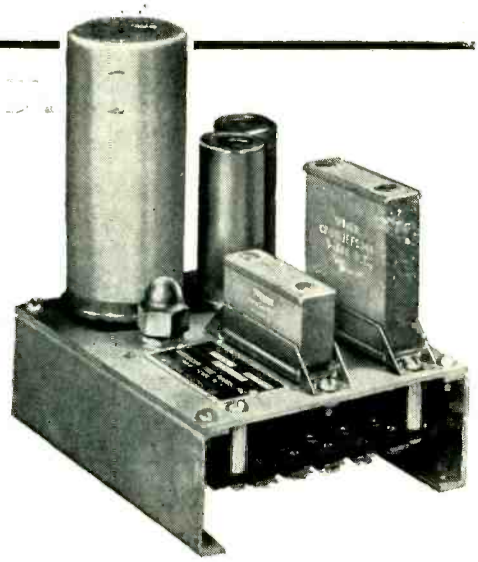

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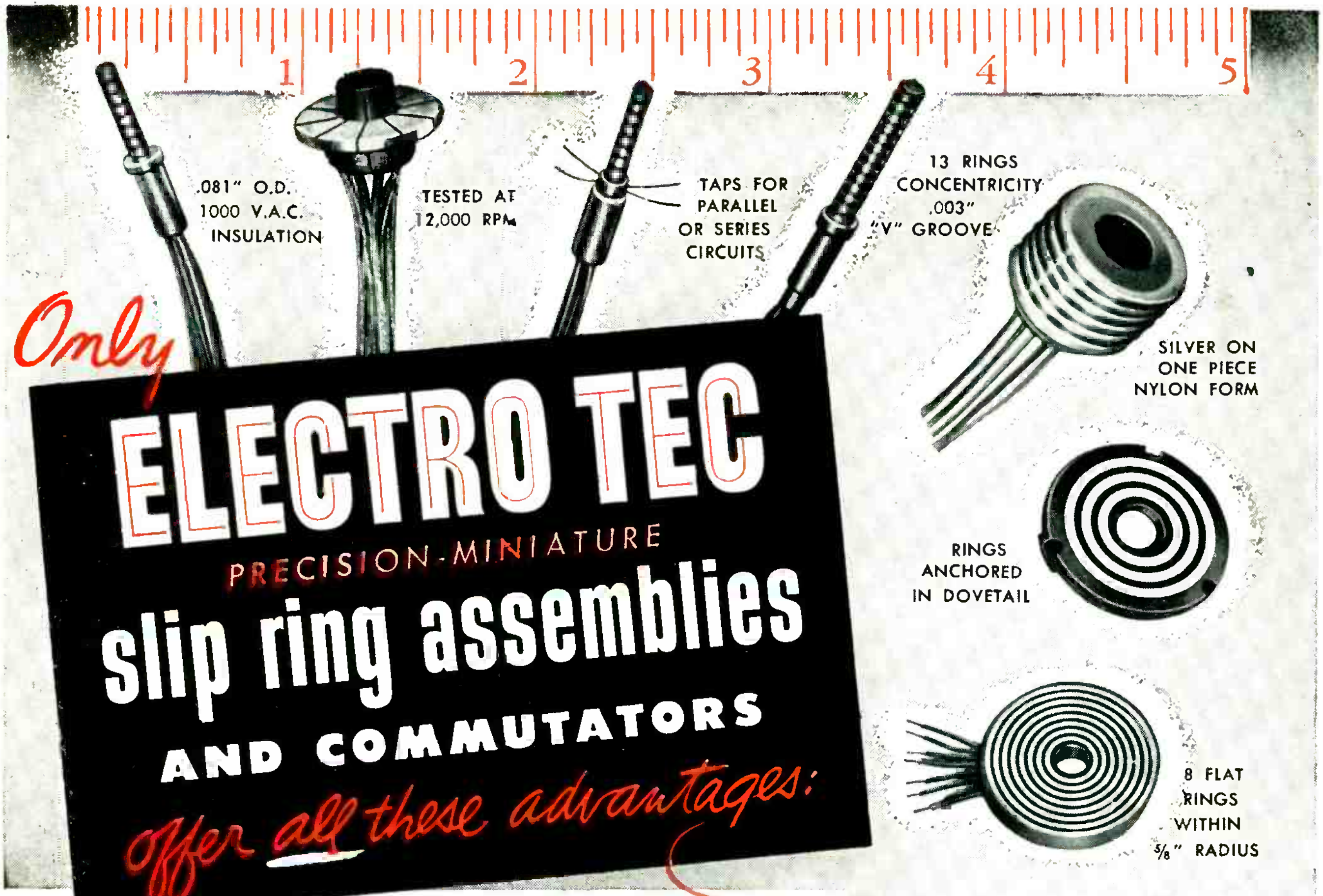

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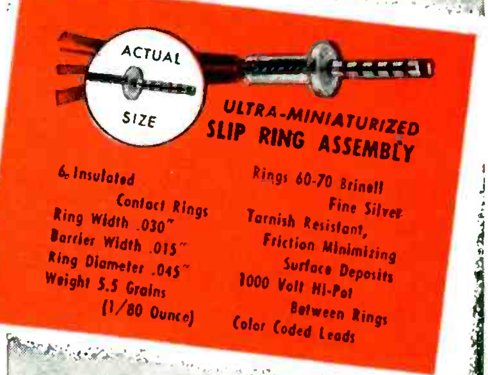

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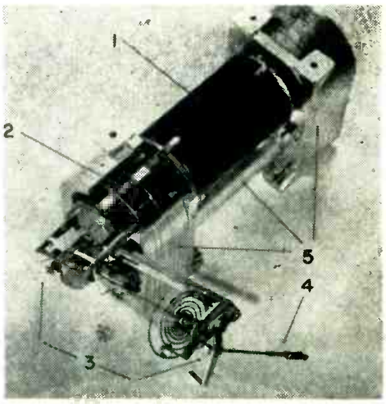


FIG. 3—The pen motor. Permanent magnet (1), moving coil (2), rotary-motion translator (3), linkage lever (4) and magnetic field structure (5)

receiver. As the instrument has a high speed of response, any sudden changes in the power supply will result in distortion of the character being recorded. A voltage kick might make a 9 of an 0 or a 6 of a 1, etc., therefore voltage control is a vital consideration in achieving high-fidelity message reproduction. In order to assure this, an electronic voltage regulator is used.

The regulated voltage supply is used only for writing circuits. A rectified, but nonregulated, source of power is employed for some of the auxiliary circuits. This rectifier is located in the terminal box also.

The circuit diagram of this regulator is shown in Fig. 4, also shown is the rectifier and filter. It can be seen that it is a conventional circuit employing 6AS7's for handling the power and a 12AX7 for controlling the 6AS7's. A VR75 is used to obtain the reference voltage. A second VR75 is used in the voltage-divider circuit to the grid of the 12AX7 to increase the sensitivity. A potentiometer is employed to control the output voltage from the regulator.

The regulator has an output volt-

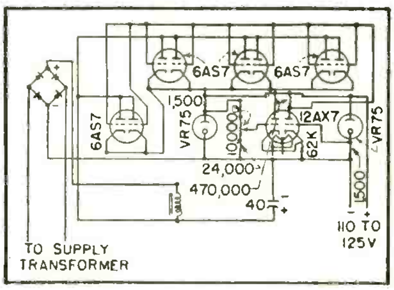
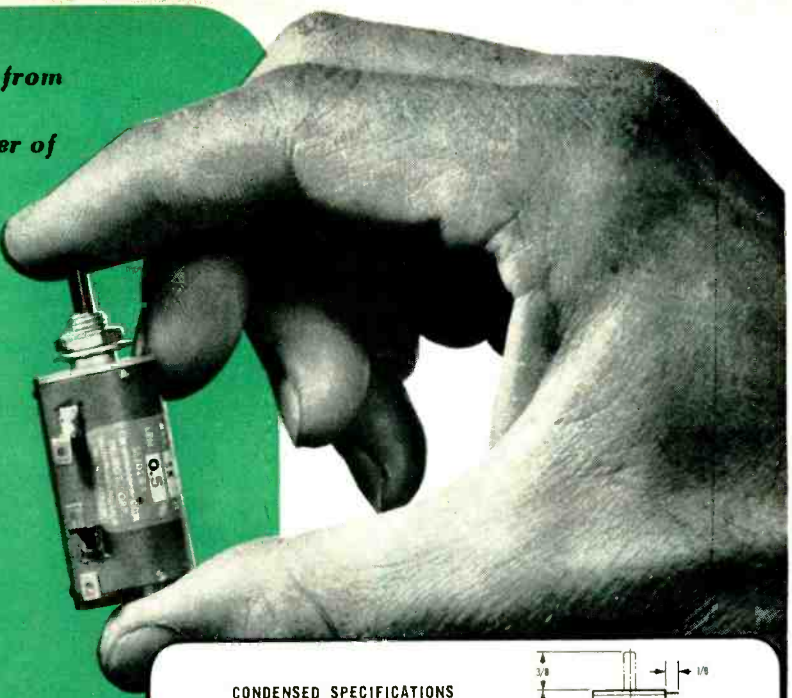


FIG. 4—Schematic of voltage regulator



Another important development from

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TINY in size—
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BIG in performance—
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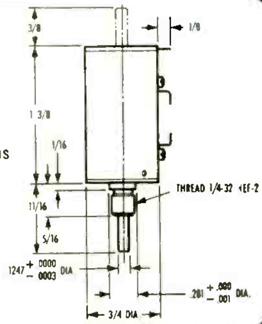
THE MODEL AJ

Helipot

CONDENSED SPECIFICATIONS

Number of turns	10
Power rating	2 watts
Coil length	18″
Mechanical rotation	3600° + 12° − 0°
Electrical rotation	3600° + 12° − 0°
Resistance ranges	100 ohms to 50,000 ohms
Resistance tolerance	± 5.0%
Linearity tolerances:	
All values	± 5% (standard)
5000 ohms and above	± .1%
Below 5000 ohms	± .25%
Starting torque	0.75 oz. in.
Net weight	1.0 oz.



Miniaturization, weight reduction and circuit simplification are key design objectives in all airborne and many other electronics applications for precision potentiometers. Helipot's new Model AJ meets these needs with a compact potentiometer having over 12 times the resolution of conventional potentiometers of the same diameter . . .

- **SIZE AND WEIGHT: The AJ is only ¾″ in diameter (small as a penny)—1⅜″ long—weighs 1.0 oz. It requires only a minimum of valuable panel space!**
- **PRECISION, WITH CIRCUIT SIMPLICITY: On many applications the AJ replaces two conventional potentiometers, providing *both* wide range and fine adjustment in one unit. Its 18″ slide wire gives a resolution of 1/3000 in a 100 ohm unit—1/6550 in a 50,000 ohm unit!**
- **RELIABILITY: The AJ is rugged and simple, is built to close tolerances with careful quality control. Its performance and reliability reflect the usual high standards of Helipot quality!**

MANY IMPORTANT CONSTRUCTION FEATURES: If you have a potentiometer application requiring light weight, unusual compactness, high accuracy and resolution, be sure to get the complete information on AJ advantages . . .

Here is a "pot" with bearings at *each* end of the shaft to assure precise alignment and linearity at all times. In addition, each bearing is *dust-sealed* for long life and is mounted in a *one-piece* lid and bearing design for exact concentricity.

Either single or double shaft extensions can be provided to meet individual needs—also, special shaft lengths, flats, screwdriver slots, etc.

Tap connections can be provided at virtually *any* desired point on the resistance element by means of a unique Helipot welding technique which connects the terminal to only ONE turn of the resistance winding. This important Helipot development eliminates "shorted section" problems!

BUILT TO HELIPOT STANDARDS

Helipot—world's largest manufacturer of precision potentiometers—has built an enviable reputation for highest standards in all its products, and the Model AJ is no exception.

The resistance elements themselves are made of precision-drawn alloys, accurately wound by special machines on a copper core that assures rapid dissipation of heat.

Each coil is individually tested to rigid standards, then is permanently anchored in grooves that are precision-machined into the case. Slider contacts are of long-lived Paliney alloy for low contact resistance and low thermal e.m.f. . . . and precious-metal contact rings are used to minimize resistance and electrical noise. All terminals are silver plated and insulated from ground to pass 1,000 volt breakdown test.

LONG LIFE: Although Unusually compact, the AJ is built throughout for rugged service. Potentiometer life varies with each application, of course, depending upon speed of rotation, temperature, atmospheric dust, etc. But laboratory tests show that, under proper conditions, the AJ has a life expectancy in excess of one *million* cycles!

Helipot representatives in all major cities will gladly supply complete details on the AJ—or write direct!

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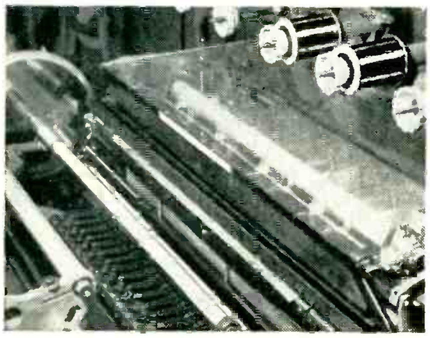
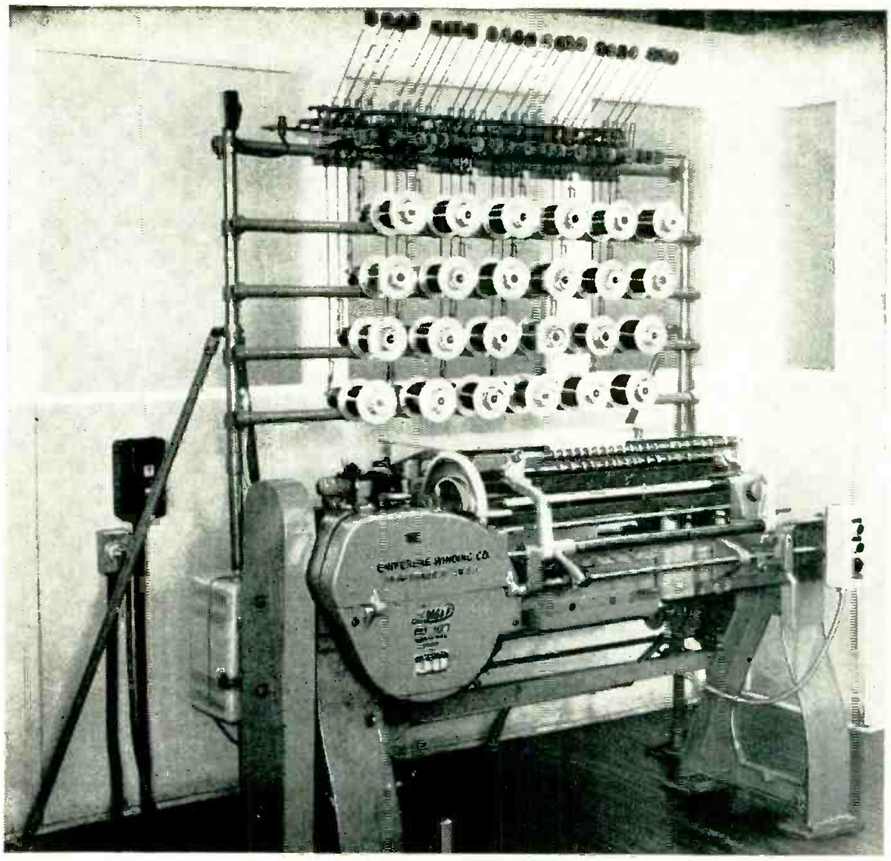
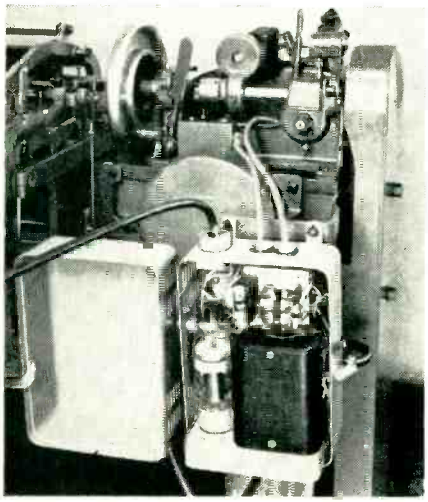


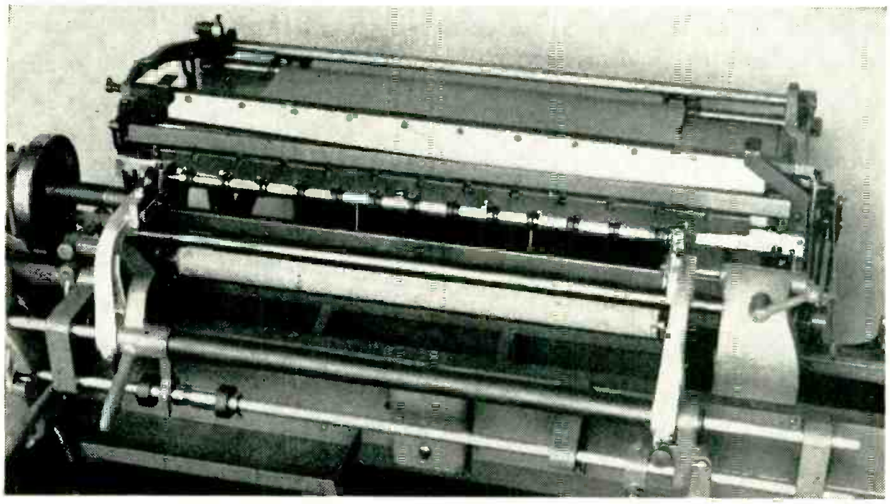
MAXIMUM COIL DENSITY An entirely new type of delivery shelf is used to insure coils of extreme accuracy and high density. It imparts a uniform backward pull to the paper as it is fed into the coil.



25 INSERTS A MINUTE Single or laminated insulating sheets, either paper or acetate, are fed into the Leesona No. 107 Coil Winder at rates as high as 25 per minute. Thus, on a coil containing 100 wire turns per layer, the machine can be run at speeds as high as 2500 rpm.



SLOW, CUSHIONED AUTOMATIC START Electronic speed-control automatically and smoothly accelerates the winding arbor to required speed and maintains it. No "jockeying" needed by operator. Wire breakage is minimized, tension is uniform.



EASY MANUAL OPERATIONS Photo shows coil arbor in position for quick transfer. Wire turn counter can be reset quickly. No cam transfers are required when changing wire layer length, wire spools are easily changed.

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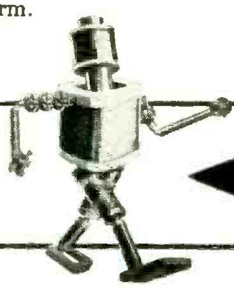

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Stemming from its sponsorship of the development of the klystron in 1939, Sperry has had many years' experience in the manufacture of these tubes. Besides the 2K-series for laboratory use, other Sperry Klystrons include transmitting tubes for microwave relays, radars (both pulsed and cw), radar beacons, aeronautical navigation (DME and ILS), and radio communication systems. Other Sperry Klystrons are used as local oscillators in radar and microwave communication receivers. Klystron multiplier tubes are used in frequency standards and for other applications where crystal control at microwave frequencies is desired.

Sperry's pioneering in microwave measuring techniques has resulted in a complete line of Microline* instruments which includes every type of device essential to precision measurement, in the entire microwave field.

Our Special Electronics Department will be happy to supply you with complete details on Klystrons and Microline equipment.

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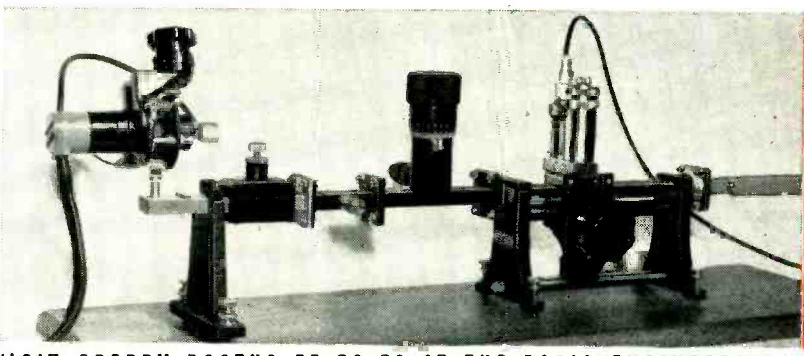

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	TUNING RANGE	POWER OUTPUT
2K 41 (WITH TUNER)	2660 -3310 mc	250 mw
2K 42	3300 -4200 mc	250 mw
2K 43	4200 -5700 mc	250 mw
2K 44	5700 -7500 mc	250 mw
2K 39	7500 -10,300 mc	250 mw

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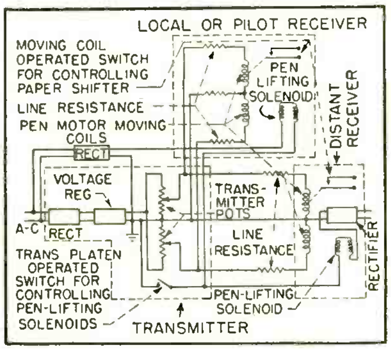


FIG. 5—Fundamental circuits of telescriber

age of 120 volts and is made in two capacities. One model supplies power for writing between a transceiver and a receiver. The other model is used when writing between a transceiver and three receivers simultaneously or, in a different transmitter arrangement, between a transceiver and seven receivers. The former employs two 6AS7's and the latter four 6AS7's. The control circuit is the same for both regulators. The output regulation is within one volt between half-load and full-load. Transient response is sufficiently fast so that a change of ten volts in the primary supply does not affect the receiver pen position.

Figure 5 shows the fundamental circuit of the telescriber.

Accurate Phase Difference by Lissajous Figures

By John L. Glaser

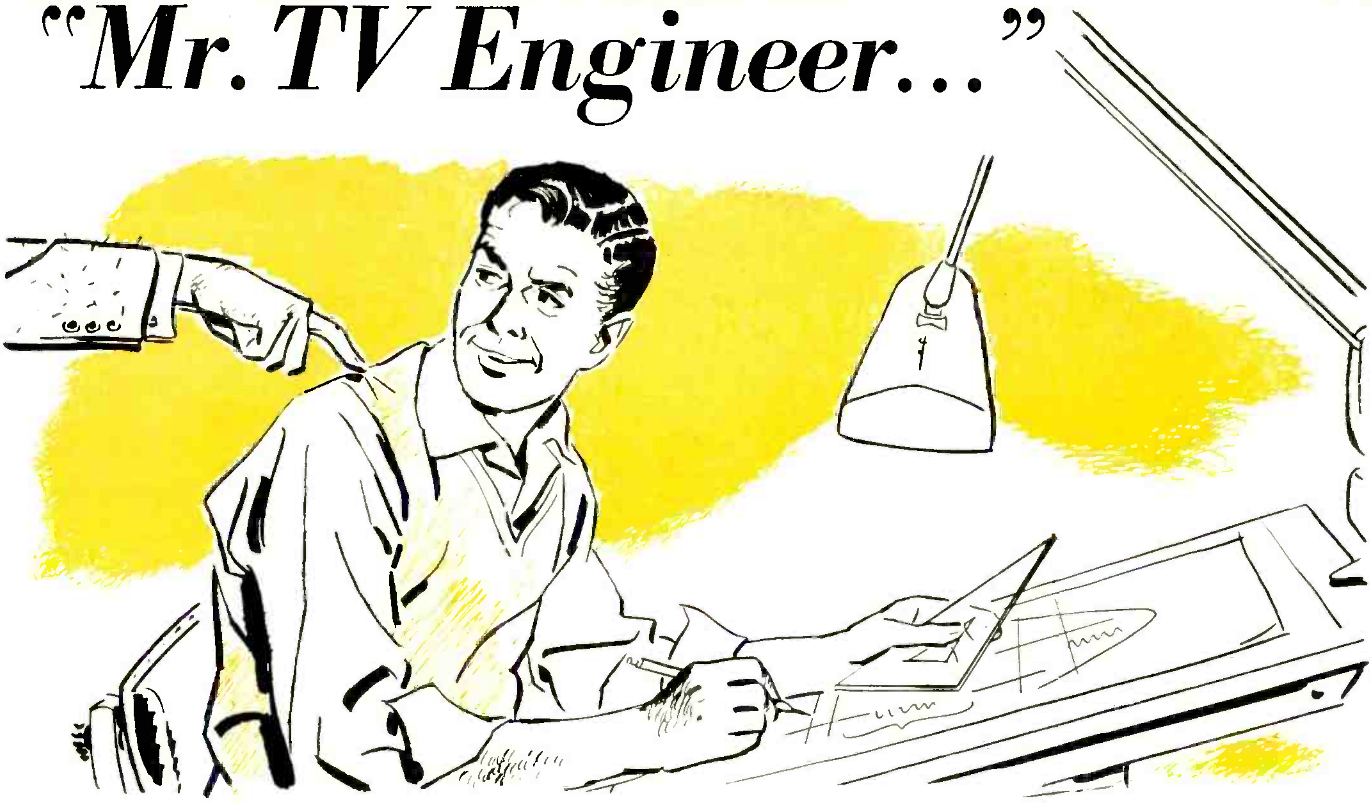
*Department of Electrical Engineering
Washington University
St. Louis, Mo.*

Practically everyone who has used a cathode-ray oscilloscope is familiar with the use of Lissajous figures to indicate the relative phase of two sinusoidal voltages of the same frequency. The usual method for interpretation of the elliptical pattern is illustrated in Fig. 1. The phase difference θ between the horizontal and vertical input signals is given by the relation

$$\sin \theta = \pm \frac{A}{B} \qquad (1)$$

The accuracy with which θ can be measured depends, of course, on the accuracy with which the ratio A/B can be measured. It is doubt-

"Mr. TV Engineer..."



For superior arc resistance, dimensional stability—plus high heat resistance, INSIST on PLASKON ALKYD

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Yes, *made-to-order* . . . for Plaskon Alkyd has exceptional dimensional stability with no after-shrinkage. This means that the very close tolerances so necessary to precision television assemblies can be met and held. Because of high heat resistance (up to 400°F.), Plaskon Alkyd does not break down, even under short-time contact with molten solder when connections are made.

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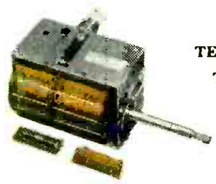

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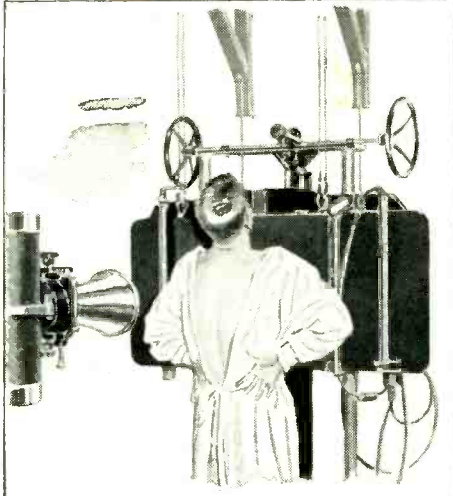

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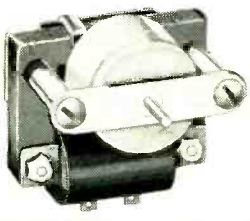

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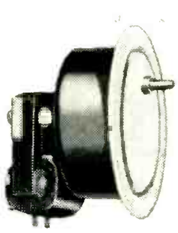

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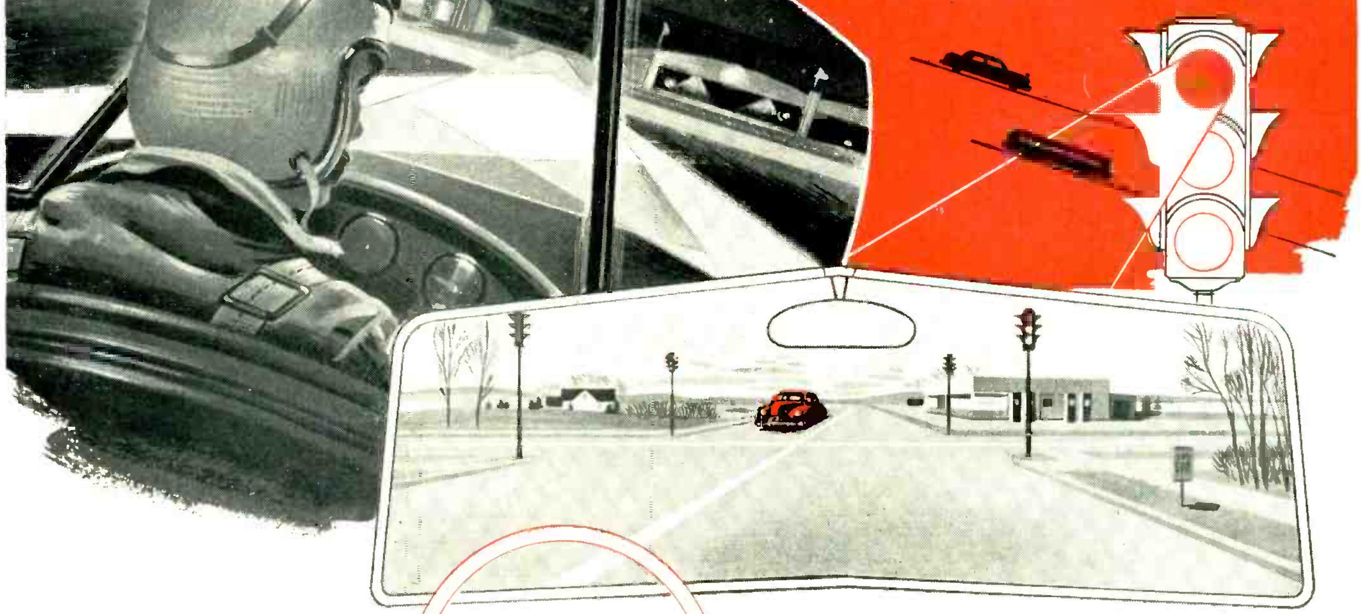

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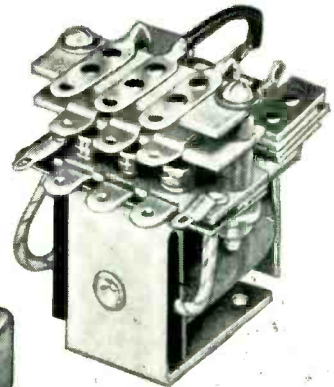

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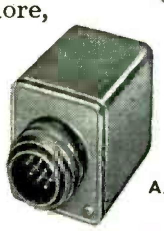

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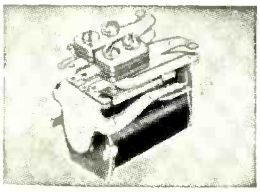

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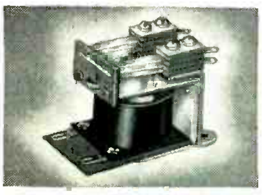

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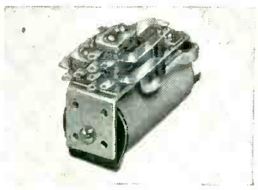

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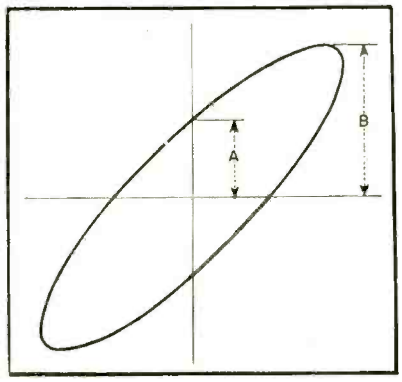

FIG. 1—Usual interpretation of Lissajous figures for measuring relative phase

ful whether the accuracy of reading this ratio is as good as ± 1 percent with most oscilloscopes. If the actual value of θ is close to ± 90 deg the effect of that great an error is appreciable. For example, if the actual phase difference is 80 deg the actual value of A/B is 0.985. With a ± 1-percent accuracy in reading this ratio, the ratio might be read to lie somewhere between 0.975 and 0.995. This range in A/B corresponds to a range in θ of 77.2 to 84.3 deg. The measured phase angle could be off by as much as 5 percent under the conditions assumed here. The effect is even worse for phase angles which are even closer to ± 90 deg.

The overall accuracy of phase-angle measurements can be improved by feeding either the horizontal or vertical input signal through a calibrated phase shifter and adjusting the phase shifter until the ellipse reduces to a single line.[1] Direct-reading phase meters have also been developed.[2,3] Unless a laboratory has frequent need for phase measurements, it is unlikely that either a calibrated phase shifter or a phase meter will be found on hand.

The utility of the oscilloscope alone in measuring phase differences can be retained over the entire range of possible angles by the somewhat different interpretation of the Lissajous figure shown in Fig. 2. For the example depicted here the gains of the oscilloscope amplifiers have been adjusted to give equal amplitudes of horizontal and vertical deflection on the screen. The ratio of dimensions C and D shown in Fig. 2 give the phase dif-

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ACCURACY	
Of amplifier: ±0.4% of reading; Of meter: ±1%	*Of amplifier: ±0.5 to 0.8%* of reading; Of meter: ±1%*
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For full scale input on any range: 10 millivolts at output impedance of 500 ohms for null recorder; 1 volt for 20,000-ohm external meter.

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ference θ according to the relation

$$\tan \frac{\theta}{2} = \pm \frac{C}{D} \qquad (2)$$

The dimensions C and D are to be measured in the directions indicated in Fig. 2. It is assumed here that positive input voltages result in deflections upward and to the right for the respective inputs. If either (but not both) of these conditions is reversed in the oscilloscope in use, the dimensions C and D should be interchanged. For values of θ between -90 and $+90$ deg, C will be less than D. With θ between -90 and -180 deg and between $+90$ and $+180$ deg, the reverse is true.

The $\pm$ sign in Eq. 2 leaves an uncertainty as to which input is leading in phase. This uncertainty can be resolved by passing either input signal through a circuit which introduces a phase shift of known direction and noting the manner in which the pattern is changed.

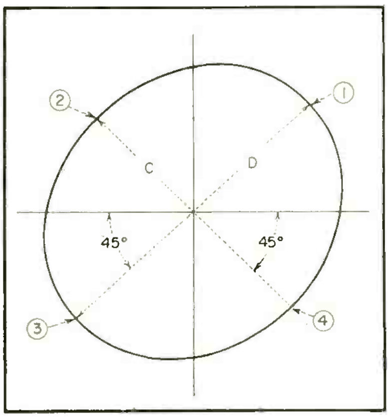

FIG. 2—Interpretation of Lissajous figures by method described

To compare the two methods discussed above, consider the example previously used but apply the interpretation illustrated by Fig. 2. A phase difference of 80 deg corresponds to a ratio C/D of 0.839. A $\pm$ 1-percent accuracy in measuring this ratio means that it might be measured to be between 0.831 and 0.847. The corresponding range in θ is from 79.5 to 80.5 deg which represents an accuracy of about $\pm$ 0.6 percent.

The proof of the relation given in Eq. 2 is readily obtained by considering the deflections at the times when the spot is at points 1, 2, 3 and

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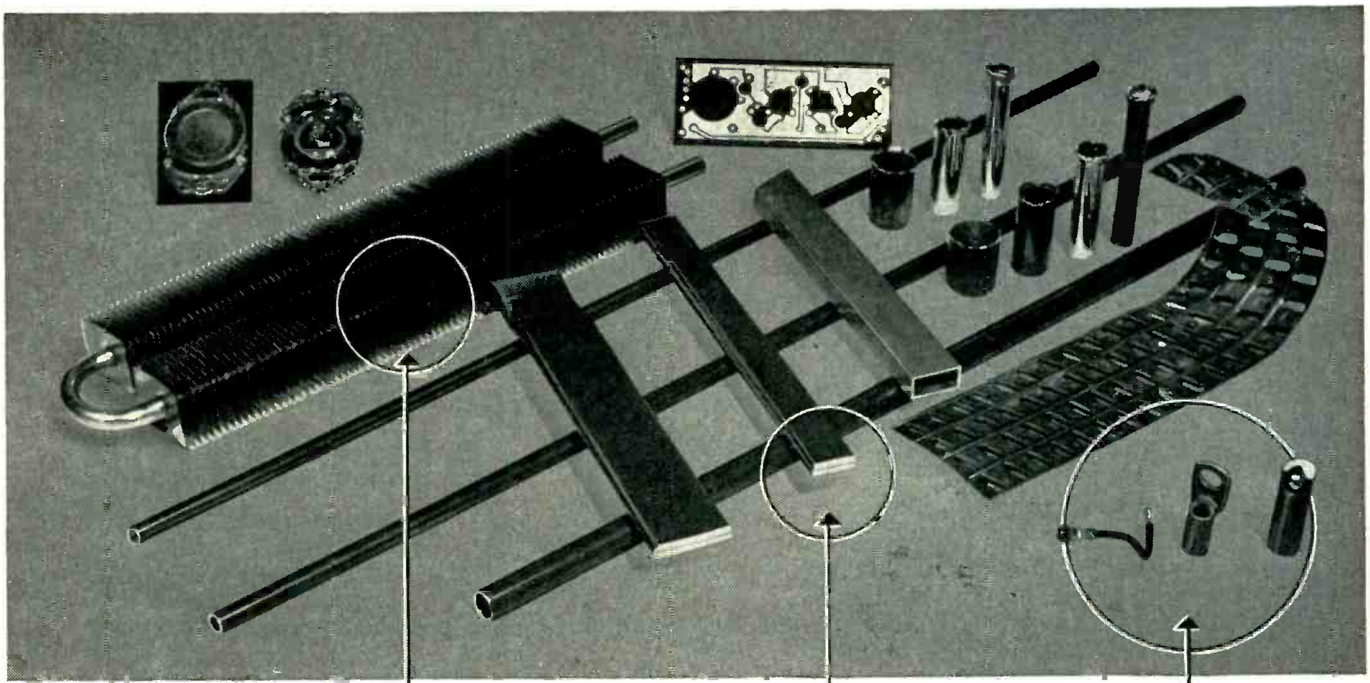

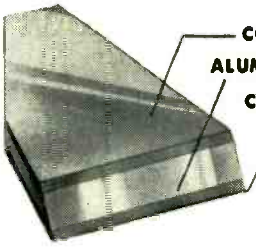

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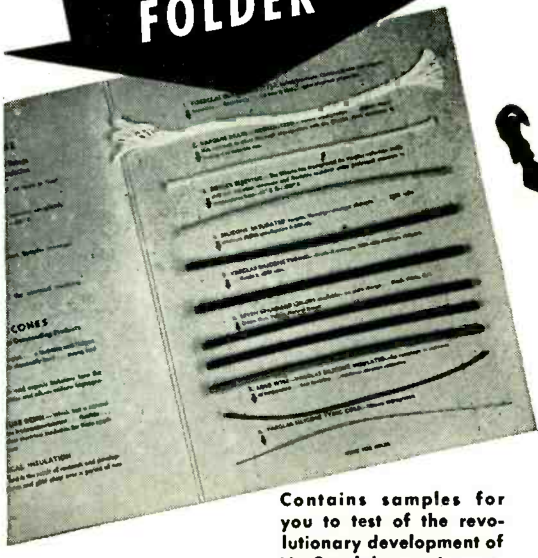

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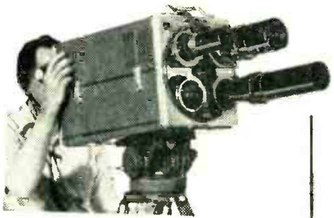

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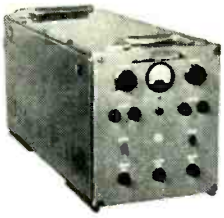

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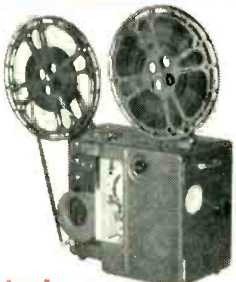

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4 in Fig. 2. Figure 3 shows the horizontal and vertical deflections as functions of time. (Recall that the amplitudes of the deflections were made equal.) Points 1 and 3 correspond to those times when the two deflections are equal and of the same sign. At points 2 and 4 the deflections are of equal magnitude but opposite sign. The dimension C is equal to the value of p in Fig. 3 multiplied by $\sqrt{2}$ and dimension D is equal to q multiplied by this same factor. Therefore $C/D = p/q$.

It follows from inspection of Fig. 3 that at point 1 both deflections are equal to $a \sin (180-\theta)/2 = a \cos (\theta/2) = p$. Similarly at point 4 the deflections are $a \sin (\theta/2) = q$. This gives

$$\frac{C}{D} = \frac{q}{p} = \frac{a \sin (\theta/2)}{a \cos (\theta/2)} = \tan (\theta/2)$$

It may be undesirable at times to adjust the deflection amplitudes equal as required in the method as presented thus far. Disturbing of the gain settings can be avoided by use of the geometrical construction shown in Fig. 4. The horizontal and vertical lines are drawn tangent to the ellipse. The diagonals of the rectangle thus formed are the directions along which C and D should be measured. Figure 4 will be readily recognized as nothing more than Fig. 2 "stretched" horizontally by an appropriate factor. This stretching does not alter the ratio C/D.

What may appear to be a formidable drafting job to perform on the face of the cro is really not so difficult if the usual celluloid coordinate scale is used to indicate the position of the tangent lines. With a small

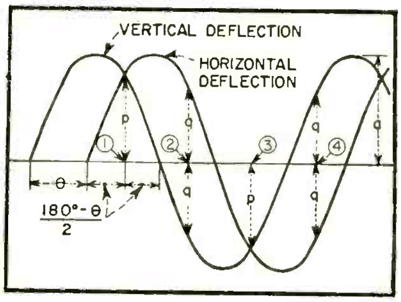

FIG. 3—Horizontal and vertical deflections as a function of time

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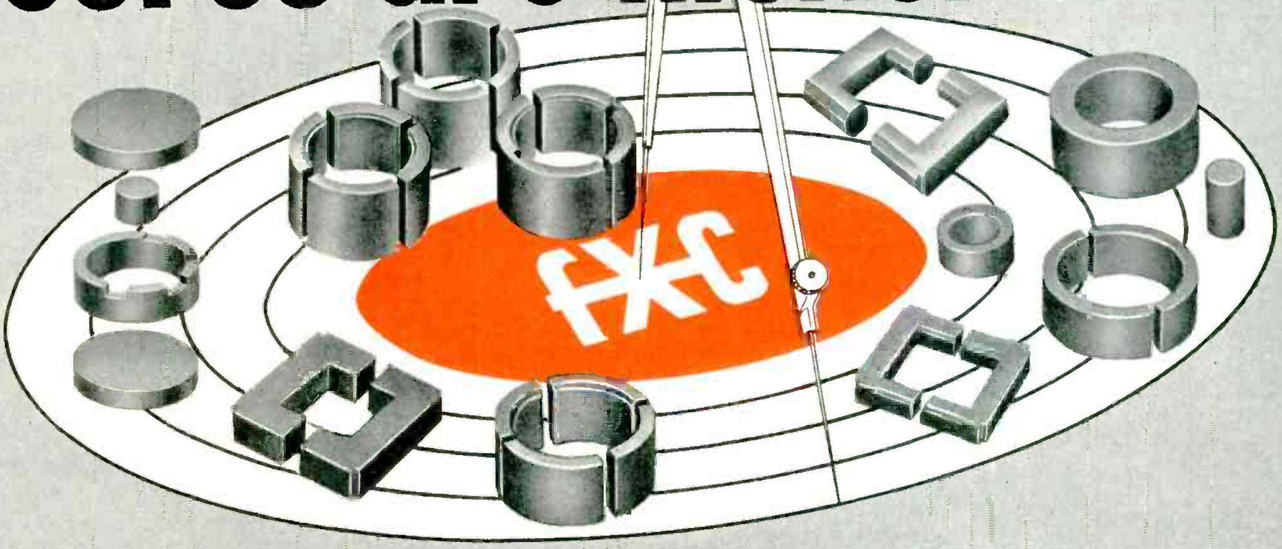

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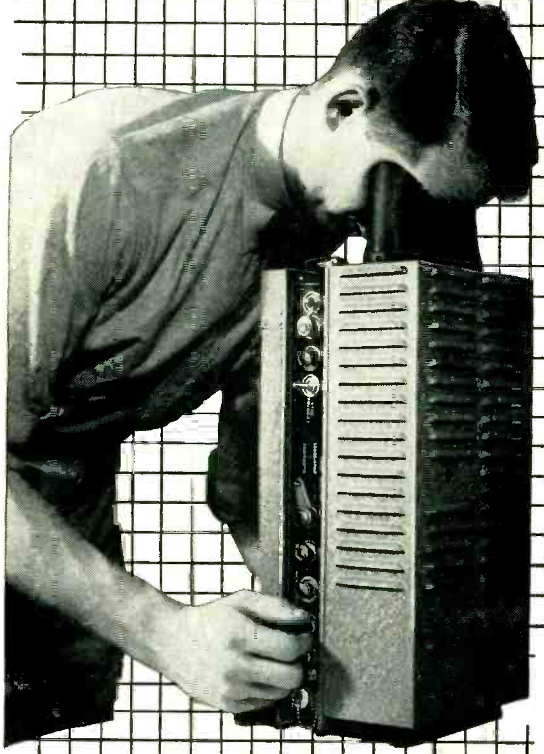

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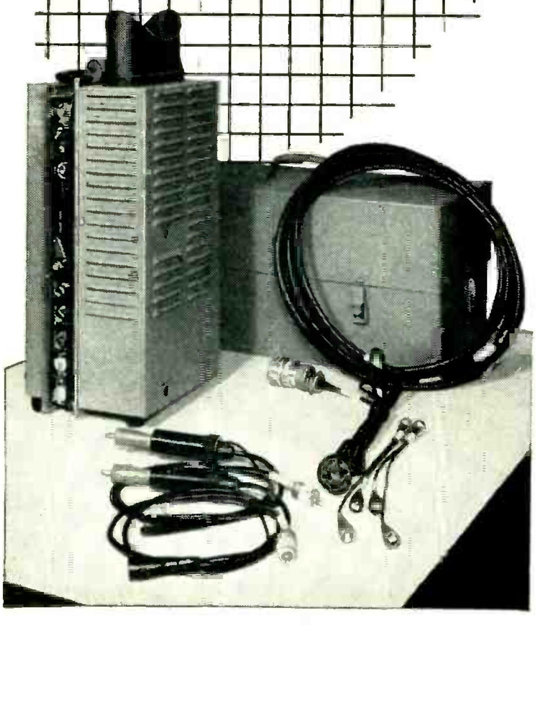

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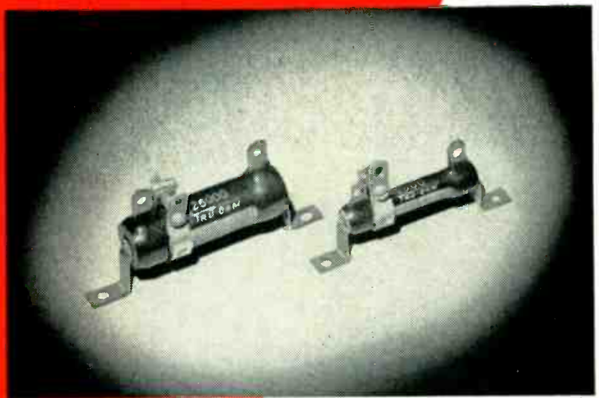

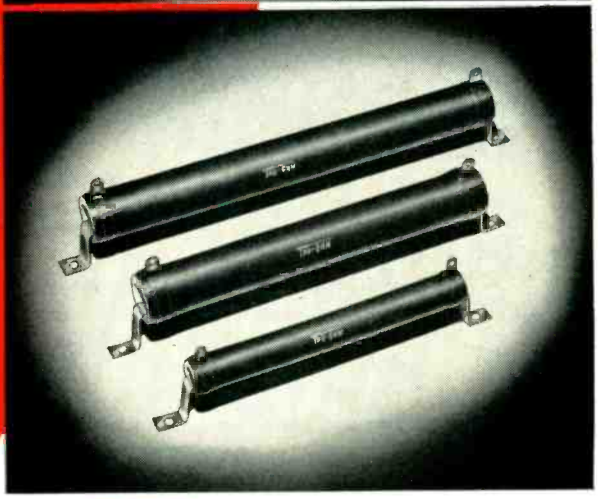

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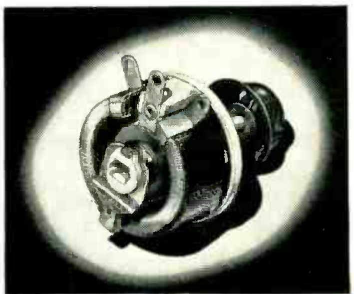

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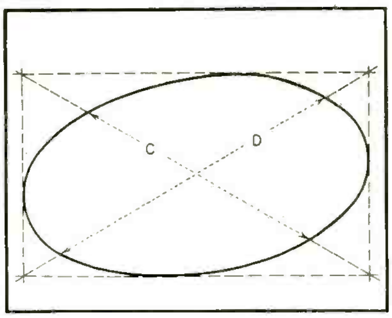

FIG. 4—Geometrical construction used to avoid disturbing of gain settings

ruler placed in the proper position the required dimensions can be measured.

REFERENCES

(1) J. P. Taylor, Cathode-Ray Antenna Phasemeter, ELECTRONICS, p 62, April 1939.
(2) E. R. Kretzmer, Measuring Phase at Audio and Ultrasonic Frequencies, ELECTRONICS, p 114, Oct. 1949.
(3) P. G. Sulzer, Victor Voltage Indicator, ELECTRONICS, p 106, Dec. 1949.

Small-Station Program Recording

By KEN DOLAN
Chief Engineer
Radio Station WARA
Attleboro, Mass.

DURING THE REGULAR broadcast day it is almost impossible for an independent radio station to make recordings consisting of records, transcription and voice unless they are fortunate enough to have spare turntables and amplifiers. The regular turntables are in almost constant use.

Station WARA has two studios. One is a large studio used primarily for originating programs consisting of two or more people; the other is a combination studio-control room, announcer operated.

An RCA Transcription Player is used in the record library for auditioning new records, transcriptions and sound effects. Ninety percent of all programming is done from the studio-control room, leaving the large studio with two microphone inputs not being used.

By adding a volume control, switch and matching transformer to the existing transcription player, it is possible to make recordings with music on tape or disks. Previous to this setup, when any recordings were made, they would have to be done during a 15-minute newscast, half-hour women's pro-

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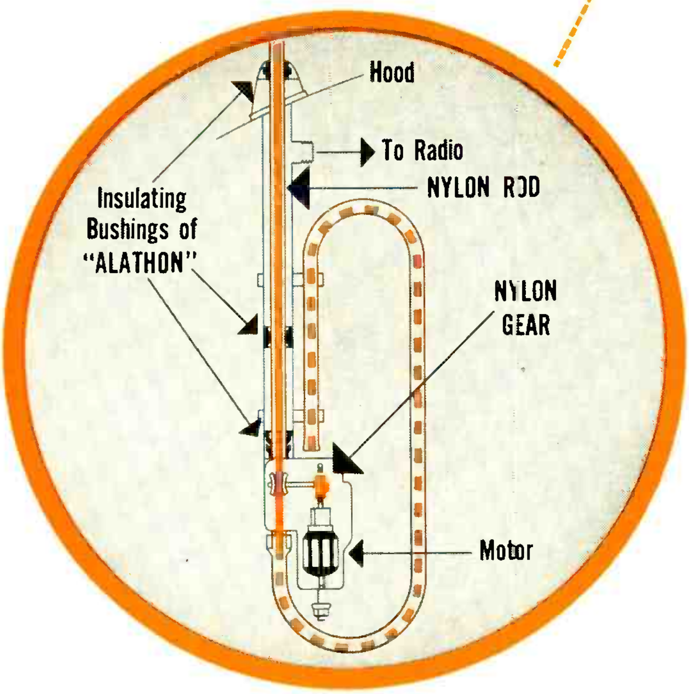
New Packard antenna design employs two Du Pont plastics



When driver pushes button, motor-driven worm gear turns nylon gears, which turn spring-loaded pulleys. Nylon rod is driven up by pulleys, forcing "live" members upward. Rod coils into trombone-like shape (dotted line) when antenna is lowered. (*Automatic antenna used on 1951 Packards made by Casco Products Corp., Bridgeport, Conn.*)

Nylon plastic and "Alathon" polythene resin meet mechanical and electrical requirements for automotive antenna

Two Du Pont plastics materials—nylon and "Alathon"* polythene resin—are playing key roles in the success of this new motor-driven antenna used on Packard automobiles. A 4½-foot flexible rod which raises and lowers the "live" members is made of nylon, as are the two gears that transmit power from the motor to pulleys which drive the rod upward and downward. Insulating bushings, which must have very low moisture-absorption and excellent dielectric properties at radio frequencies, are molded of "Alathon."

The rod must have an unusual combination of properties. Most important of these: it must be rigid enough to force the antenna up and down, yet flexible enough to fold into a trombone-like position when the antenna is down; and it must also have good dielectric properties. Only nylon was found to meet the mechanical requirements, while at the same time maintaining a high "Q" and low capacity. The nylon rod and gears have been subjected to as many as 80,000 cycles—many more times than they could possibly be called on to withstand during the life of any car. Neither shows any sign of wear.

Both nylon and "Alathon" are finding a number of uses in molded parts for electrical equipment, in addition to their many well-known applications in wire and cable. Nylon is used in such items as coil forms, insulator bushings, grommets, motor slot liners, switch components . . . "Alathon" in radio and television parts, potting compounds, etc.

For additional information about nylon, "Alathon" and other Du Pont plastics, write:

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grams or any program that could be done without turntables. These programs would originate from the large studio.

This arrangement clears out the regular turntables and, for a short period of time, the audition bus in the console can be used for making recordings. The only other alternative is to come in after sign-off hours, with resulting rushed and poor-quality work.

When the dpdt switch, Fig. 1, is thrown to the record position, the playback arm is disconnected from the grid circuit of the self-contained amplifier in the transcription player and is connected to the matching transformer high-impedance primary. The secondary matches into 250 ohms.

A regular microphone plug and

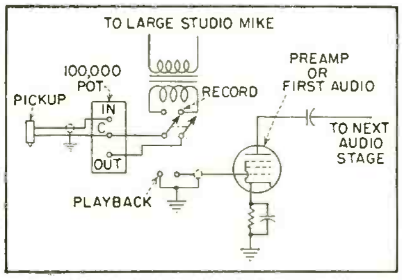

FIG. 1—Circuit changes to the transcription player

cable are connected to the secondary in order to plug into the large studio microphone input. The 100,000-ohm potentiometer controls the input to the microphone preamplifier in the console so as not to overload it and cause distortion. When the dpdt switch is thrown to the playback position, the transcription player functions as a normal record player.

When a recording is to be made from the large studio, the switch on the player is thrown to RECORD. The output cable is plugged into the studio microphone input receptacle and a regular microphone is plugged into another studio microphone input. The console monitor and the corresponding large studio microphone switches are placed on AUDITION.

Output from the monitor amplifier is fed into either a tape recorder or disk recorder. The end result

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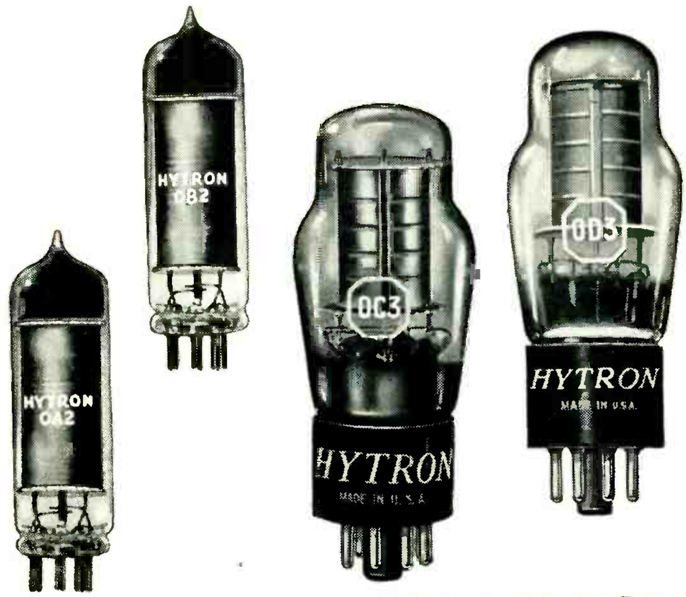

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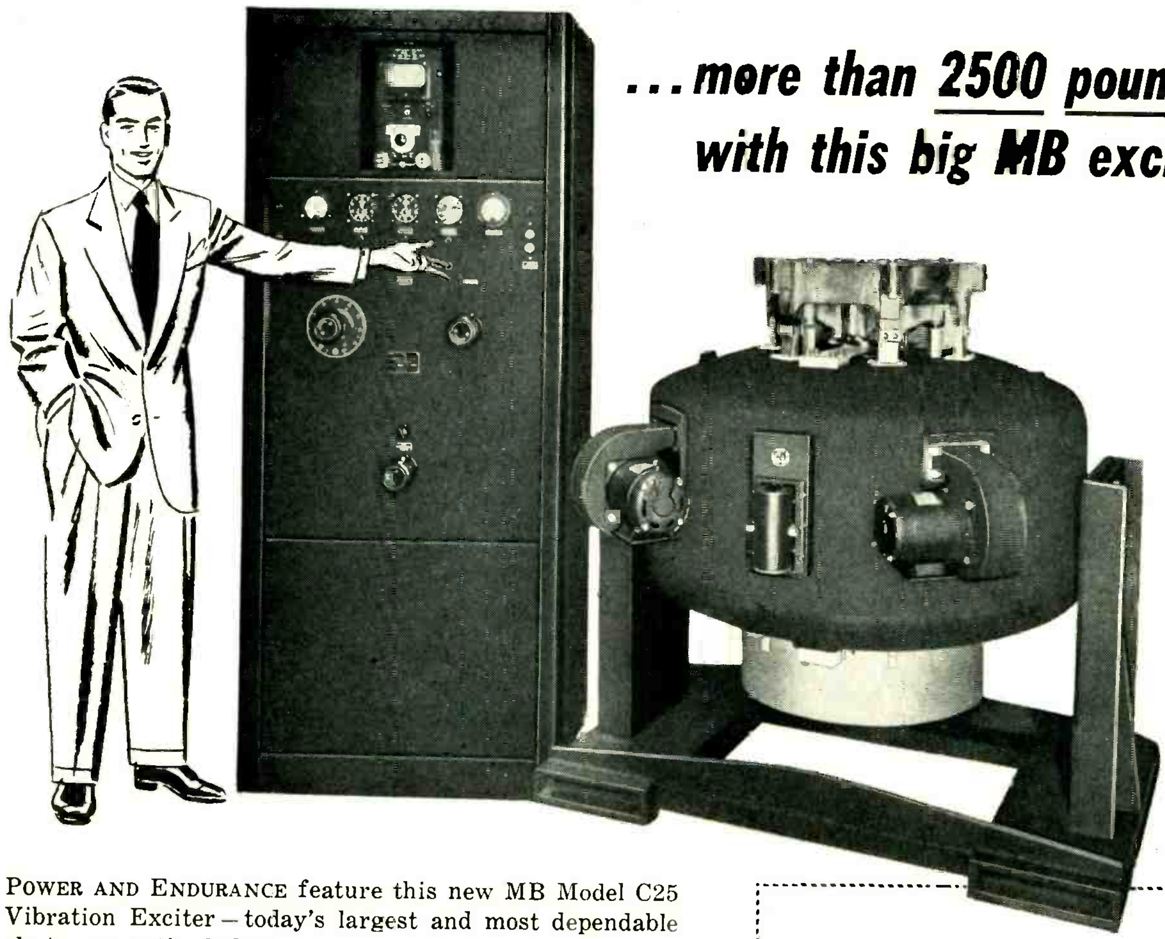

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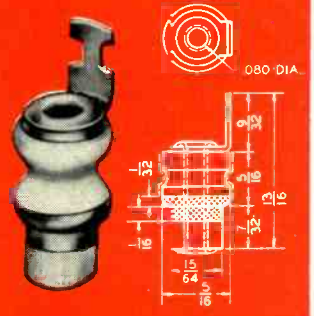

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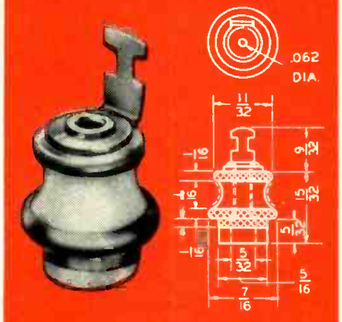

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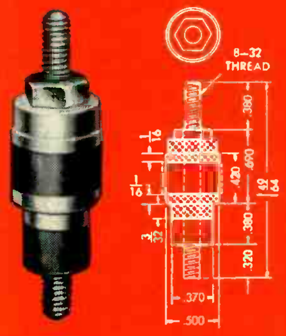

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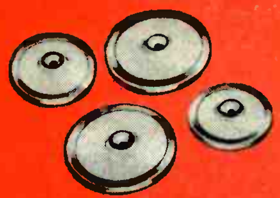

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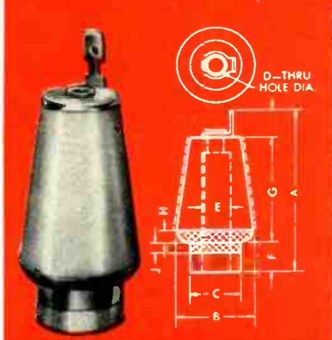

PART NO.	D-3342	D-3346	D-3350	D-3349
A	1 1/32	1 19/32	2 9/32	3 3/16
B	.490	5/8	15/16	3/4
C	3/8	.490	11/16	9/16
D	.095	.095	.130	.130
E	3/16	1/4	3/8	1/4
F	3/16	3/8	3/8	5/16
G	1/2	7/8	1 15/32	2 7/16
H	1/16	3/32	1/8	1/8
J	3/32	1/8	1/8	1/8

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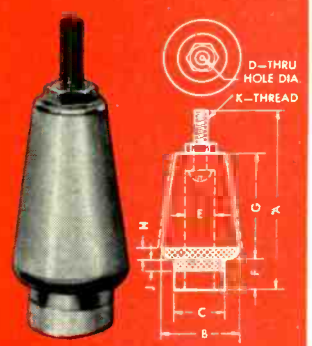
A	1 7/32	1 51/64	2 15/32	2 15/32
B	.490	5/8	15/16	15/16
C	3/8	.490	11/16	11/16
D	1/16	1/16	.055	1/16
E	1/4	1/4	3/8	3/8
F	3/16	3/8	3/8	3/8
G	1/2	7/8	1 15/32	1 15/32
H	1/16	3/32	1/8	1/8
J	3/32	1/8	1/8	1/8
K	6-32	6-32	8-32	10-32



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By NATHANIEL G. A. DORFMAN
President
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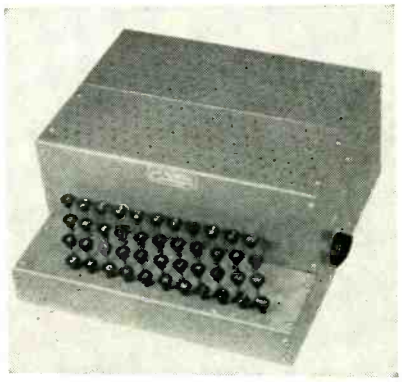
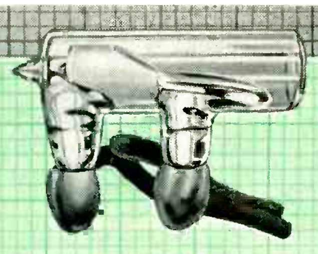
The unit interval generator section generates the rectangular



The Codetyper with keyboard and speed-control knob on right-hand side



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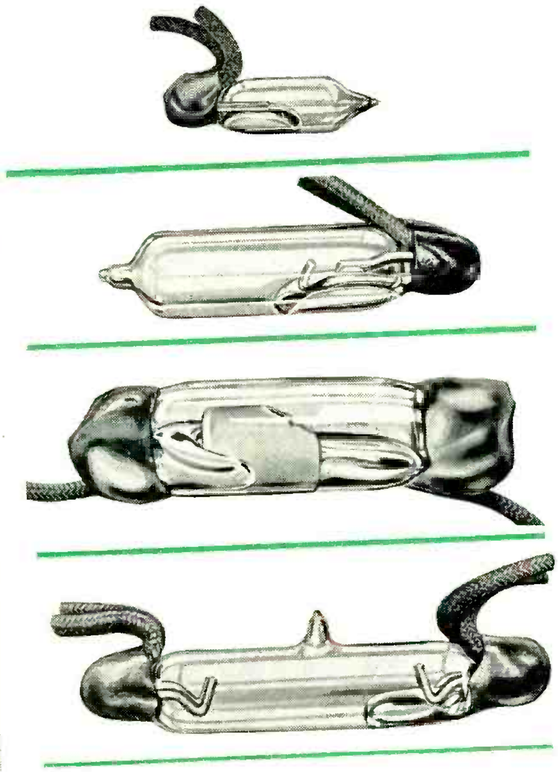

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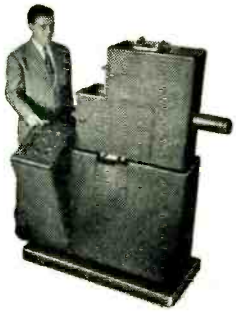
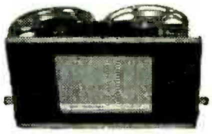


Makes PROFITS GROW for TV Stations. The Gray Telop projects low-cost, easily produced TV 'commercials.' Without keystoning, any two photos, titles, slides, etc., or small objects may be broadcast with superimposition, lap dissolve or fade-out. Four optical openings. Strip material may be used horizontally or vertically with Stages #2 and #3. (For full details write for Bulletin T-101.)

Gray STAGE #2

Attaches to three optical openings of the Telop. Accommodates roll stock *vertically* to televise commentary or the commercial in the same way movie introductions are projected.

Gray STAGE #3



Attaches to optical openings of the Telop. News ticker tape fed from 8-mm reels is projected on any part of the screen, top to bottom, horizontally. May be used with test pattern or other commercial.

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MODEL 556

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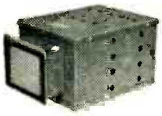
Provides back lighting for Telop use.



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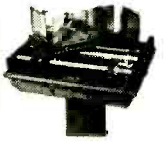

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Gray TRANSCRIPTION ARMS

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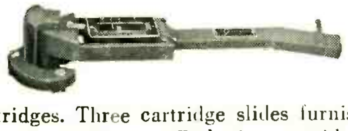
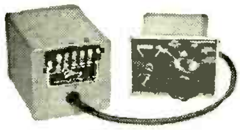
Model 106-SP Arm



Designed to meet strictest requirements of modern highly compliant pickup cartridges. Three cartridge slides furnished enable GE 1-mil, 2½-mil or 3-mil cartridges or Pickering cartridge to be slipped into position in a jiffy. No tools or solder! Superb reproduction of 33⅓, 45 or 78 r.p.m. records. Low vertical inertia, precisely adjustable stylus pressure.

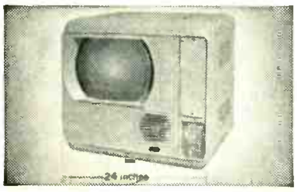
Gray EQUALIZERS



MODEL 602 EQUALIZER has been specially engineered to provide constant velocity frequency response for both conventional and LP records. Four steps—flat, transcriptions, good records, poor records. Gray Equalizers used as standard professional equipment by broadcast stations.

MODEL 603 — Has 5 control positions. For both GE and Pickering cartridges.

Gray Color Television Monitor



This latest product of Gray Research was developed for professional monitoring of color telecast of the CBS field sequential system.

Gray MILITARY PRODUCTS

Illustration shows typical airplane controls made for Hamilton Standard, Division of United Aircraft Corporation. Other military developments and products include video indicators, intricate mechanisms, trainers, electronic-mechanical development contracts.

See you at the I.R.E. Show, Booths S-9, S-10

GRAY RESEARCH

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Division of The GRAY MANUFACTURING COMPANY—Originators of the Gray Telephone Pay Station and the Gray Audograph

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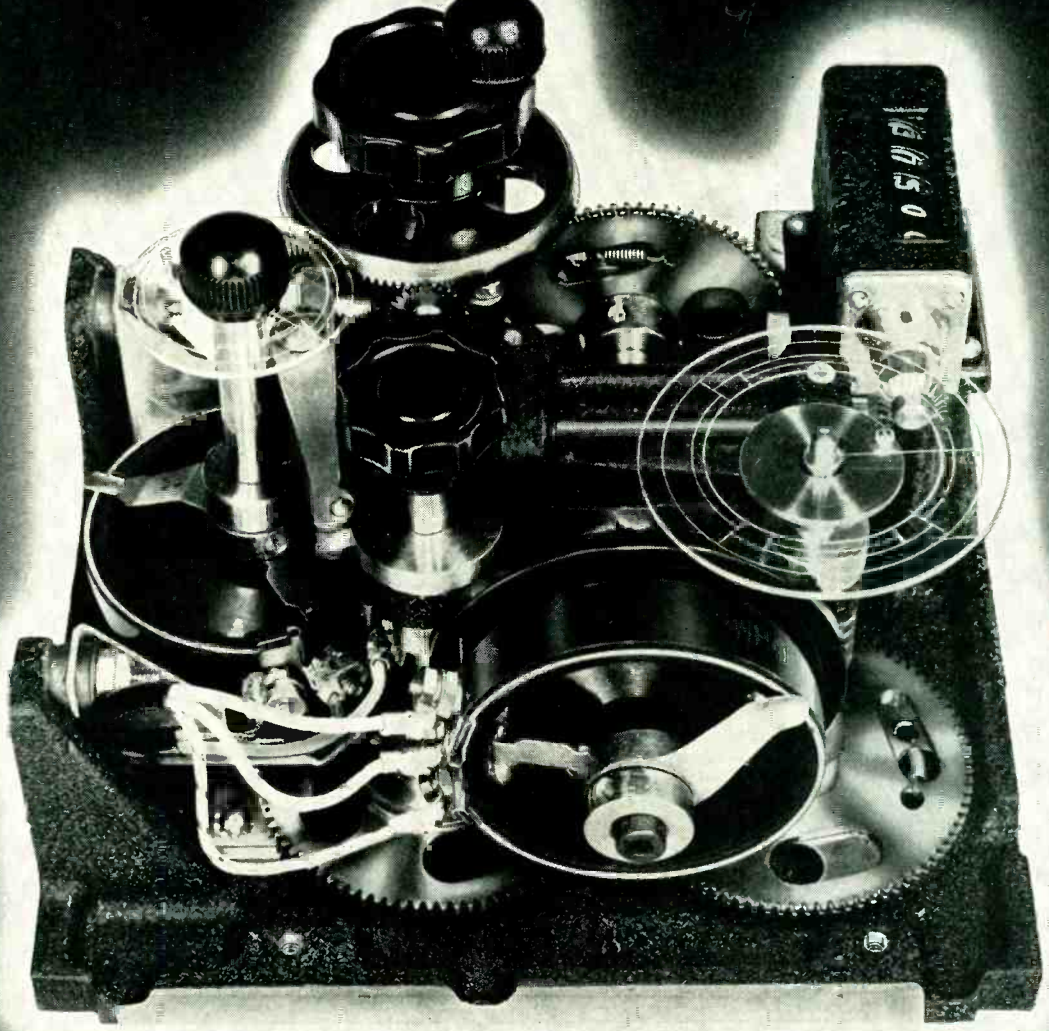

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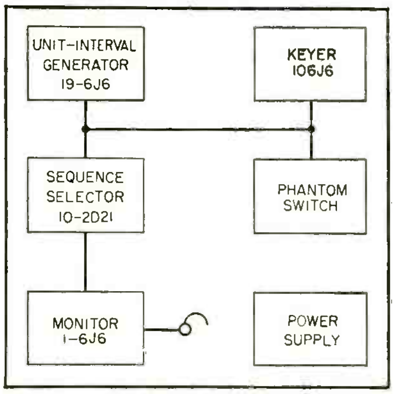


FIG. 1—Block diagram of the Codetyper

pulses that form the dot marking and spacing intervals. No dash markers are generated, they are formed by action of the sequence selectors upon the keyers. To generate the 19 units that are required there are 19 6J6's. All pulse generators are univibrators producing two different output pulses, a rectangular pulse of 15 to 125 milliseconds duration which is fed to the keyer section and a sharp spike pulse 180 deg removed which is used to trigger the numerically adjacent unit.

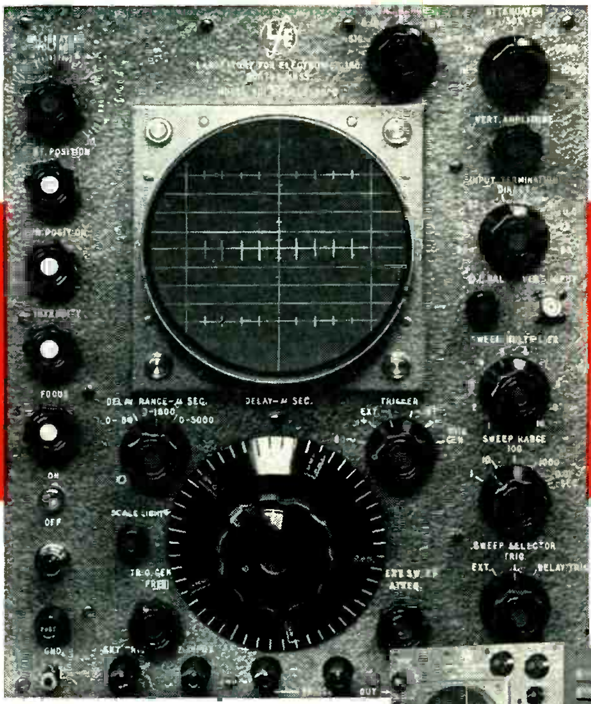
As all pulse generators are normally quiescent and are hooked up so that they will only deliver a pulse to the keyers when they are triggered off from the preceding stage, all unit interval generators can be seen to be effectively in time series. Therefore, a trigger applied to the unit interval generator number one will effectively travel down the chain, setting off all interval generators up to the last or 19.

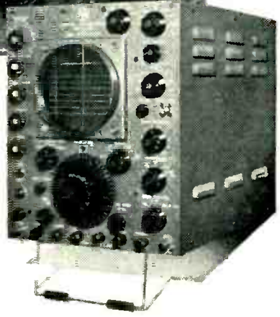
A shorter combination may be obtained by inserting a triggering pulse somewhere along the chain. Control is had on all 19 interval generators by varying one potentiometer which changes the duration of the 19 units simultaneously, precisely and over wide range from minimum to maximum.

The keyer section functions to form the marking and spacing intervals that comprise a code character and to arrange these intervals in the proper sequence so that the time intervals supplied by the unit generators are fashioned into a Morse code character upon the keying relay which is used to actuate the radio transmitter. To do

NEW, Advanced design Oscilloscope...

for precise, quantitative studies of pulse waveforms, transients and other high or low speed electrical phenomena





LFE Model 401 Oscilloscope . . .
A high gain, wide band, versatile, general purpose instrument

Advances in electronics have placed greater demands on the time, frequency, and amplitude measuring capabilities of laboratory oscilloscopes. LABORATORY FOR ELECTRONICS, INC., recognizing the ever-increasing requirements of the rapidly expanding electronics industry, and using specifications set forth by electronic engineers, has developed the Model 401 oscilloscope to provide the features and conveniences required in a medium price, general purpose instrument.

SPECIFICATIONS

Y-Axis

- Deflection Sensitivity — 15 millivolts peak-to-peak/cm
- Frequency Response — DC to 10Mc
- Transient Response — Rise Time — 0.035 microseconds
- Signal Delay — 0.25 microseconds
- Input line terminations — 52, 72, or 93 ohms, or no termination, for either AC or DC input
- Calibrating Voltage — 60 cycle square wave.
- Input Imp. — 1 megohm, 30 mmf.

X-Axis

- Sweep Range — 0.01 sec/cm to 0.1 microseconds/cm
- Delay Sweep Range — 5-5000 microseconds in three ranges — continuously adjustable
- Triggers — Internal or External, + and −, or 60 cycles, or delayed trigger outputs are available at suitable binding posts.
- Built-in trigger generator for triggering external circuits and sweeps.

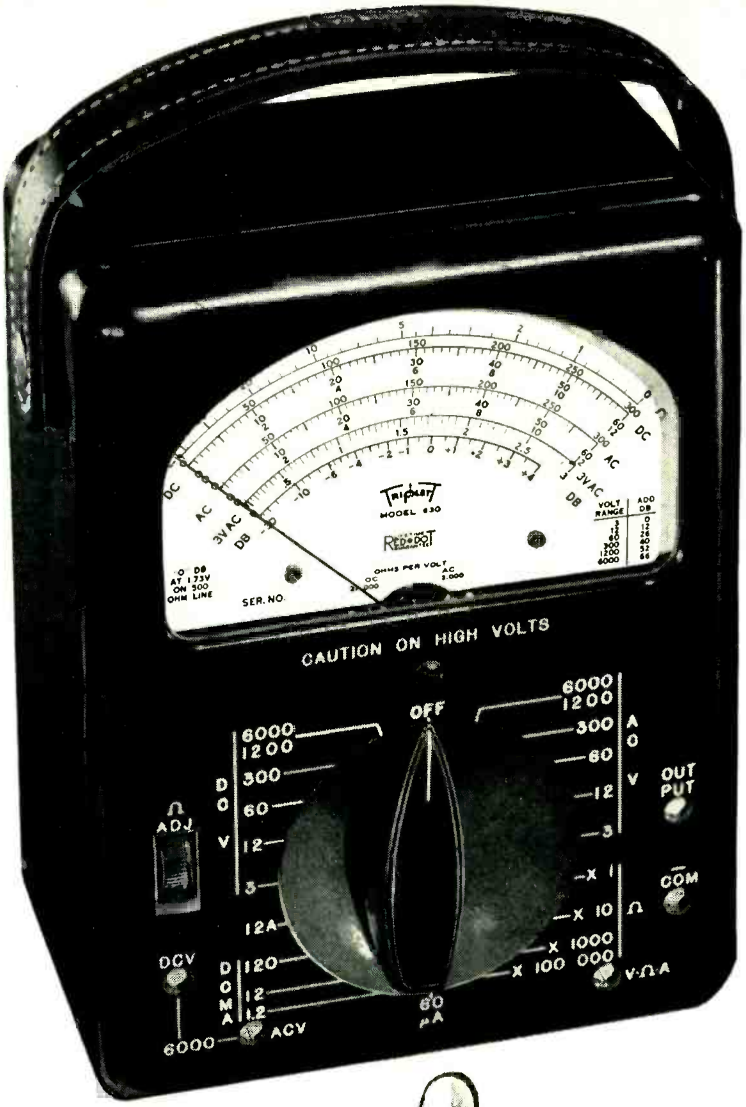
General

- Low capacity probe
- Functionally colored control knobs conveniently grouped
- Folding stand for better viewing
- Adjustable scale lighting
- Facilities for mounting oscilloscope cameras
- Dimensions — 12½" wide, 15" high, 19" deep
- Weight — 50 lbs.

See the LFE Oscilloscope demonstrated at the New York I. R. E. Show, March 3, 1952, fourth floor, booth 461, or write for complete information.

L/E

LABORATORY for ELECTRONICS, INC. 43 LEON STREET BOSTON 15, MASS.



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Model 630

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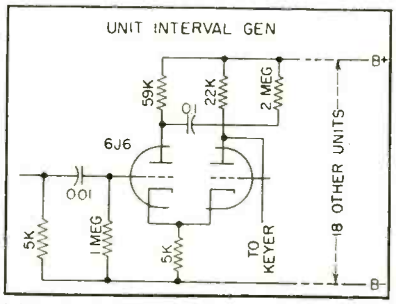


FIG. 2—Schematic diagram of one of the 19 unit interval generators

this there are 10 dual triode 6J6 tubes used.

The sequence selector section consists of nine gating tubes and one eraser tube making 10 shielded grid thyratrons of the 2D21 type. All thyratrons are biased to current cutoff and arranged to be triggered on by the keyboard control through the phantom switch network.

The phantom switch must supply a trigger voltage to the interval generators. This can be accomplished by picking off the network through a suitable decoupling voltage to raise the cathode potential of the generator preceding the one to be triggered. This will cause the coupling capacitor to put a positive-going pulse on the generator to which it is connected and cause that stage to trigger off.

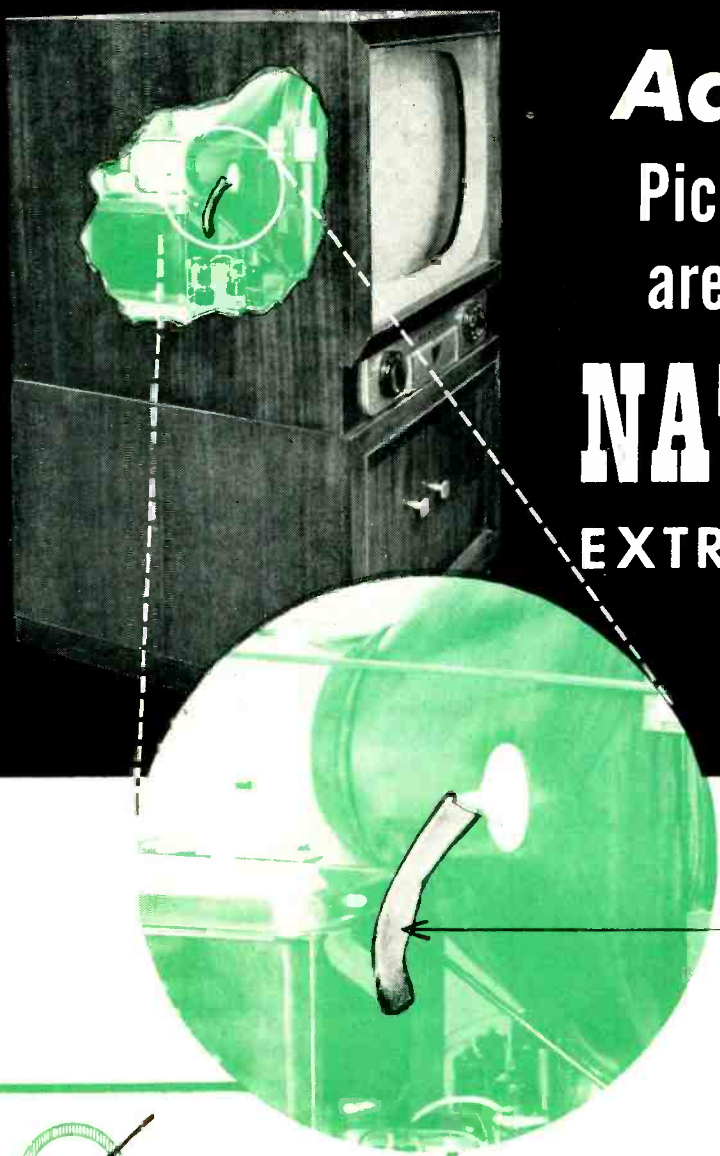
For the convenience of the operator as well as a built-in method of checking the operation, a monitor circuit is provided.

The Codetyper uses 40 tubes and therefore the design requires that the servicing of the system be quickly and easily accomplished. Toward this end and with the prospect of making a compact unit possible, all units except the power supply are constructed as potted plug-in cells.

Video-Detector Sound Amplifier

A RATHER unconventional vido-detector circuit is employed in recent Magnavox tv receivers.

The video second detector and first sound i-f amplifier are combined in one pentode, a 6AU6. Detection is accomplished by the diode action of the grid and cathode of the pentode tube. The 4.5-mc component for intercarrier sound is recovered at the plate of the tube after amplification. The video com-



Admiral TV

Picture Tube Leads are insulated with

NATVAR 400

EXTRUDED PLASTIC TUBING

In this Admiral Model 121 K 16 TV with 20" picture tube, the 2nd anode lead from the high voltage rectifier carries 12,500 volts to the picture tube. This important lead is insulated and protected with Natvar 400 Extruded Plastic Tubing.

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- Slot insulation
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- Extruded plastic tubing and tape
- Extruded plastic identification markers

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Admiral Corporation, in the past decade, has grown to be one of the largest and best known makers of TV and Radio Sets and Electrical Appliances. Leaders in research, design, and engineering, they have succeeded by offering *quality* merchandise at the lowest possible price.

To safeguard this quality, Admiral is extremely careful in the selection of component parts and materials. They use Natvar 400 Extruded Plastic Tubing because of its excellent electrical and mechanical properties, and because it is dependably uniform.

Natvar 400 and other Natvar flexible electrical insulating materials are available either from your wholesaler's stock or direct from our own.

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Eight ML-5682's mounted in a Doherty high efficiency linear amplifier designed for 500 kW output.

The ML-5682

A High-Power Coaxial Triode for Full-Power Operation to 88 mc/sec.

The development and commercial production of the ML-5682, a new water- and air-cooled coaxial triode for very high power operation, is an important contribution to all phases of modern electronic development. It is of particular significance in the present effort to provide the highest possible power in international broadcast applications. It finds wide application in high power AM, FM and TV broadcasting, in particle accelerators and in electronic heating. It is the key tube type in the highest power AM transmitters being built today.*

The ML-5682 is an unusually compact, rugged, high-power electron tube ideal for all high-frequency applications. It is an all-ring-seal triode capable of long-life operation at 9kVdc plate voltage and 170 kW plate input at a frequency of 88 mc/s. Operation at 16 kVdc plate voltage and 300 kW plate input is permissible up to 30 mc/s. This tube is ideal for cavity operation and its low impedance makes it advantageous for broad-band service.

*Includes State Department's Voice of America Transmitters.

Outstanding design features include:

- High-conductivity, gold plated kovar glass-to-metal seals.
- Sturdy electrodes.
- Integral anode water jacket.
- Quick-change water coupling.
- High-conductivity, heavy-wall copper anode designed to dissipate in excess of 100 kw.
- Multi-strand thoriated-tungsten filament cathode completely balanced and stress free throughout tube life.
- Grid capable of unusually high heat dissipation contributing to maximum stability of tube performance and circuit operation.

For full technical information on the ML-5682 or other Machlett tube types write to Machlett Laboratories, Inc., Springdale, Connecticut, or contact your nearest Graybar or Westrex office.

Machlett Industrial and Broadcast Tubes will be exhibited at the 1952 I.R.E. Show—Booth 96-97

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fine wire

MADE FINER

custom drawn
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Spool after spool after spool — as much or as little as you require. For our facilities are flexible and extensive enough to serve the largest and the smallest user alike with custom-made fine wire.

Let us have your specifications and requirements. Our Winsted Division will meet and maintain your specifications. Which explains why Winco fine wires are the first choice of radio-electronic and electrical manufacturers whose products are noted for reliability and long life.

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We solicit your wire problems, specifications and requirements. We shall be happy to develop, produce and supply whatever fine wires you need.

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Nylon, Celanese, Silk
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Available on bare or enameled wire; single or double covered.

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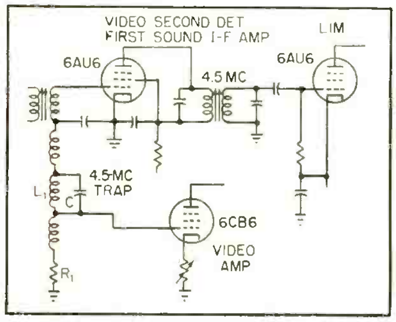
MATERIALS	TYPES	COVERINGS
Copper	Instrument Tubing	Plain and Heavy Enamel
Aluminum	Litz	Formvar
Iron	Multiplied and Twisted	EZsol (Liquid Nylon)
Copper-clad Steel		Cement-coated Enamel

SILVER-PLATED WIRES

Silver plated wires, in coarse and fine sizes, for high-frequency conduction. Also intended for use in high-temperature applications, taking the place of tinned wire. Available in various sizes and constructions.



Circuit for using a single pentode as video detector and sound intercarrier amplifier

ponent is recovered at the detector load R_1. The effect is identical to having a diode directly coupled to a pentode. However, since the grid and cathode of the pentode act as a detector and produce the same results, the diode is eliminated.

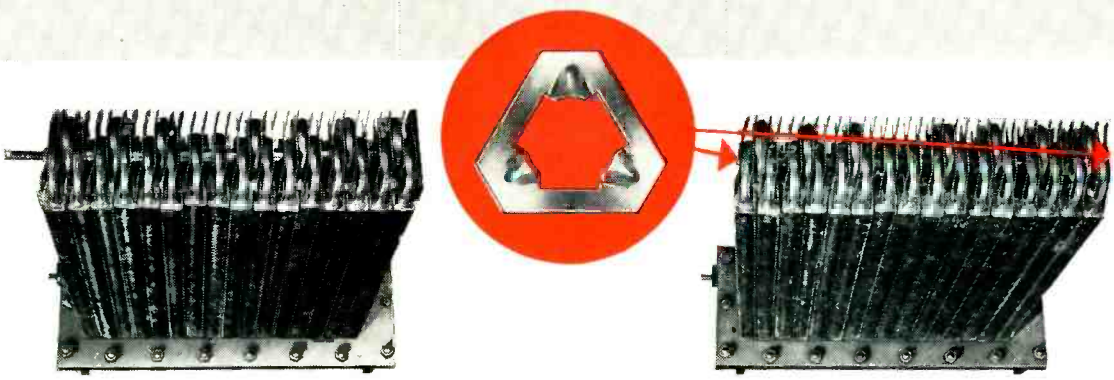
The video voltage developed across the diode load resistor R_1 is of negative polarity. This signal is amplified by a direct-coupled video amplifier, a 6CB6, and coupled to the cathode of the picture tube. To obtain the proper video response, the total stray and circuit capacitance had to be kept to a minimum. For this reason, the third video i-f coil had to be modified, since a standard bifilar coil would contribute about 70 $\mu\mu$f of capacitance. Peaking coils provide the necessary high-frequency response for the video amplifier. Capacitor C and L_1 resonate at 4.5 mc to attenuate the 4.5-mc beat at the video amplifier and increase the amplitude of the 4.5-mc carrier to the first sound i-f amplifier.

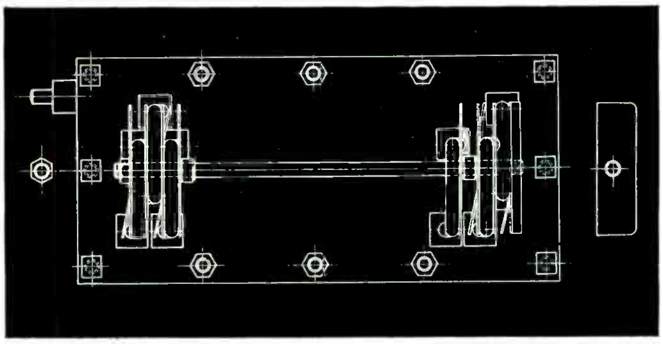
The 4.5-mc f-m carrier produced by the diode mixing action is amplified and transformer-coupled to the sound limiter, 6AU6. A double-tuned circuit is used to provide good selectivity since a large portion of the demodulated video frequencies also exist in the plate circuit.

Photoelectric Dew-Point Hygrometer

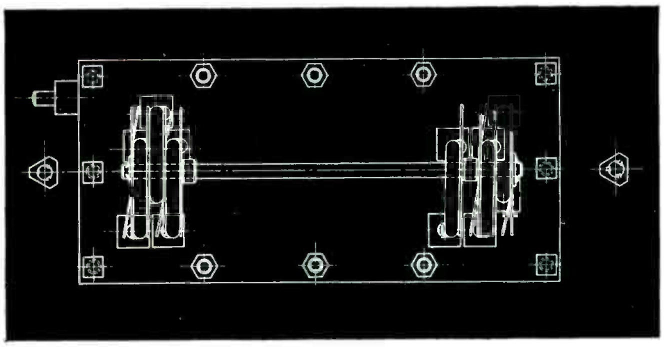
THE convenient means of measuring the water content of the atmosphere down to −85 C described in the November 1951 issue of Electronics, p 136 is a feature of the instrument manufactured by Elliott Brothers Ltd., Century Works, Lewisham, London, S.E. 13, England.

2 WALDES TRUARC TRIANGULAR RETAINERS REPLACE NUTS... CUT MATERIAL AND ASSEMBLY COSTS 52%





OLD WAY—Tie rod for thermal tubes required threading at both ends, a jam nut at top, a drilled and tapped cast iron tube-rest at bottom. Assembly was slow, costly.



NEW WAY—Truarc Retainers (triangular type) simply push into position at both ends of rod...hold securely without grooves, threads, or nuts. Assembly is inexpensive, speedy!

When the Grinnell Co., Providence, R. I. redesigned their Thermolier Unit Heater to include Waldes Truarc Retaining Rings, they were able to cut down on scarce raw material... eliminate the many machine operations entailed in nut fastening—for a savings of 26½¢ per unit! Truarc Triangular Retainers are self-locking...have unusually high thrust capacity... can be applied at high speed by unskilled labor.

Re-design with precision engineered Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to hold parts together better, with a never-failing grip. Quick, easy to assemble and disassemble.

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

WALDES TRUARC RINGS MADE THESE SAVINGS POSSIBLE...

OLD WAY Parts:	Cost Per Unit	NEW WAY Parts:	Cost Per Unit
tube rest, threaded rod, jam nut	$.306	plain rod, 2 Truarc Rings	$.060
Assembly	.202	Assembly	.183
	$.508		$.243

TOTAL SAVINGS PER UNIT WITH TRUARC RINGS $.265

SEE THE WALDES TRUARC EXHIBIT. I R E SHOW, GRAND CENTRAL PALACE, N.Y.C., MARCH 3 through 6th. Booths 358 & 359 • ASTE SHOW, CHICAGO AMPHITHEATRE, MARCH 17 through 21st. Booth 751

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Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. E-034

- ☐ Bulletin #5 Self-locking ring types
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- ☐ Bulletin #7 Ring types for radial assembly
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Production Techniques

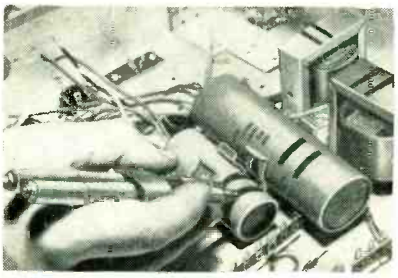
Edited by JOHN MARKUS

THIS department presents techniques for expediting the production of military and commercial electronic equipment and components. Here, production and methods engineers will see how problems comparable to theirs are solved in other plants.

Topics covered range from the jigs and fixtures of incoming inspection to the tricks of final packaging, all showing how to boost output, simplify an operation, improve quality or cut costs.

Contributions are welcomed, and will be paid for, with full credit to the author and his company

RTMA Date-Coding



Color-dating larger components with taped-together fountain brushes

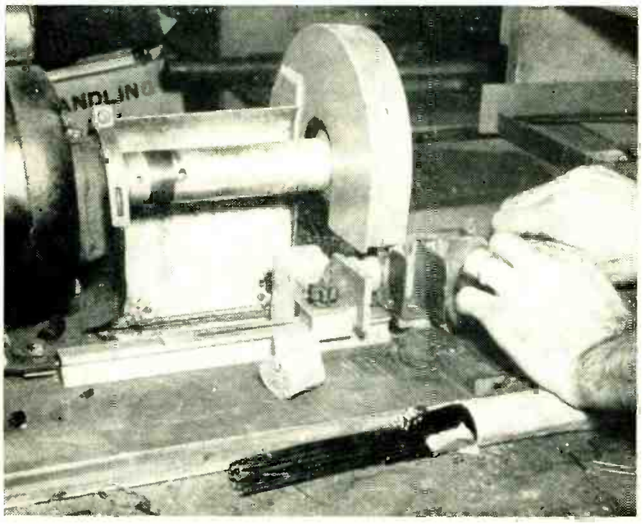
TELEVISION receiver parts likely to be returned for replacement under the manufacturer's warranty are quickly color-coded with year and month of production by taping together appropriate color combinations of fountain brushes and marking the parts with a single stroke. One color represents the last digit in the year, from 0 to 9. The second color gives the month from 1 to 9, and three brushes are used for 10, 11 and 12 during the last three months of the year.

Ambiguity between month and year stripes is not ordinarily important since the usual warranty is 90 days or less, but for precise dating the year mark can be placed closest to the edge of each component. As used by CBS-Columbia in its Brooklyn plant, this marking method is intended only as a rough check to show up parts that are turned in a year or more later for free replacement.

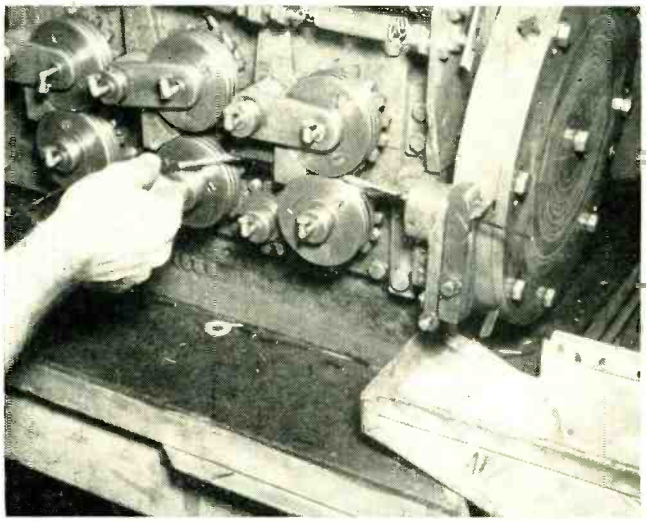
Automatic Spaghetti-Cutter Meets Production Requirements

SLEEVING or spaghetti is cut to precise lengths at high speed, with clean right-angle cuts and no frayed threads, by a simple modification of a standard wire bus-cutting machine at RCA's wire-cutting plant in Camden.

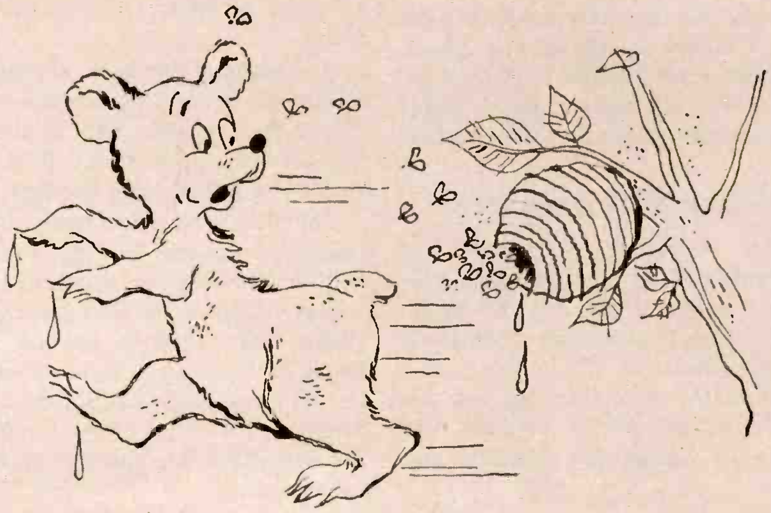
Larger grooves were machined in the final pair of feed wheels and copper tubing added to guide the spaghetti through these wheels. Lengths of cut pieces are easily



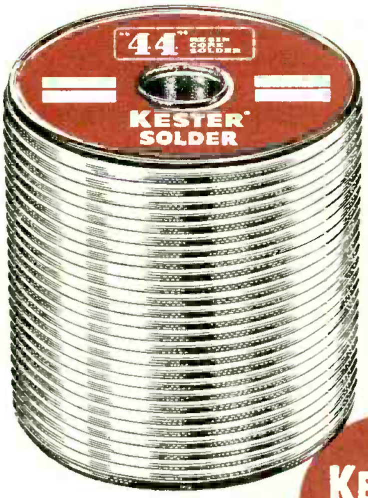
OLD METHOD—Bundle of 36-inch spaghetti was wrapped with masking tape and cut to desired short lengths on circular saw having length gage. Tape then had to be peeled off by hand



NEW METHOD—Simple modification of standard bus-cutting machine does job automatically, almost as fast as operator can thread new lengths of spaghetti into the copper guide tube.



INSTANT ACTION!



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RESIN CORE SOLDER

ESPECIALLY FOR TV . . . RADIO WORK . . . EVERYTHING ELECTRONIC

In speed of action for fast soldering, this product far surpasses anything in the Industry today. Unbelievably more active and mobile . . . absolutely non-corrosive and non-conductive.

For an actual demonstration in your plant, contact Kester's Technical Department.

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I.R.E. SHOW

KESTER SOLDER COMPANY
4204 Wrightwood Ave., Chicago 39
Newark, N. J. • Brantford, Canada

changed by changing the speed of the cutter wheel with relation to the feed wheels, using the existing gear-changing system of the machine.

With the available gear changes and 8 blades on the cutter wheel, the range of lengths is ½ to 2 in. Removing alternate cutter blades changes the range to 1 to 4 inches.

Soldering With Two Irons

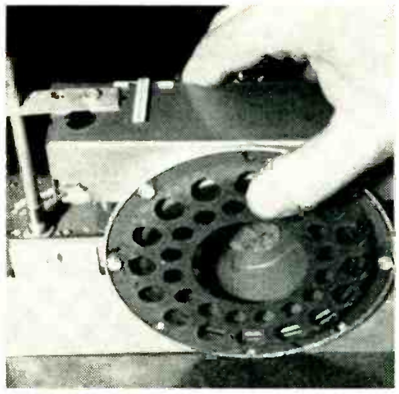
WHEN soldering operations are concentrated in the smallest possible number of positions on an assibly line, maximum soldering speed is attained. To maintain this speed without cooling an iron too much, many plants provide two irons per worker for alternate use.

Protecting Speakers

Two ways of protecting paper diaphragms of radio speakers from the thumbs of assembly-line workers are used in Emerson's Jersey City plant.

One method involves slipping a square of corrugated cardboard between the speaker and a chassis bracket for protection while the chassis is going down the line.

The other method, used chiefly when the chassis has no suitable holding bracket for cardboard, involves using a speaker mounting gasket that extends inward over much of the cone. Holes punched in this large gasket minimize interference with sound waves. A forming operation pushes the punched gasket outward so that the diaphragm cannot touch it during extreme in-and-out movements.



Inward-widened speaker gasket prevents thumbs of workers from punching hole in diaphragm

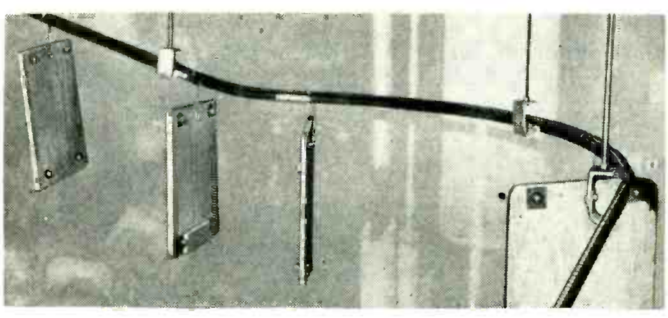
Flexible Threaded Shaft Serves as Overhead Conveyor for Empty TV Dollies

Motor drive for shaft, and type of hook used on pallet

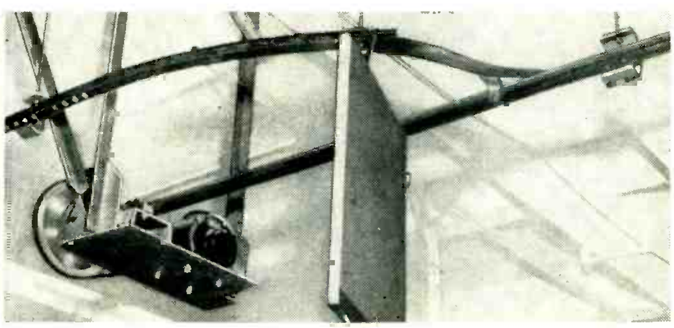
A SIMPLE and inexpensive overhead conveyor installation at Emerson's Jersey City plant returns empty television chassis dollies a total of 240 feet from the end of the assembly line to the start of the line. Motive power is a flexible threaded shaft that rotates in a U-shaped channel and is driven at one end by a motor. Each dolly has a wire hook like a coat hanger; when this is hooked over the rotating shaft, the dolly is moved lengthwise along the shaft by the threads. The system was introduced by Martin Richmond, facilities planning engineer for the company, at a total installed cost of under $3,000.

Formerly, empty dollies were tossed into a hand truck and moved in batches to the start of the line; this took about half the time of one man and tied up several material-moving trucks. By eliminating this, the conveyor system will pay for itself in about one year. An important added benefit is complete elimination of damage to dollies. When trucked, rough handling frequently damaged the chassis-holding brackets and the ball casters, causing line jam-ups since the damage was usually not detected until the dolly was in use again. Reduction in maintenance cost of dollies is another benefit accruing from the conveyor.

The conveyor used is an adaption of a garment-industry coat-hanger conveyor made by Teleflex Inc., 248 W. Wingohocking St., Philadelphia. The flexible shaft turns in a U-shaped steel channel with sides bent inward about 15 degrees from parallel so the shaft cannot jump out. The shaft itself has a core of longi-



Pallets hooked over threaded-shaft conveyor ride easily around 90-degree bends and up grades. Conveyor support rods are about five feet apart



Pallet ready to drop off end of one line and slide down metal strip to start of next line, which is driven by motor hanging from ceiling at left

All Band, Direct Reading

SPECTRUM ANALYZER

10 MC to 21,000 MC

The Model LSA is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an rf signal.

Outstanding Features:

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

Model LSA

The instrument consists of the following units:

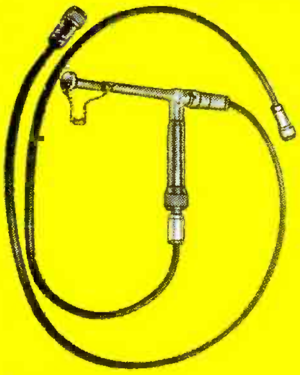
Model LTU-1 RF Tuning Unit—10 to 1000 MC.
Model LTU-2 RF Tuning Unit—940 to 4500 MC.
Model LTU-3 RF Tuning Unit—4460 to 16,520 MC.
Model LTU-4 RF Tuning Unit—15,000 to 21,000 MC.
Model LDU-1 Spectrum Display Unit.
Model LPU-1 Power Unit.
Model LKU-1 Klystron Power Unit.

Polarad PRECISION LABORATORY INSTRUMENTS

BROAD BAND MICROWAVE ATTENUATOR

Model SIJ

4 kmc to 12.4 kmc



Polarad's Broad Band Microwave Attenuator is intended for use as an external attenuator in microwave measurements with signal sources, receivers and for power measurements. Its useful frequency range is from 4000 mc to 12,400 mc. Model SIJ can be used as a standard calibrated attenuator or to couple a small amount of energy from a high level source for circuit protection, or for monitoring and for measurement purposes without introducing discontinuities or to insure rf circuit isolation.

By its use a Polarad Microwave Signal Source or a laboratory oscillator is converted into a signal generator.

Features:

- Continuously variable attenuation.
- Stub tuned; 50 ohm impedance.
- Waveguide beyond cut-off attenuator.

WIDE BAND VIDEO AMPLIFIER

Model VT 10 CPS to 20 MC

Designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of short duration and rise time. Excellent for TV, both black and white and color applications.

Model VT

Features:

- Flat frequency response from 10 cps to 20 mc ±1.5 db.
- Uniform time delay of 02 microseconds.
- Gain of 50 db.
- Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
- Fine attenuator covers a 10 db range.
- Phase linear with frequency over entire band.

SEE US AT BOOTH S-7—IRE SHOW

MICROWAVE SIGNAL SOURCES

Models SSR, SSL, SSS, SSM, SSX

634 MC to 11,000 MC

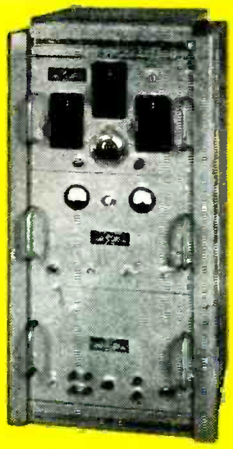
For use as a reliable source of microwave energy in transmission loss measurements, standing wave determination, etc. Unidial Control for accuracy and ease of operation. Direct reading (no mode charts to consult). Frequency determination accurate to 1% through use of present calibration and temperature compensated klystrons.

Five Microwave Signal Sources are available to cover the frequency range from 634 MC to 11,000 MC. Units ruggedly constructed, mounted on aluminum castings to insure mechanical stability. Klystron reflector voltage automatically tracked with tuning of the klystron cavity to provide unidial control. Signal sources supplied complete with klystron.

FREQUENCY MARKER

Model FM-L

950 mc to 2,040 mc



Polarad's Frequency Marker, Model FM-L, provides accurate frequency determination to within 10 kc over the frequency range 940 to 2020 mc.

The Frequency Marker produces calibration signals at precisely determined frequencies and these signals may be displayed and compared with an unknown rf signal, whose frequency can then be accurately measured.

Features:

- Frequency standard accurate to one part in 10^6.
- Frequency determination accurate to ±10 kc.
- Ten mc, 1 mc, and interpolation markers available.
- Markers throughout entire frequency range, 940 mc to 2040 mc.

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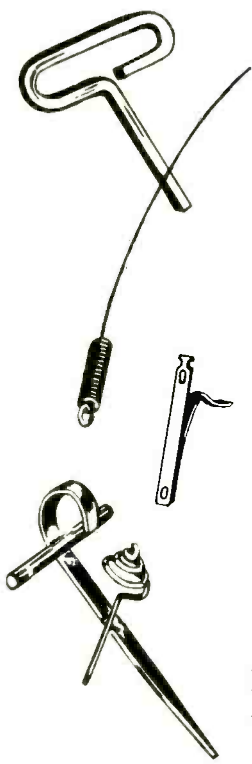

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THE *Better* PLASTIC U. H. F. INSULATION

BECAUSE OF:—

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- high heat resistance
- dimensional stability
- and extremely low initial cost

Rexolite 1422 has been specifically designed and developed to meet the growing need for a lightweight — low cost U. H. F. insulating material.

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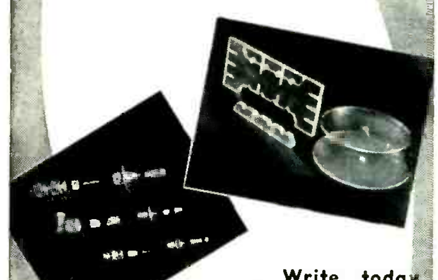
Meets JAN-P-77 and MIL-P-77A specifications.

The unusual chemical inertness and physical properties of Rexolite 1422 allow its use where other materials fail.

For use in: connectors, coaxial connectors, waveguide, antennas, leads and spacers, spreaders and air wound coil supports, coil forms.



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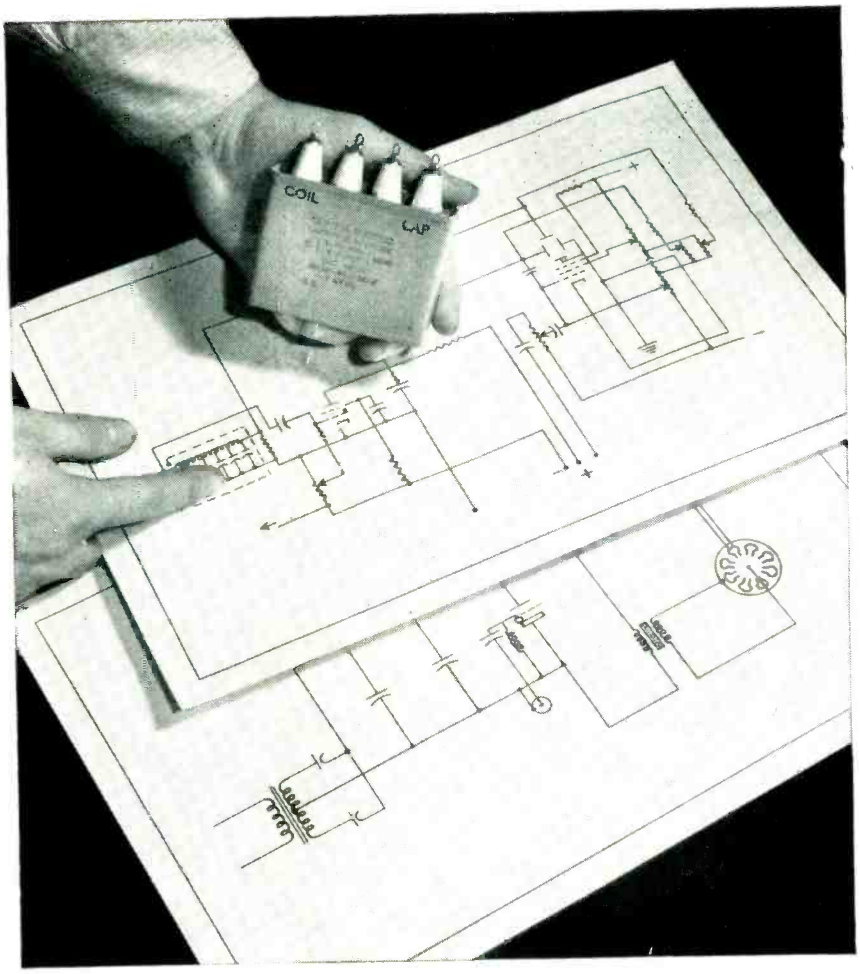
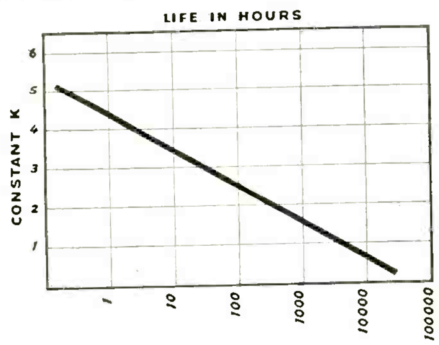
Got a really tough capacitor network problem for us?



...let our network designers help you solve it!



This curve results from actual life tests of capacitor networks under pulsing conditions in a radar modulator. Service life, for varying values of "K", starts at 2 tenths of one hour and stretches out to something over 40,000 hours (more than 4½ years of continuous operation at full-rated voltages.)

It's just one example of actual performance data G-E engineers use in designing capacitor networks for the job they must do.

Whether your problem deals with guided missiles—aircraft—land or sea radar equipments, General Electric application and design engineers can help you solve it. We've designed and built capacitor networks for every type of pulse radar equipment since the inception of radar.

Take service life for example. You can specify a service life of 10,000 hours—or just 60 seconds. And we'll deliver pulse networks to match your requirements. Here's why:

> Since 1944 General Electric has been running continuous life tests on many types of networks. We've established life limitations, under varying conditions of temperature and voltage, for all types of dielectrics, bushings, materials for coil forms and treating processes.

Let us use this store of information and experience to solve your capacitor network problems. Your inquiry addressed to your nearest Apparatus Sales Office, or to Capacitor Sales Division, General Electric Company, Hudson Falls, N. Y. will receive prompt attention.

General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

407-308

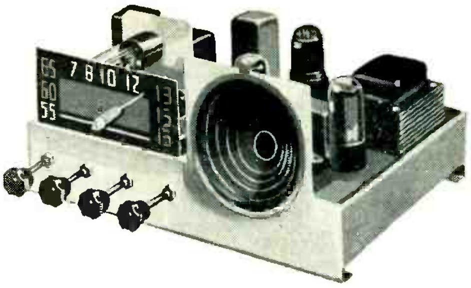
Using heat to strip rubber-covered insulation from wire. Stripped insulation drops into drawer below. Rheostats permit independent control of current through each heating jaw

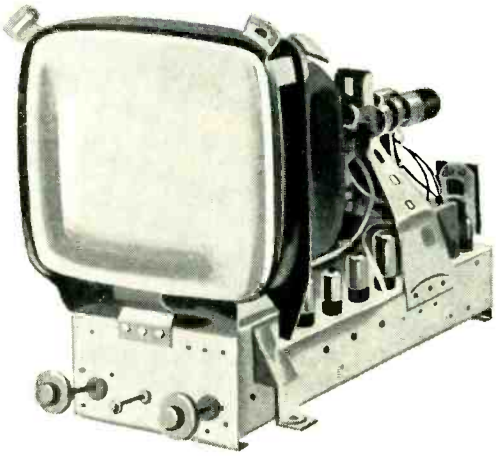
copper alloy jaws until an adjustable back-stop is touched by the wire. A foot pedal is then pressed, bringing the hot jaws together. Usual time to cut through the insulation with heat is less than 1 second. The wire is then pulled out while jaws are still closed, stripping it clean. Heating jaws have U-shaped indentations like conventional wire-stripping blades, eliminating need to rotate wire during heating.

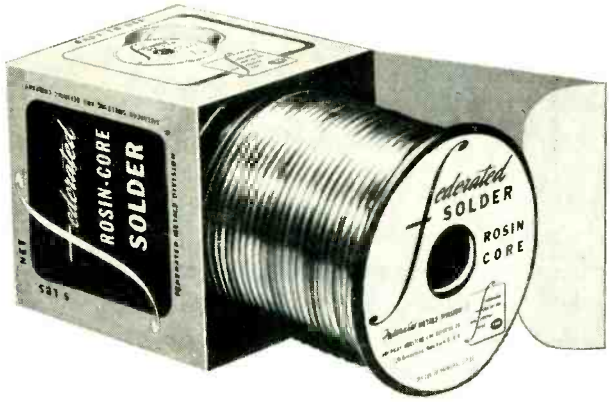
Twin-Lead Connector

As FAST as any fixture for connecting 300-ohm twin-lead line to screw-type antenna terminals of a television receiver is the new Tenna-Clip made by Industrial Television Inc. in Clifton, N. J. During alignment and test operations on a receiver production line, an operator can connect or disconnect the antenna just as fast as if making a

Clip permits connecting two wires to two adjacent terminals quickly

FOR RADIO  AND

TV  SOLDERING THAT LASTS...

USE... 

For any soldering job that demands freedom from corrosion and conductive flux residue . . . for ease of working and unequalled consistency . . . there is nothing better than Federated Rosin Core Solder.

Each Rosin Core Solder composition . . . there is a variety for different purposes . . . is a tin and lead alloy with a rosin flux that is effective but not corrosive. Because the rosin residue is chemically inactive, current leakage at radio and television frequencies is prevented.

Federated Rosin Core Solder is a quality product that is unsurpassed for the permanence of the bond it produces . . . for the consistently easier soldering job it does! Look for it in 1, 5, 20, 25, and 50-pound sizes on the familiar orange and black metal spool. Listed by Underwriters' Laboratories Inc.

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Zirconium metal powder, finely divided, may be sprayed for coating tube parts, suspended in temporary binders such as nitro cellulose dissolved in amyl acetate.—Shipped wet.

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Cossor Double Beam Precision Oscillographs

Model 1035 General Purpose Instrument
- Double beam C.R.T., flat 90 mm screen.
- Time base has directly calibrated time scale. 15 microseconds — 150 milliseconds in 9 ranges. Repetitive or triggered operation, internal or external synch. by selection, suppressed fly-back, calibration waveform provided.
- Y1 Amplifier. Response 7 mcs. to 20 c.p.s. directly calibrated voltage scale with 7 ranges.
- Y2 Amplifier. 100 Kcs. to 20 c.p.s. directly calibrated voltage scale with 5 ranges.
- All necessary circuitry accessible on front or side panels.

Model 1049 Oscillograph with D.C. Amplifiers
- Double Beam flat face C.R.T. 90 mm dia.
- Time base. Directly calibrated time scale, response 150 microseconds to 1.5 seconds in 9 ranges. Internal or external synch., repetitive, triggered or single stroke T.B. operation, by selection.
- Y1. D.C. Amplifier. D.C.—100 Kcs., with directly calibrated Y shift control. Gain 900.
- Y2. D.C. Amplifier. Calibrated switch attenuator for Y2 sensitivity. Gain 25.
- Beam Trigger operation facilities, off, electrical and time marking, mechanical sources and from power supply or push button.
- All necessary circuitry accessible on front or side panels.

MODEL 1037 (Portable). A general purpose double beam oscillograph. Y1 amplifier direct coupled. Y2 amplifier A. C. connected.
Power supply: **80-230 VOLTS INPUT AT ANY FREQUENCY FROM 25 TO 2400 CYCLES.**
MODEL 1428 — Camera. Manual or power driven.
MODEL 1429 — Motor drive for camera.
MODEL 1430 — D. C. amplifier. (Trolleys and usual accessories available.)

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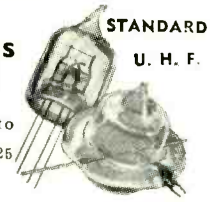

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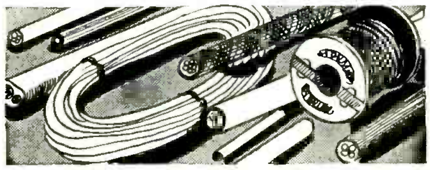

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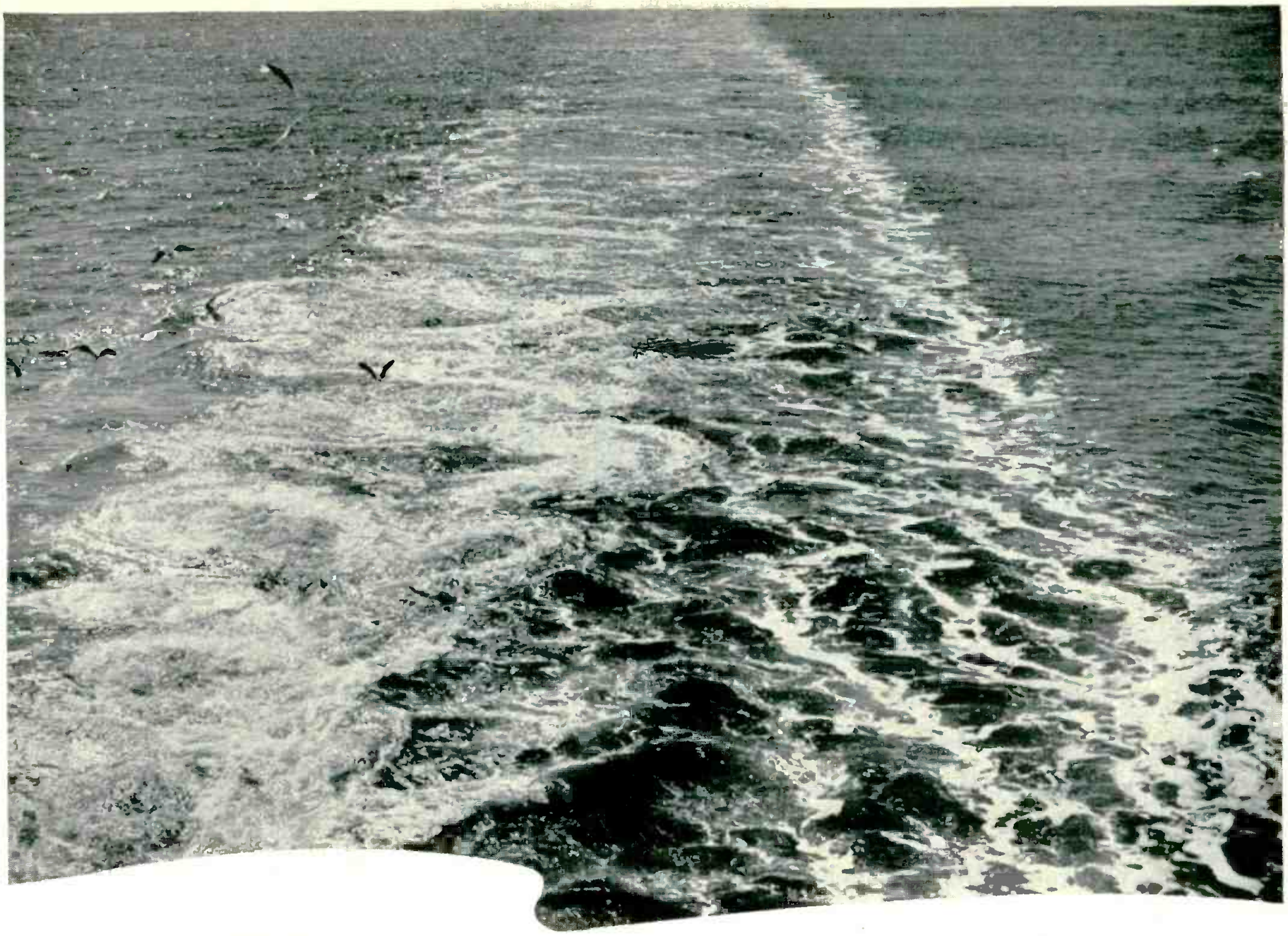

SONAR

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THE WAKES... of more and more vessels churn over water accurately scanned by Edo sonar. A major electronic development in underwater detection equipment, Edo sonar will measure depths over far greater ranges with accuracy, clarity and legibility never before achieved.

Because of such development work in its electronics laboratories, Edo has become a major supplier of sonar equipments for the United States Navy.

EDO CORPORATION College Point, L. I., N. Y. SINCE 1925 single clip connection. Metal jaws are attached to a spring-type clothespin and each jaw is connected to one of the twin-lead conductors.

Assembly-Line Merry-Go-Rounds

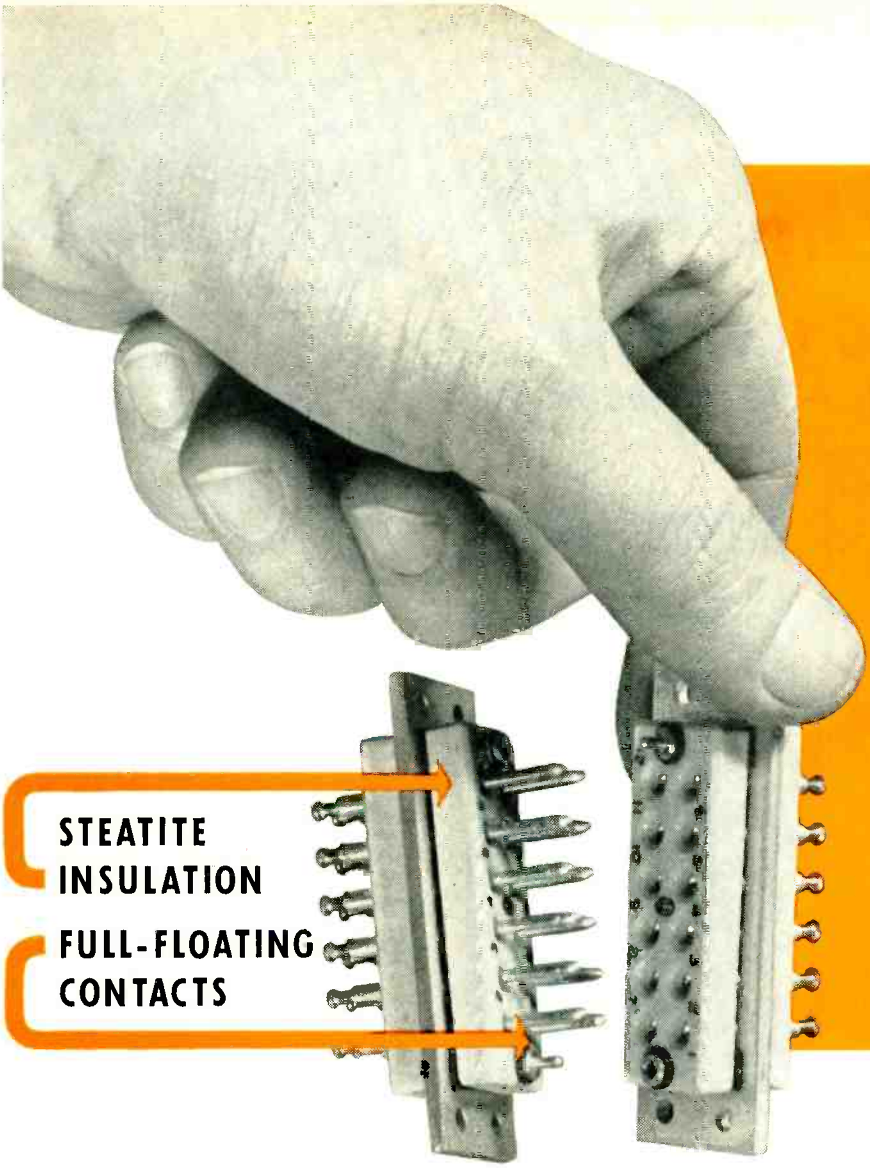
A SMALL angle-mounted turntable speeds assembling and soldering of parts on ten pairs of sockets at a time during production of X-ray diffraction instruments at the Mount Vernon, N. Y. plant of North American Philips Co.

Ten pairs of inverted tube bases are screwed to individually rotatable wood discs on the all-wood rotating turntable to serve as holders for the sockets. Mounting and soldering of small parts and short leads has proved much easier when done before the sockets are riveted in place deep in a crowded chassis. Errors are cut to a minimum by adding the same part or lead to each of the ten subassemblies in turn as the platform is turned.

Cabinet Merry-Go-Round

A large four-position turntable holds four console television cabinets at convenient working height for installation of speakers and loop antennas at the Brooklyn plant of CBS-Colubia. Fastened on top of the table at each position is a rectangular frame of 2-by-4's covered with several thicknesses of sponge

Subassembly merry-go-round at North American Philips Co. holds ten pairs of sockets. Each pair is on a pivoted wood disc that can also be turned



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PLUG-AND-RECEPTACLE for Sectionalizing Circuits

SIMULTANEOUS contact of any number of leads can be made or broken by use of Lapp Plug-and-Receptacle units, for panel-rack assembly or other sectionalized circuits. Insulation is Steatite, the low-loss ceramic which is non-carbonizing, even when humidity, moisture or contamination sets up a leakage path. The unit shown above provides twelve contacts, rated for operation at 2.5Kv peak terminal-to-terminal, 1.5Kv peak terminal-to-ground, 25 amps at 60 cps. All contacts are silver-plated; terminals are tinned for soldering. Polarizing guide pins assure positive alignment. Write for specifications of this and other available units, or engineering recommendations for special units for your product.
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INTERNATIONAL DIVISION: 19 RECTOR STREET, N. Y. C.

Cabinet merry-go-round used in place of conveyor line at CBS-Columbia when only a few cabinet operations are needed

rubber, to protect the finish when the cabinet is handled upside-down. Three positions serve for three different series of assembly operations, and the fourth position serves for loading and unloading the cabinets.

The cabinet turntable is constructed from wood, with a vertically mounted pipe serving as pivot. Eight fixed rubber-wheel casters mounted on a four-foot diameter under the turntable roll on the plywood sub-table to take the weight of the merry-go-round.

Counter Merry-Go-Round

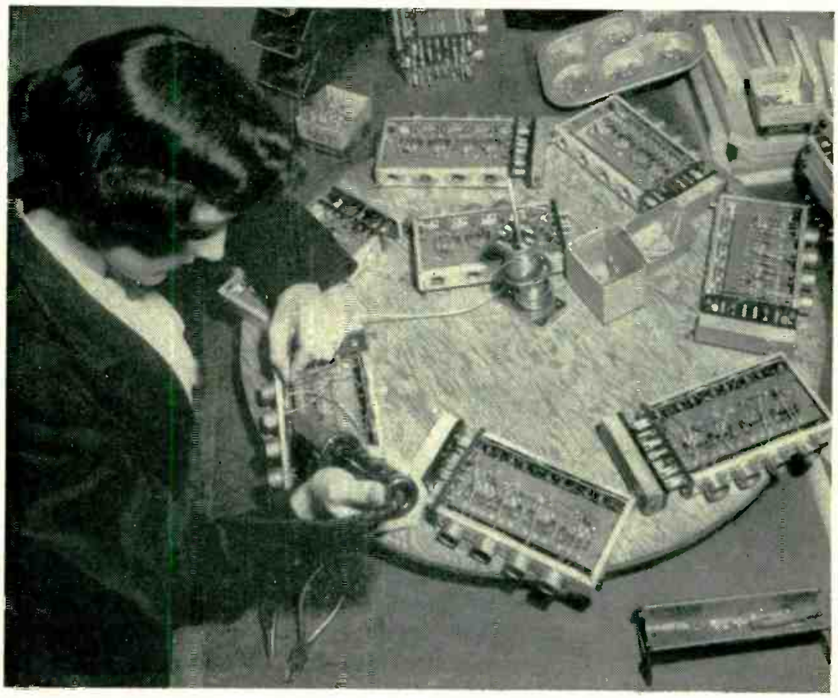
Plug-in electronic counter units are assembled seven at a time on a half-inch plywood merry-go-round in the Great Neck, Long Island plant of Potter Instrument Co. Mating sockets for the plug-in terminals are mounted on wood strips that are hinged to the turntable, to serve as holding fixtures for the chassis units and still permit turning over the chassis units quickly for work on the opposite side.

The projecting shaft of the turntable is a convenient holder for solder and wire spools. As in all merry-go-round assembly work, the same short cycle of operations is performed on each chassis in turn as the table is spun around, to take advantage of accuracy and speed gained through repetition of simple operations.

Pass-Along Merry-Go-Round

A merry-go-round assembly line is used by the Crosley Division of Avco Mfg. Corp. to maintain quality during excessively long operator cycles involved in low-quantity production of complicated electronic equipment. Chassis wiring operations are broken down to approximately one-minute cycles and the work for each such cycle is listed on a 3 by 5-inch card.

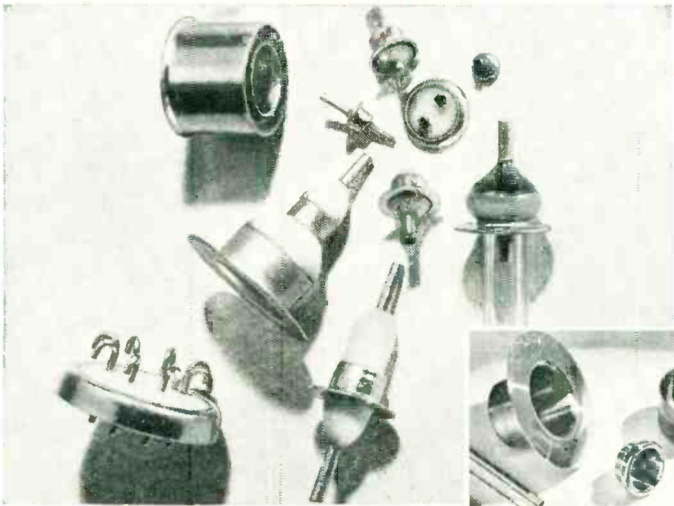
Operators sit on both sides of a long work table having raingutter-type parts trays down the full length of each side. The chassis



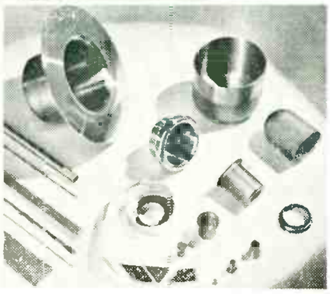
Merry-go-round assembly of electronic counters at Potter Instrument Co.

Your sealed assemblies can be kept TIGHT with

STUPAKOFF
Kovar-Glass Seals



Stupakoff Metal-to-Glass Seals are made in a variety of sizes and ratings.



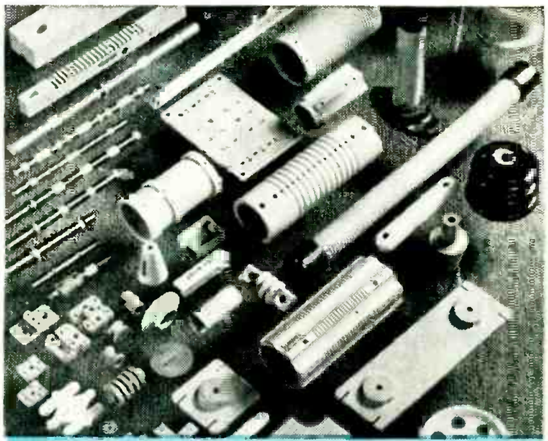
Kovar Metal, the ideal alloy for glass sealing, is furnished in the form of tubes, rods, sheet, foil and fabricated shapes.

Metal-to-glass seal making has been highly perfected by Stupakoff. When you specify Stupakoff Seals, you get well-designed, accurately-made products that are easy to assemble, mechanically strong, have high flashover ratings, provide high resistance to thermal shock and are dependable. They are made in a wide variety of standard types and sizes, or in special designs to meet your specific needs.

Stupakoff seals are all made with Kovar Metal, which is readily bonded with hard glass producing no undesirable structural stresses. It has substantially the same expansitivity as hard glass from -80°C to the annealing point of glass. These characteristics of Kovar make Stupakoff Seals dependable.

Write for samples and prices of typical Stupakoff Kovar-Glass Seals.

STUPAKOFF
CERAMIC & MANUFACTURING COMPANY
Latrobe, Pennsylvania



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CERAMICS—Stupakoff has long been a leading supplier of ceramic products for a wide variety of electrical and electronic applications—precision made for all voltages, frequencies and temperatures.

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CERAMIC DIELECTRICS—For by-pass, lead through, blocking, standoffs and trimmer applications. Temperature compensating Ceramic Dielectrics have coefficients from P-100 to N-2700, and high K materials up to K-6000. Tubes, discs and special shapes, plain or silvered.

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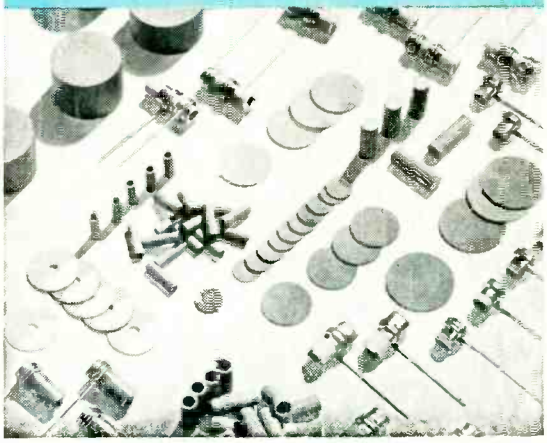
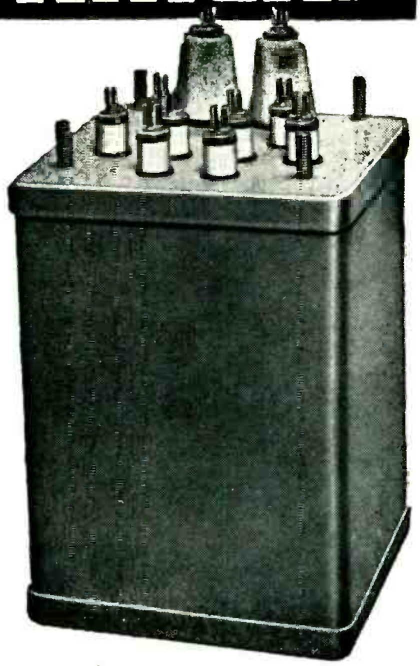


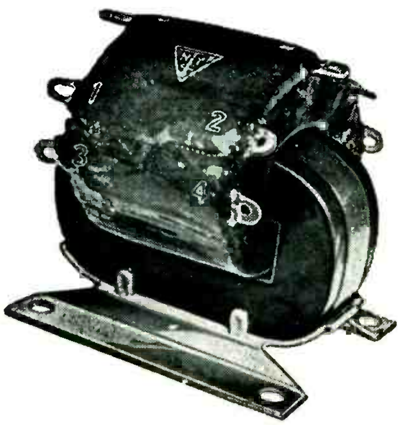
FULL RANGE OF MIL-T-27 TRANSFORMERS

HERMETICALLY SEALED UNITS



NYT hermetically sealed transformers are available in all standard sizes to meet MIL-T-27 specifications, and especially designed constructions for a wide variety of military as well as civilian applications. Designed and built to meet the most exacting specifications. Production facilities for quantity production of all sizes.

the HORNET



HORNET transformers, pioneered by NYT, are of open type construction, utilizing Class H insulating materials. Approximately one-fourth the size and weight of comparable Class A units. Filament and plate supply transformers and chokes. Units can be designed for ambients up to 190 deg. C., altitudes up to 60,000 feet; power ratings from 2VA to 5KVA.

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has the experience in

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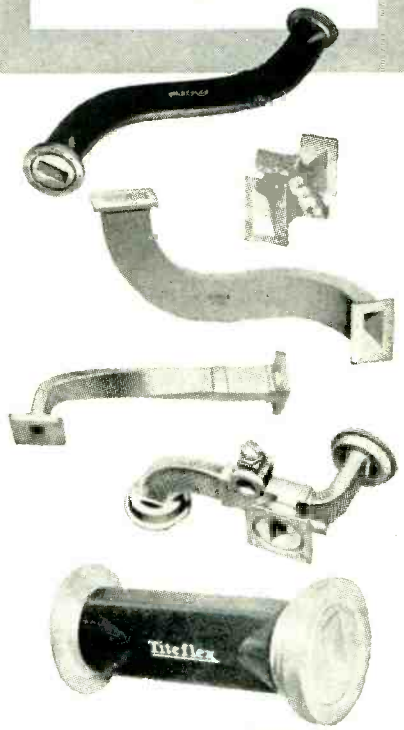
Regardless of the types of waveguides and components you require, Titeflex can supply them. We manufacture rigid and flexible guides, combinations of the two, and any required component parts. As an A-N approved source, our engineering and testing facilities are always available for the development of new designs. Write us.



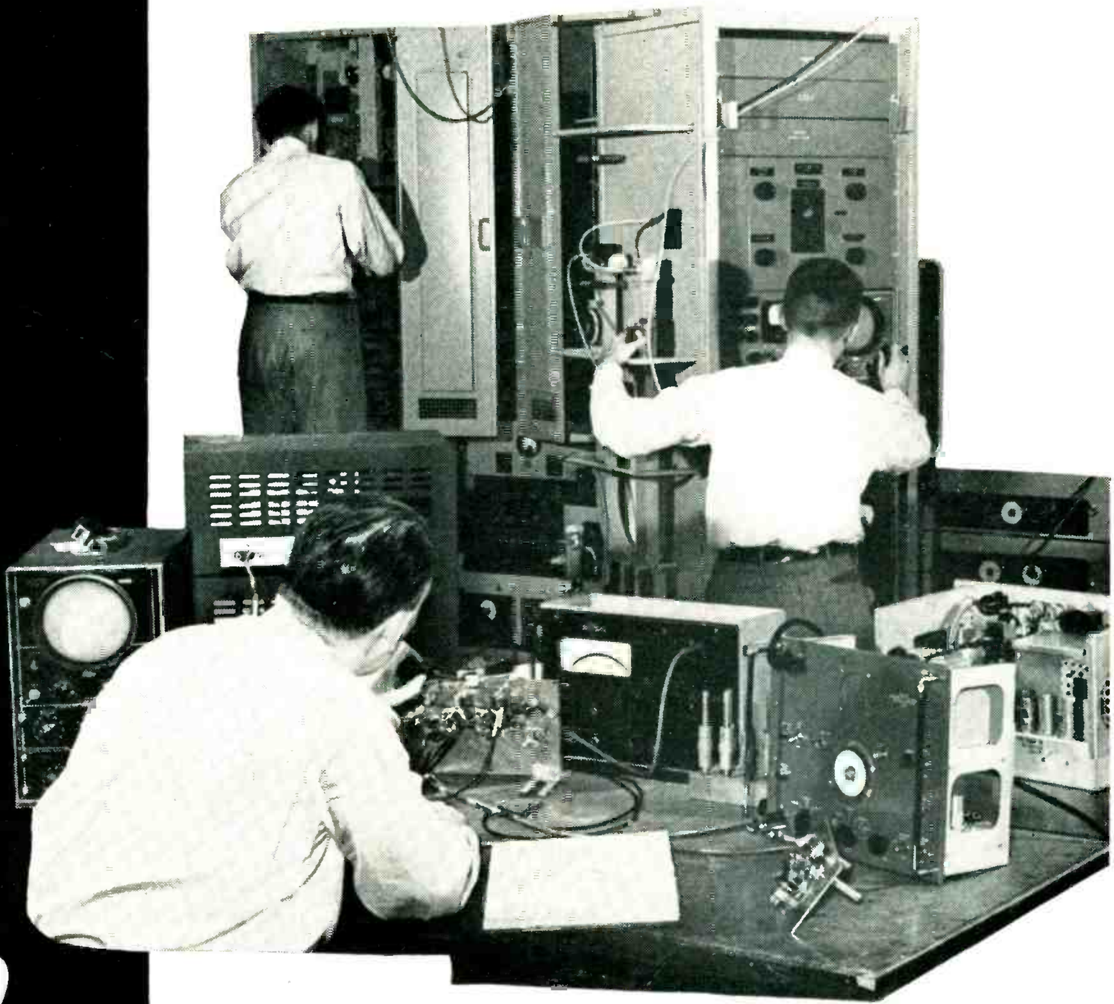
SEND FOR THIS *NEW BULLETIN*

Contains complete waveguide specifications, including materials, dimensions and recommended operating ranges for all types.

Titeflex, Inc.

524 Frelinghuysen Ave., Newark 5, New Jersey

What kind of men?



What kind of men are the 2500 scientists and engineers of Bell Telephone Laboratories?

They are men of many types, yet they work well together, for all have good minds as a foundation, years of study in the fundamentals of their science and in the methods of research and design. Vital, too, is their teamwork — for without the co-operation of many individuals the products of research and development could never be perfected.

Above all else these men have "the spirit to adventure, the wit to question, and the wisdom to accept and use."

Such men can develop the world's finest telephone systems — and have done so.

Perhaps there is a place among them for you. Write the Employment Director, Bell Telephone Laboratories, New York 14.

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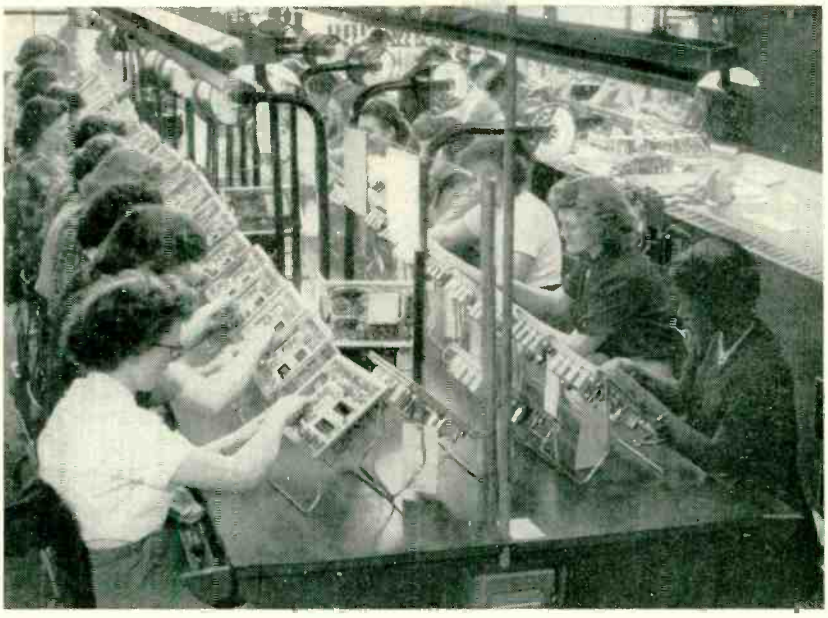

Merry-go-round pass-along assembly line used by Crosley. Each chassis goes down one side of table, across end, up other side, across end, then around again as many times as necessary to complete all the one-minute cycles of work

units are delivered to this table with all large items such as chokes, transformers, coils and riveted parts already mounted. Each chassis is on a fixture that holds it at an angle facing the operator and permits easy sliding on the table.

Operation of the merry-go-round is best illustrated by a specific example. Assume that fifty units are to be produced and 20 operators are available. At one-minute intervals, a load of 50 riveted chassis units from subassembly is fed to operator No. 1. She does operation No. 1 on each chassis and slides it on to the next operator for the next one-minute cycle of work. Fifty minutes later the merry-go-round assembly line is full and operator No. 20 is finishing operation No. 20 on chassis No. 1, whereas operator No. 1 is finishing her work on the 50th and last chassis of the run. When

Self-service parts supply cart used in conjunction with Crosley merry-go-round production line. Cart is loaded in stockroom with quantities to match single day's production, giving close control of material. Each operator takes from the cart the individual filled trays she will need, and places them in the raingutter-type holder that runs the full length of the work table. Ball-caster chassis jacks are used on this particular line

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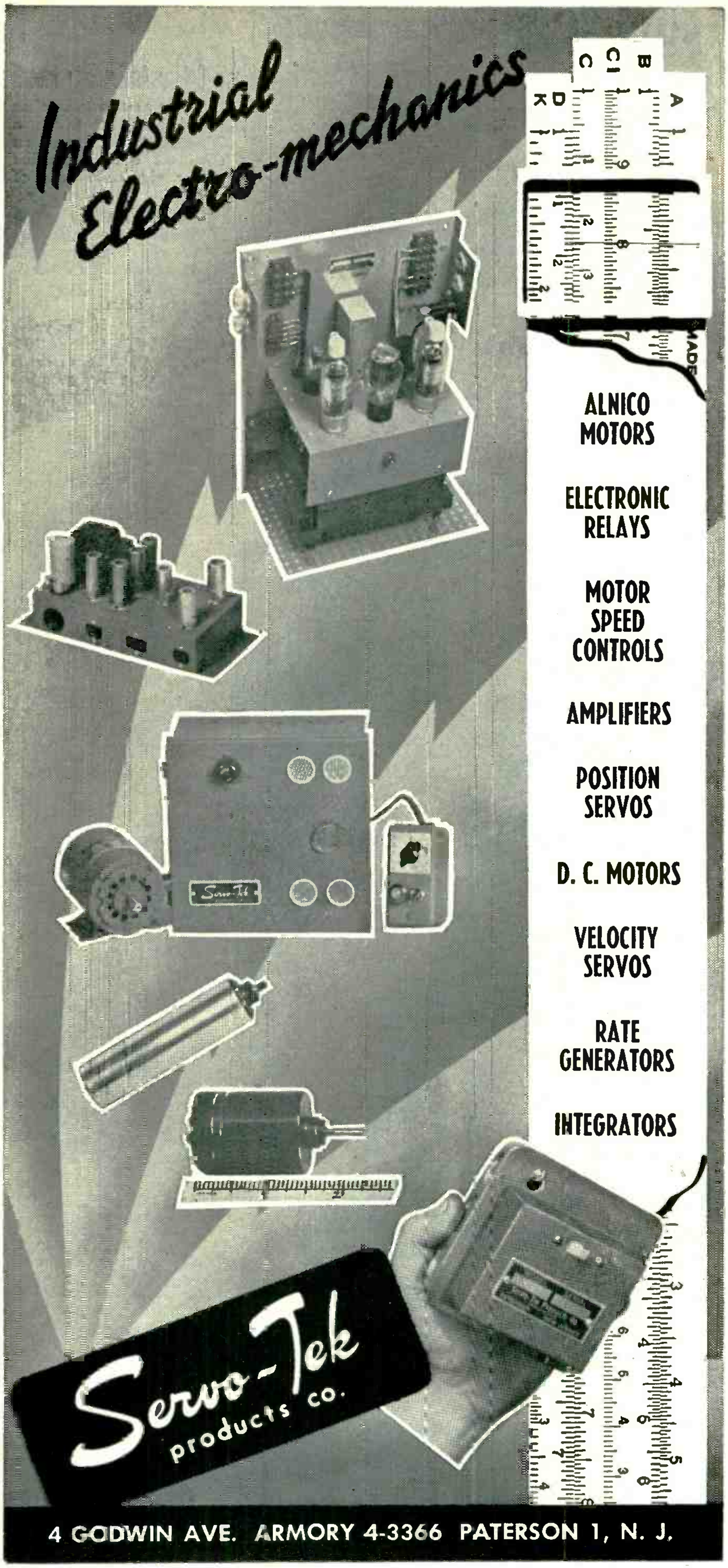
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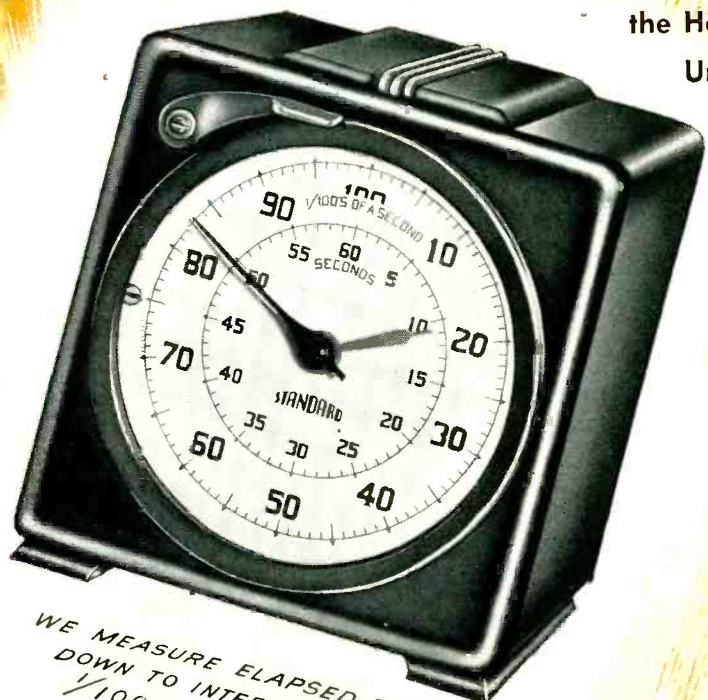

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the line is starting, some operators are idle or doing other work until the first chassis reaches them, just as in any other sequential assembly line.

Operator No. 1 now changes to the work card for operation No. 21 and performs the specified new operations as Operator No. 20 passes the 50 units to her across the table one by one for their second trip around the table. This procedure is continued until all work has been performed on all 50 units. If it is desired to continue production beyond 50 units, a new chassis may be fed into the line as each completed chassis is removed from the last line position.

Since the operations are simple and are printed on cards passed out by instructors each time a merry-go-round line is started, the line can operate with less than 20 girls whenever there are absentees. With 50 units on the table once the line is full, one or more units are between operators to even out the cycle of work.

Advantages of the technique include shorter training time for each operator, easing of absentee problem and faster improvement in quality and output when starting a new production line. These advantages in turn give lower production costs, easier line balance, improved quality and reduced scrap.

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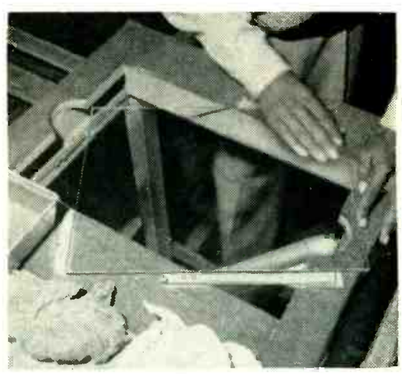
SAFETY-GLASS windows for television receivers are cleaned with denatured alcohol while the glass is resting on a felt-covered frame over a fluorescent lamp, to highlight all spots and smears requiring removal. Fine steel wool is used



Safety glass rests on felt-covered frame of light box during cleaning

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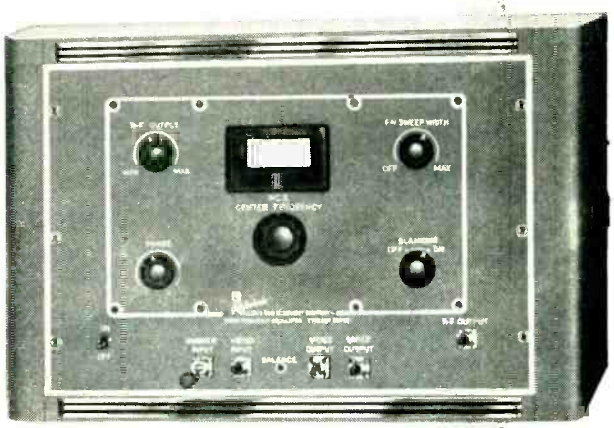

The Type 907 is a fundamental oscillator which can be swept in frequency over a band of not less than 10 mc/s for a center frequency of 35 mc/s. The sweep width is greater than 20 mc. for carrier frequencies above 60 mc/s. Output is continuously variable over a voltage range of 10 microvolts to 1 volt. Internal blanking circuits provide a "true zero" base line for an oscilloscope display.

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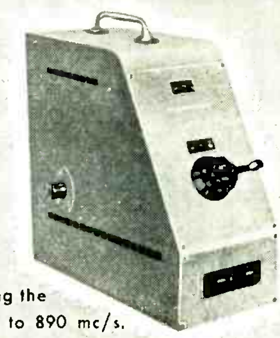
Type 584 UHF Frequency Meter

is a high Q Frequency Meter covering the band of 470 to 890 mc/s.



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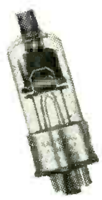

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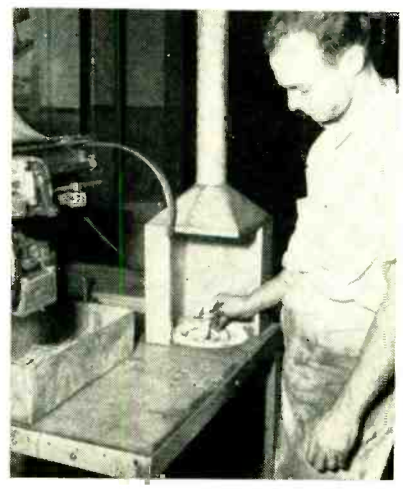
Wire-Stripper Keeps Busy

WHEN all the wire-stripping machines in his department were loaded and running smoothly, operator E. J. Pike found he had nothing to do. From him came the suggestion for installing a solder pot at one of the machines, so he could twist wire ends together and give them a solder dip while keeping one eye on the machines. This idea was given a Suggestion Award at RCA Victor's Camden, N. J. plant.



Solder pot near wire-stripping machine permits tinning wires during otherwise idle operator time

Production Testing of Selenium Cells

By C. A. KOTTERMAN

Chief Engineer, Belcon Rectifier Division Bogue Electric Mfg. Co., Paterson, N. J.

and D. H. RANSOM

Director of Research & Development, Bogue Electric Mfg. Co., Paterson, N. J.

BOTH the forward and reverse characteristics of a single selenium rectifying cell can be measured simultaneously in 15 seconds with the simple yet accurate test circuit shown. This test can be applied to any quantity of cells during a daily production run, for sorting accord-

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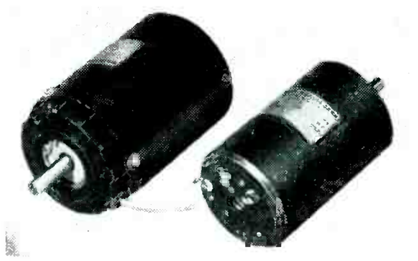
5½-watt PS101, right, is no larger than grain of puffed rice. Type MV1, center, is 4-watt economy size. Type P5306, left, is rated at 8½ watts to 15,000 ohms.

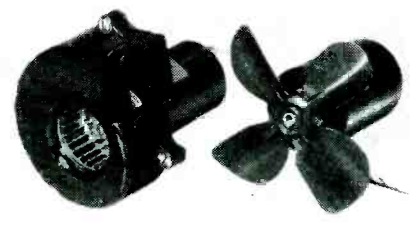
Special Induction Motors

INDUCTION MOTORS CORP.'s new miniature AC motors have unusually low temperature rises and are de-



Shockproof aluminum housings show perfect bearing alignment after shocks.

signed for operation from −65°C to as high as +85°C with standard A-type insulation. Special insulations are available for much higher ambient temperatures. Meeting all military specs, the series includes induction, synchronous, non-synchronous, 60-cycle, 400-cycle, variable-frequency, single-phase and polyphase motors in ratings of 1/1000 HP to 1/10 HP. These anodized aluminum sealed



Lowered power input and heat rise give higher speed and air output, reduce size.

motors feature ruggedized construction, ball or sleeve bearings, midget size and weight for given HP rating, and protection from fungus and humidity extremes. Applied to all types of radar, timing, fire control, camera, servo and automatic devices, they are also used on IMC's own blowers and fans for cooling electronic tubes and assemblies. The centrifugal blowers range from tiny 1½" wheels through plastic 2", 2½" and 3" units on up to large metal-housed types providing high CFM and/or high pressure. Axial fans are available in similar variety. Induction Motors Corp., 55-15 37th Avenue, Woodside, N. Y.

Industrial Solder Pack

H. J. ENTHOVEN & SONS LTD. eliminate waste and labor in the issuing of roughly-measured hanks of solder to production and maintenance personnel. Their accurately precut lengths, spooled within a cylindrical shockproof handle labeled with alloy, core and gauge, are compactly stored and inventoried, carried in tool kits without the solder becoming dirty, knotted or entangled with tools, and eliminate innumerable waste ends. H. J. Enthoven & Sons Ltd., c/o British Electronic Group, 366 Madison Avenue, New York 17, N. Y.

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H. J. ENTHOVEN & SON's colored core solders expose the "sloppy" wireman from among many doing the same operation. The colored core "Flashes" are basically the Enthoven water-white activated rosin core Superspeed solders with the addition of a minute amount of stable dye having no effect upon the wetting action for which the core is known. No extra charge is made for colored cores. As in Superspeed, the multiple fluted

Superspeed's fluted core has greater area of dispersion than all competitive brands.

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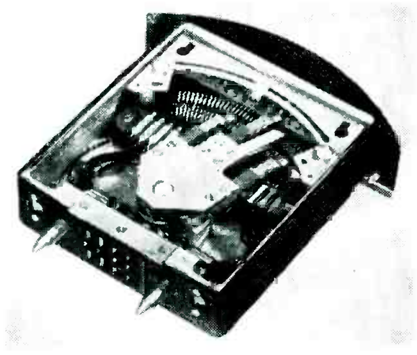

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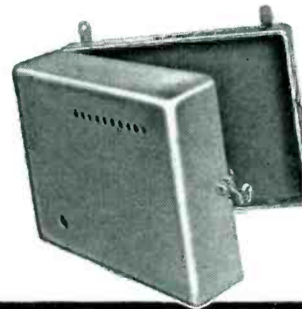

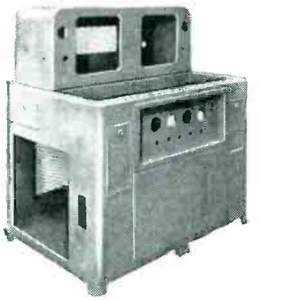

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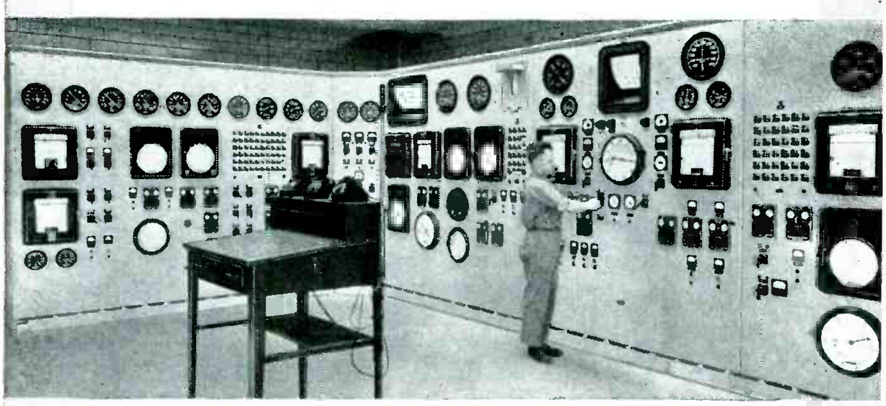

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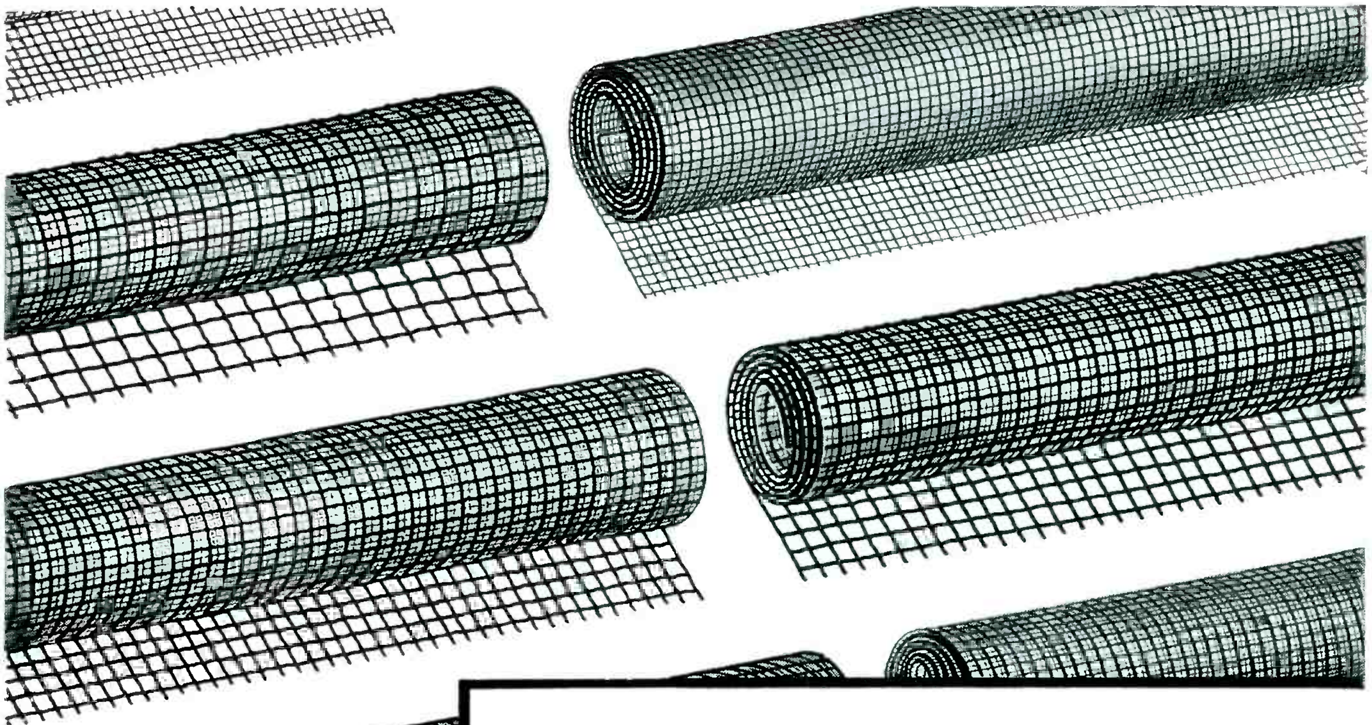

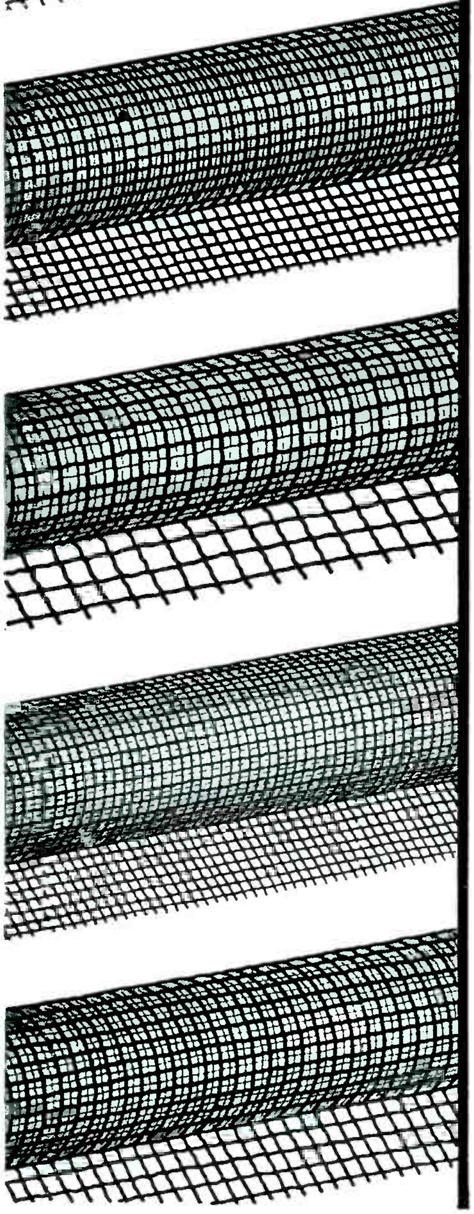

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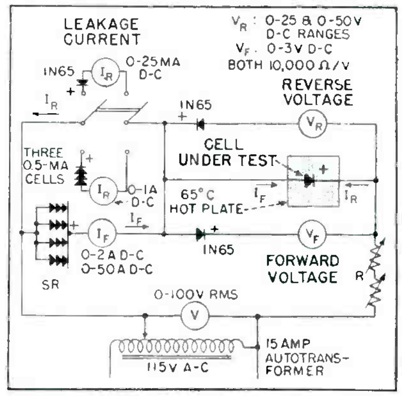


Test circuit, proposed as standard for metallic rectifier industry

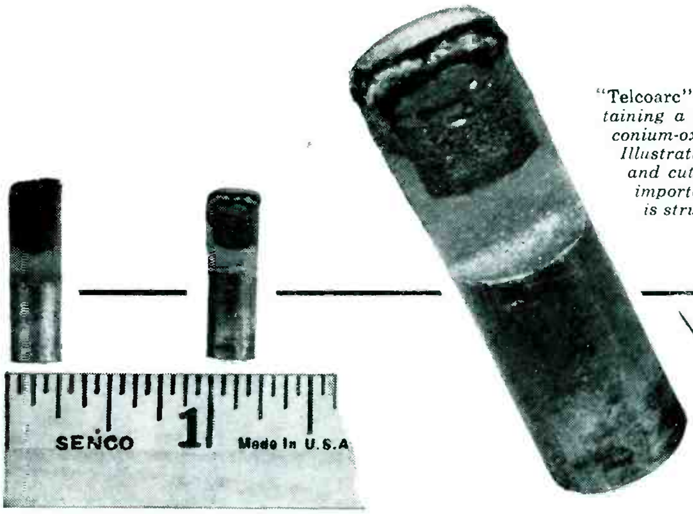
ing to characteristics as well as for quality control.

The circuit tests a single cell for maximum allowable leakage current for a given blocking voltage, and also checks the maximum allowable voltage drop for the current density the cell is processed to deliver. These two measured values form the basis for an acceptance or rejection test.

Selenium rectifier *SR* should have a leakage current of less than 0.0005 ampere per sq in. of actual rectifying area when blocking 20 volts rms per cell. This rectifier should pass more than 20 amperes continuously in the conducting direction and pass 40 amperes or more for the short time intervals necessary to make a test. Twelve special 5.5-ampere half-wave cells, each 6″ x 6″ in size, met this requirement.

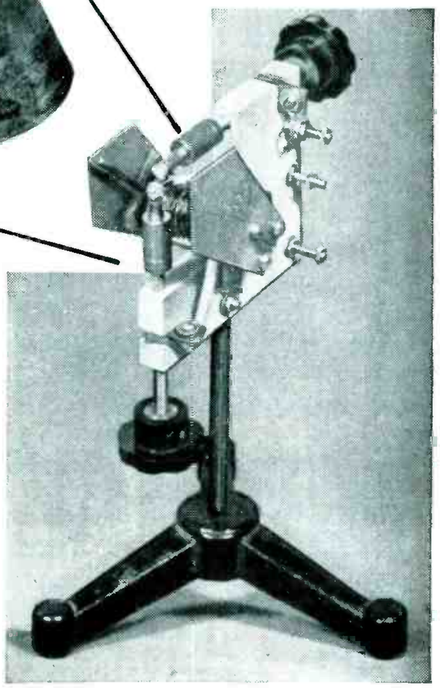
To simulate field operational conditions, the test cell should be placed on a hot-plate maintained at 65 C by a built-in thermostat. This enables all cells to be tested at their minimum forward resistance and eliminates variations in ambient temperatures. Series load resistor *R*, used to establish the correct forward current value for the test cell, should have sufficient resistance range and wattage rating to handle the maximum current that the largest test cell is capable of passing in the conducting direction.

To make a measurement, the cell is placed on the hot-plate with the counter-electrode alloy surface facing upward. Connection to the alloy surface is made with a half-pound brass block that also presses the cell into intimate physical con-



"Telcoarc" lamp electrodes are nickel tubes containing a powdered core mixture of 87% zirconium-oxide, 8.7% nickel and 4.3% iron oxide. Illustration shows cut-away of new electrode, and cut-away of used electrode showing the important zirconium cap on which the arc is struck.

1/8 as bright as the sun ...from 1/4" electrodes



"Telcoarc" lamps, says Western Union Telegraph Company research, will prompt major developments in the projection, television, photographic, lithographic and photo copying industries, as well as in the medical field. They operate on either AC or DC.

Another tough metal problem solved by the use of Nickel

Western Union's open-air "Telcoarc" lamps give a controlled, concentrated spotlight one-eighth as bright as the sun. Yet the light is produced by only quarter-inch diameter nickel tube zirconium electrodes.

More than the light, the most unique fact about these lamps is the exceptional long life of the electrodes. In *open-air* at 650 watts, they are consumed at the rate of one inch in 100 hours.

It was no easy task to develop these electrodes. First the engineers had to find a metal for the outer tube to hold the zirconium-oxide filler—*a metal that did not oxidize readily.*

They tested a wide variety of materials. Then they tried Nickel!

The first Nickel tube electrode showed promise; but the core gave trouble. A poor conductor when cold, it had to be heated through the nickel outer tube. Also, a fragile oxide bead formed on the end of the electrode. These two defects indicated the need for a material to be added to the zirconium-oxide, in order to make it conductive when cold, and also to bond the bead and filler to the nickel tube.

More tests were made. Finally, zirconium metal powder was mixed with powdered nickel and pressed into the tube. When tested, the electrode performed satisfactorily and did not progressively oxidize, even with temperatures as high as 6500°F.

* *

Good conductivity and resistance to high temperatures make nickel a valuable and economical metal for use in electronics. For example . . . to weld tungsten filament leads . . . and leads on miniature components.

If you have a special design problem, it will pay you to consider Inco Nickel Alloys. But remember, right now they are on extended delivery because so much is taken for defense. Therefore, ordering well in advance of your production schedule will improve your chances of getting delivery when you need it. For help with your problem write to Inco's Technical Service Dept., they will be glad to assist you. Also ask for your free copy of "66 Practical Ideas for Metal Problems in Electrical Products."

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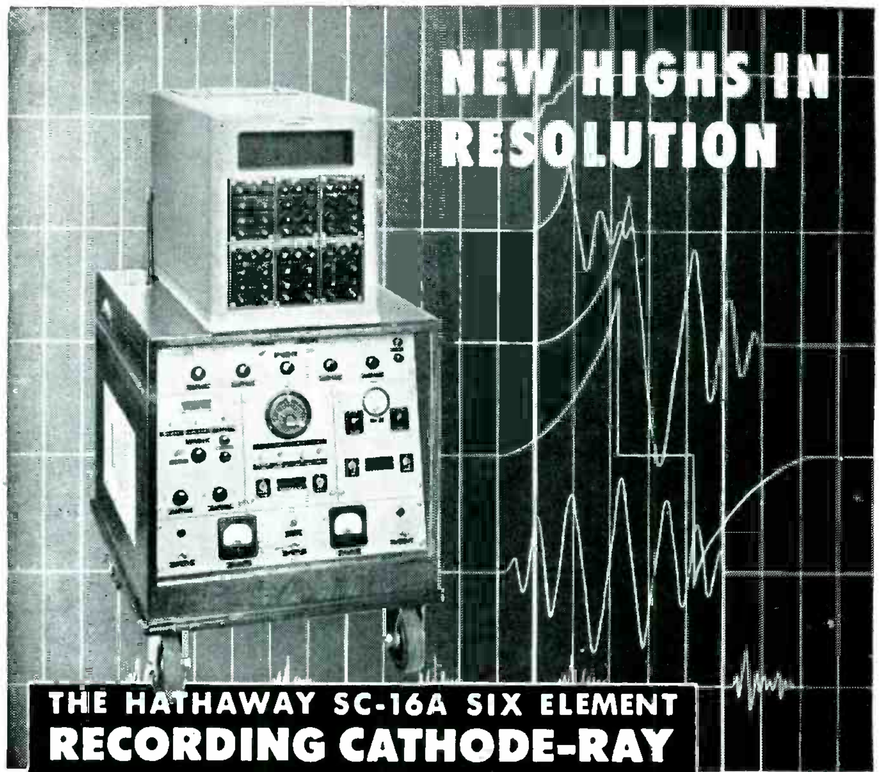
NEW HIGHS IN RESOLUTION



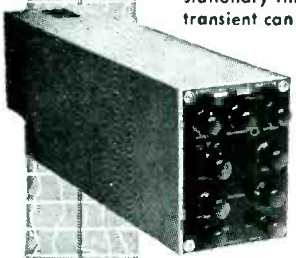
THE HATHAWAY SC-16A SIX ELEMENT RECORDING CATHODE-RAY OSCILLOGRAPH

NEW HIGHS IN RESOLUTION are obtained by this new oscillograph because of its unusually HIGH FREQUENCY RESPONSE and HIGH CHART SPEED...designed for recording fast transients and continuous phenomena.

FREQUENCY RESPONSE 0 to 200,000 cycles per second
RECORDS up to 1000 ft. long at speeds up to 600 inches per second
RECORDS up to 10 ft. long at speeds up to 6000 inches per second
WRITING SPEED as high as 5,000,000 inches per second

Note these additional unusual features.

- SIX ELEMENTS with convenient interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart.
- INTERCHANGEABLE RECORD MAGAZINES for CONTINUOUS RECORDING on strip chart, either 6 inches or 35mm in width up to 1000 feet in length, DRUM RECORDING for short, high-speed records, and STATIONARY CHART for very short transients.
- PRECISION TIMING EQUIPMENT, tuning fork controlled, for 1-millisecond or 10-millisecond time lines.
- Crystal-controlled Z-AXIS MODULATION for 1/10 millisecond time marks.
- QUICK-CHANGE TRANSMISSION for instantaneous selection of 16 record speeds over a range of 120 to 1.
- AUTOMATIC INTENSITY CONTROL.
- CONTINUOUS SWEEP OSCILLATOR which permits viewing as well as recording.
- Single-pulse LINEAR OSCILLATOR for recording transients on stationary film. The record can initiate the transient to be recorded, or the transient can initiate the record.



Each recording element is a complete unit, fully housed, which can be instantly inserted or removed. Recording element contains high-intensity cathode-ray tube, and both AC and DC amplifiers. Control panel is located on outside end.

FOR FURTHER INFORMATION, WRITE FOR BULLETIN 2 G1-G

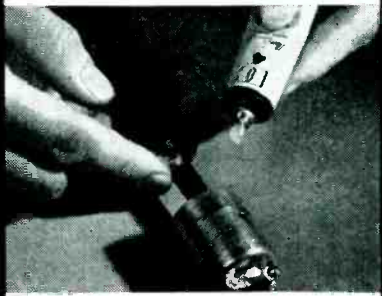
Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

The Nonmelting Silicone Insulating and Waterproofing Compound that is stable from —70° to over 400° F.

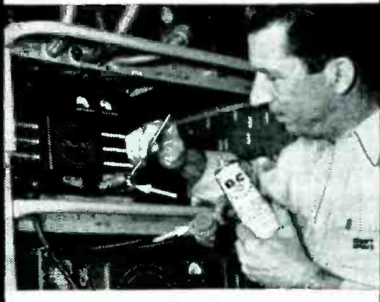
Meets all Requirements of AN-C-128a

DOW CORNING 4 COMPOUND

Dow Corning 4 applied by brushing to AN connector receptacle of pilot's "jack box" prevents interference caused by moisture at this critical junction in aircraft communications system.



Dow Corning 4 applied by brushing to AN connector on V. H. F. Transmitter/Receiver excludes moisture without appreciable change in resistance across properly mated pin and socket connections.



Arrows show where Dow Corning 4 is used on variable inductance rollers in a Collins-Western Electric V. H. F. Transmitter/Receiver to lubricate, minimize resistance and reduce leakage losses.

Photos courtesy Braniff International Airways.

More water repellent than paraffin, Dow Corning 4 Silicone Compound is highly resistant to oxygen, ozone and deterioration caused by corona discharge. ***Write Today!*** **for your copy of our new booklet on Dow Corning 4 Compound. Address Department BD.**

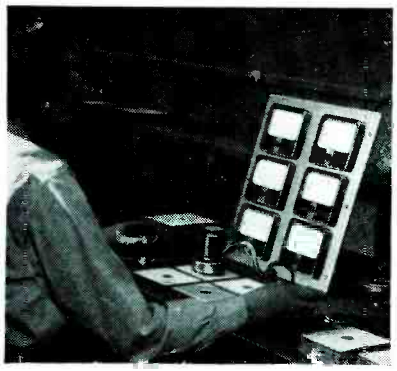
FIRST IN SILICONES

DOW CORNING CORPORATION

MIDLAND, MICHIGAN

tact with the surface of the hot-plate. The autotransformer and R are then adjusted until the ammeter I_F shows that the cell is passing its rated half-wave current in the conducting direction. The forward voltage drop across the cell is then read on V_F. The product of the readings of I_F and V_F is the forward power dissipation of the rectifier under test. A wattmeter could be used here if desired.

During the reverse cycle, current I_R flows through R (which has a negligible voltage drop), through the rectifier under test and through the appropriate range of reverse-current ammeter I_R. The blocking voltage is read on voltmeter V_R,



Test setup for measuring forward and reverse resistance characteristics of single selenium cells. Hot-plate on bench holds four cells, reducing waiting time for warm-up

and is equal to one-half the rated blocking voltage of the cell. The product of the readings of I_R and V_R is the power dissipated in the rectifier under test in the reverse direction.

The readings of all the meters are the average values of one-half of a sine wave. It is convenient to have voltmeters V_F and V_R calibrated in terms of the equivalent full-wave bridge rectifier values in addition to the regular calibration, by having a second scale with double values or calibrated in terms of peak readings which are 3.14 times the average half-wave values.

While waiting for the cell to reach the hot-plate temperature, the autotransformer and R can be adjusted. The autotransformer output voltage should be reduced to zero before removing the test cell, to avoid damage to meters, and

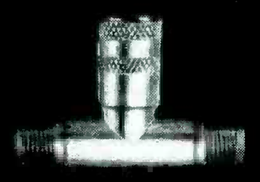
BN

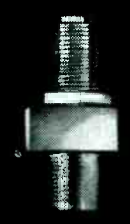
CONNECTORS BY KINGS


UG-85/U KB-51-01


UG-86/U KB-71-01


UG-114/U KB-11-01


UG-242/U KB-91-02


UG-244/U KB-91-03


UG-245/U KB-51-02


UG-246/U KB-11-02


MX-195/U KB-81-01

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

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

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

KINGS *Electronics* CO., INC.

40 MARBLEDALE ROAD, TUCKAHOE, N. Y.

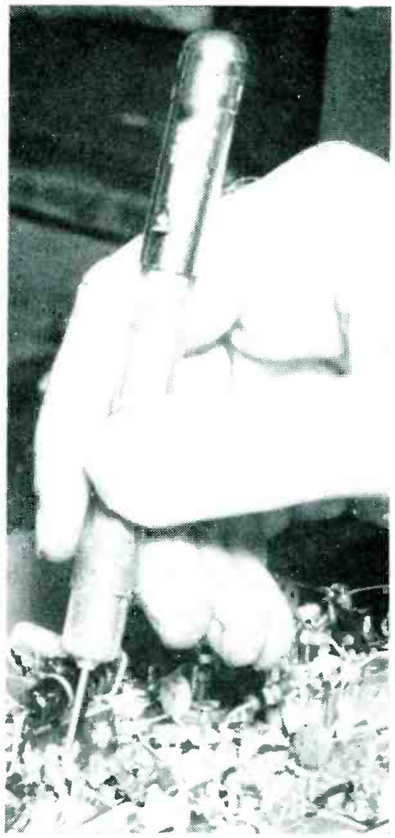
IN CANADA: ATLAS RADIO CORP., LTD., TORONTO should be kept at zero until after the next cell is put on. Keep the brass weight on the hot-plate, so the weight stays hot and does not conduct heat away from the next test cell.

With slight modifications, the test circuit described can be adapted to the testing of copper-oxide rectifier cells, but has little practical value for testing copper-sulphide cells because of their high leakage currents.

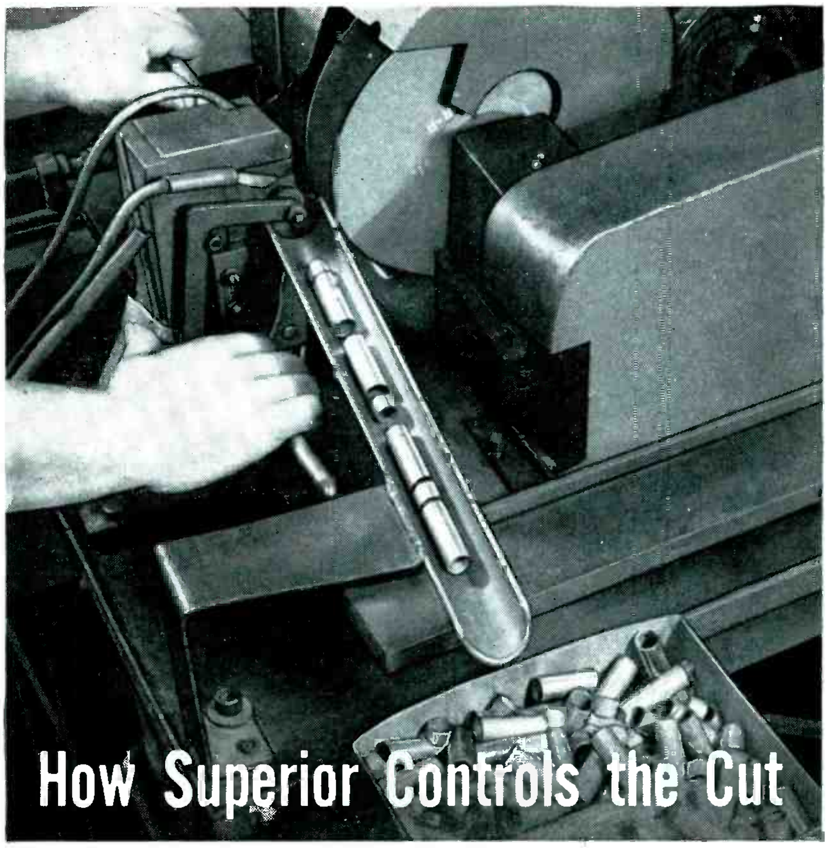
It is hoped that through publication of this test circuit, manufacturers and users of selenium rectifiers as well as government testing laboratories and all agencies setting up standards or procurement specifications for metallic rectifiers will adopt this method. The metallic rectifier industry will then have, for the first time, a universally accepted and standard method for testing metallic rectifier cells.

Applying Paint With Oiler

USE of a fountain-pen-type oiler for applying colored lacquer or glyptol to each soldered joint during in-



Oiler filled with red lacquer is used in place of brush to mark soldered joints that pass inspection



to give you better tubular parts

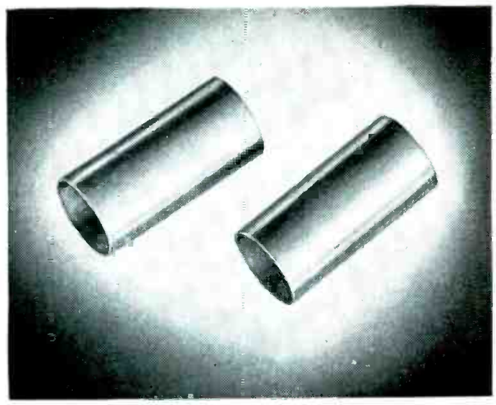
● Cutting tubing into exact lengths as the first step in the fabrication of tubular Electronic parts is a simple operation. Or is it?

Complications set in when the temper of the tubing is changed to meet customer specifications; when the tubing to be cut has a wall .010″ or thinner; when length tolerances as close as .010″ are required; when a 3° to 10° angle cut with a tolerance of ± ½° is called for; and when flattening, denting or other distortion must be prevented.

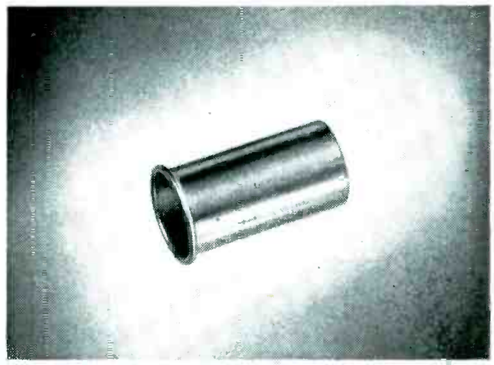
But overcoming complications in simple operations . . . and finding ways around them in other basically more difficult ones, is a specialty of the Electronics Division of Superior.

Our customers for Electronics parts have come to expect us to deliver the goods, exactly to specifications, whether standard production or complex experimental parts. What's more, they frequently ask us for suggestions about improvement on their designs and specifications . . . and they get them.

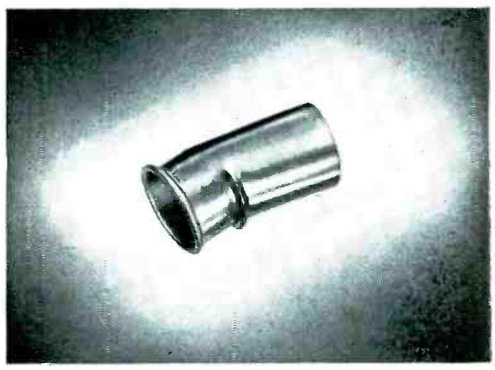
There is nothing unusual about all this—it's our job and we know how to do it. If you are a manufacturer or experimenter in the Electronics Industry and you need a tubular part that presents a problem, tell us about it. We'll probably be able to help and will gladly do so. Write The Superior Tube Company, 2500 Germantown Ave., Norristown, Pennsylvania.



Cutting and Tumbling. Cutting machines and jigs of many types and sizes are combined with extensive tumbling equipment to permit fast accurate production of quantities of parts at Superior.



Fabrication: Parts can be readily rolled at either or both ends, flared, flanged, expanded, or beaded (embossed) as required. The anode above is one of many such parts we produce at high speed and low cost.



The Finished Part. Final stage in the fabrication of the part shown above at three stages of production is a bend nicely controlled for both precise angle and freedom from other, unwanted distortion.

This Belongs in Your Reference File
. . . Send for It Today.

NICKEL ALLOYS FOR OXIDE-COATED CATHODES: This reprint describes the manufacturing of the cathode sleeve from the refining of the base metal. Includes the action of the small percentage impurities upon the vapor pressure, sublimation rate of the nickel base; also future trends of cathode materials are evaluated.

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All analyses .010″ to ⅝″ O.D.
Certain analyses (.035″ max. wall) Up to 1⅛″ O.D.

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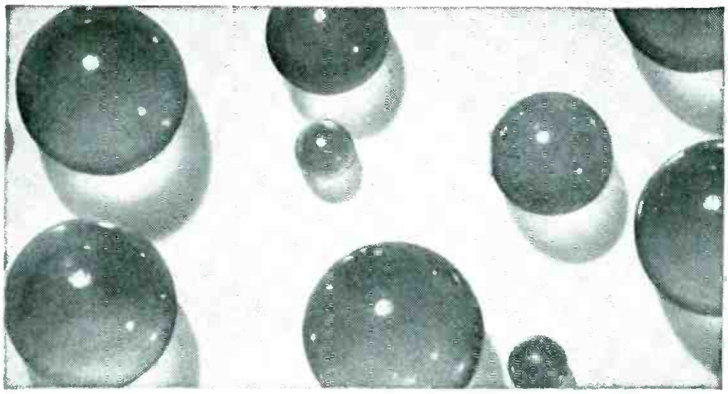


Now PRECISION BALLS

of Synthetic Sapphire

Now . . . the wear, corrosion, and heat resistance of synthetic sapphire in balls polished to within 20 micro-inches of sphericity.

THESE unicrystalline spheres resist corrosion or erosion by many acids and alkalis . . . possess a higher dielectric strength than glass or mica . . . have a low coefficient of friction and superior hardness. In many applications, they need not be lubricated.

LINDE synthetic sapphire balls are available in 1mm, 1/16 inch, 1/8 inch, and 1/4 inch sizes. Three surface finishes are available: super-finished, semi-finished, and rough-ground blanks.

CALL or WRITE any LINDE office for information on these balls, or the other forms of LINDE synthetic sapphire.

PROPERTIES

Composition	Al_2O_3
Coefficient of Friction (Steel pivot on sapphire ring)	0.140
Hardness (Knoop)	1525—2,000
Modulus of Elasticity in Flexure	50—56 x 10^6 psi
Dielectric Constant	7.5—10
Modulus of Rigidity	21.5—27.5 x 10^6 psi
Thermal Coefficient of Expansion up to 50°C (per °C x 10^{-6})	5.0—6.7
Chemical Resistance	Unaffected by acids, dilute alkali.

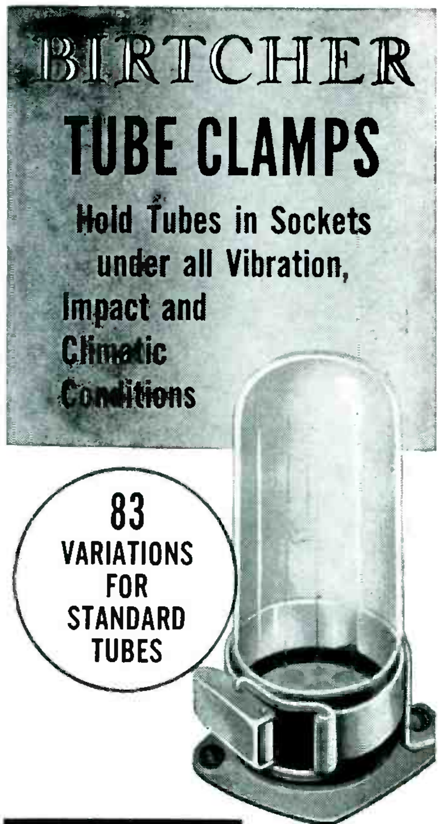
LINDE AIR PRODUCTS COMPANY

A DIVISION OF UNION CARBIDE AND CARBON CORPORATION

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

The term "Linde" is a trade-mark of Union Carbide and Carbon Corporation.



You can't shake, pull or rotate a tube out of place when it's secured by a Birtcher Tube Clamp. The tube is there to stay. Made of Stainless Steel, the Birtcher Tube Clamp is impervious to wear and weather.

BIRTCHER TUBE CLAMPS can be used in the most confined spaces of any compact electronic device. Added stray capacity is kept at a minimum. Weight of tube clamp is negligible.

Millions of Birtcher Tube Clamps are in use in all parts of the world. They're recommended for all types of tubes: glass or metal—chassis or sub-chassis mounted.

THERE'S A BIRTCHER TUBE CLAMP FOR EVERY STANDARD AND MINIATURE TUBE!

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Los Angeles 32, Calif.

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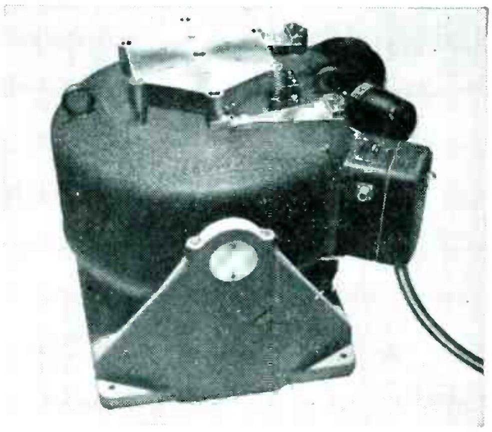
TRADE MARK

CALIDYNE VIBRATION TEST EQUIPMENT

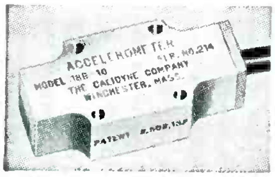
for testing to

Air Force, JAN, MIL, and other environmental test specifications



Model	Force rating	Maximum acceleration	Load for 20g (Pounds)	Load for 10g (Pounds)	Frequency range std. supply, cps	Signal generator
6	25	38.0	1/2	1-7/8	2 or 7 to 70,000	none
6C	25	34.5	1/2	1-7/8	2 or 7 to 70,000	velocity
6T	50	43.5	1-1/3	4-7/8	2 or 7 to 70,000	none
6CT	50	41.5	1-1/4	4-7/8	2 or 7 to 70,000	velocity
46	15	23.0	1/10	7/8	2 or 7 to 70,000	acceleration
49	25	34.5	1/2	1-7/8	2 or 7 to 70,000	velocity
44	450	51.5	14	36-3/4	2 to 500 or 2000	velocity (op.)
48	2500	38.0	50	185	3 to 500	velocity

Contact our representatives or consult our engineers regarding special requirements for cycling, monitoring, or controlling these shakers. We specialize in equipment for vibration testing, and offer many standard and special instruments for measuring, calibrating, and standardizing.



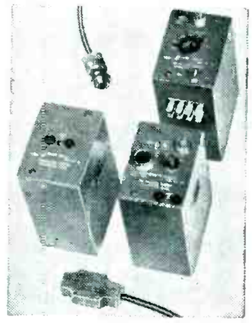
PICKUPS

Special pickups in ranges from 1g to 100g, and natural frequencies up to 1700 cps. Water-tight and pressure-tight cases available.

Model	g-range	Minimum natural frequency	Sensitivity volts/g
18B-5	5	110	3.0
18B-10	10	150	1.5
18B-25	25	250	0.6
18B-50	50	380	0.3

COUPLERS

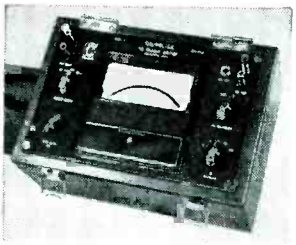
Couplers for using pickups with recording oscillographs or cathode-ray oscilloscopes are available for single- or multi-channel use.



STANDARDS

Model 3 and Model 23 Calivolters

—for voltage standardization of amplifiers and monitors. A precise working standard which can be readily checked against primary laboratory standards.

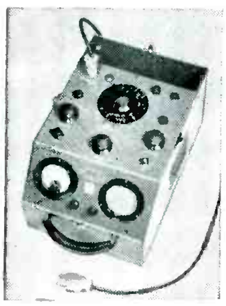


CALIBRATORS

Model 1 and Model 6C Calibrators

—for calibrating accelerometers and velocity pickups respectively, by use of a rapid and accurate ratio method. Bulletin on request.

METERS



Model 38 Vibrascope

Uses direct-coupled Model 18B pickup as input to combination vibration meter and calibrated oscilloscope for measuring acceleration, velocity, or displacement, and giving frequency and wave form indication.

Model 5 Vibration Meter

Direct-reading in acceleration, velocity, or displacement units when using velocity type pickups. A very compact, battery-operated unit.

Model 54 Signal Monitor

AC-operated unit for direct measurement of displacement or g output of shakers having velocity signal generators.

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spection proved faster and more satisfactory than the conventional paintbrush technique in the mobile radio transceiver manufacturing section of an RCA plant in Camden. Operator can work steadily, whereas former brush method required redipping of brush in lacquer at regular intervals.

Slide For Transformers

To KEEP a supply of heavy TV-receiver power transformers within easy reach of an operator at all times, the units are loaded onto a metal-bottom slide in DuMont's East Paterson, N. J. plant. Parti-

Transformers feed to operator by gravity each time she takes one from bottom of slide for subassembly operation involving mounting of rectifier socket and bracket

tioning strips divide the slide into four rows, separated sufficiently so transformers in adjacent rows cannot catch on each other. Stock boys replenish the supply at their leisure.

Sample-Testing CRT Cables

A SIMPLE test setup consisting essentially of two selector switches and an ohmmeter is used to check correctness of color-coded wiring to the socket of a television picture-tube cable, during sampling inspection of incoming cables at the Television Receiver Division of DuMont in East Paterson, N. J. Zero ohmmeter reading when both switches are set at the same number indicates continuity as well as correctness of wiring. The wire ends of the cables are pushed into clips on the panel. Colored-wire connections to these clips are run over the top of the panel for a short distance intentionally to serve as color iden-

Emerson
RADIO and PHONOGRAPH CORP.
says:

"Murray Breakers... safe, dependable protection for highly sensitive electronic equipment"

PHONE CHELSEA 2-1800 CABLE ADDRESS: EMPHONOCO NEW YORK CODES: BENTLEYS ABC 5TH EDITION IMP

Emerson
RADIO AND PHONOGRAPH CORPORATION
111 EIGHTH AVENUE NEW YORK CITY, 11

Murray Manufacturing Corporation
1250 Atlantic Avenue
Brooklyn 16, New York

Dear Sir:

Every Emerson Television and Radio Set undergoes a series of rigid tests using delicate electronic instruments.

During these tests a momentary short circuit or overload could damage or destroy the electronic equipment. A safe dependable means of circuit protection must be used.

It has been our experience that the Murray fully magnetic circuit breaker provides this safe dependable protection for the highly sensitive electronic equipment used in these tests.

We had tried various other types of circuit protection before we began using the Murray fully magnetic circuit breaker and none operated as well.

We would not hesitate to recommend very highly the Murray product.

Yours truly,
EMERSON RADIO AND PHONO.

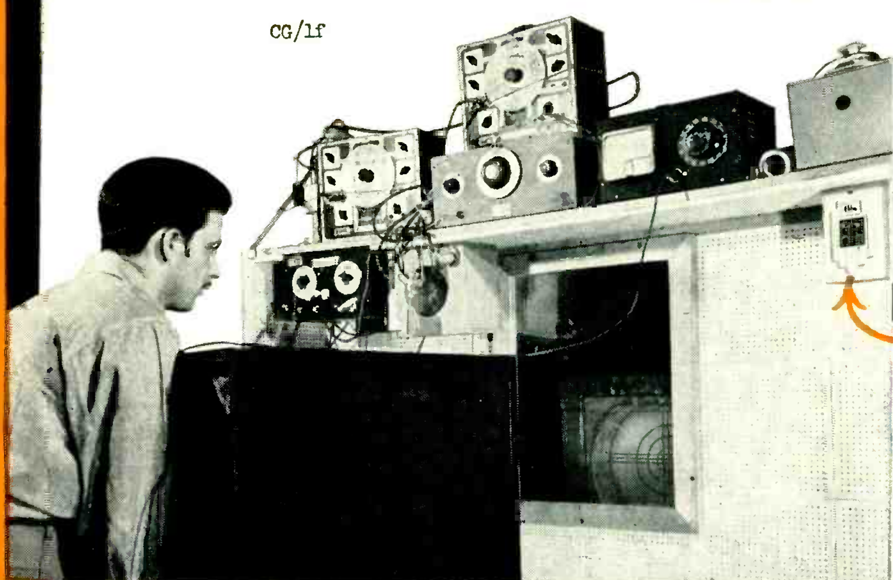
C. Gustafson

C. Gustafson
Plant Engineer

CG/lf

lurray
reakers
lways carry
ull load, regard-
ess of temperature.
They never
eed "derating."

Fully Magnetic!



Here is a typical Murray Breaker set-up used by Emerson in testing television sets

For the complete story on Murray Circuit Breakers, write for Bulletin 530

IF YOU WANT TO INSTALL THE BEST... specify Murray

Murray ®

MURRAY MANUFACTURING CORPORATION

1250 Atlantic Avenue, Brooklyn 16, New York

Service Entrance & Meter Equipment • Magnetic Circuit Breakers • Switches • Current Limiting Reactors • Crows'nest Aerial Ladders

The biggest "small part" in the world!

Many of the parts needed in factory production are mighty small. But these parts can loom up mighty *large*—when they're missing!

For tiny as they are, their absence can halt an entire production line—can cost a manufacturer thousands of dollars *every day* while he waits for replacements to arrive.

And the sources of supply are often hundreds of miles from his factory!

What does he do? He cuts replacement time from days to hours. He gets needed parts the world's fastest way—via Air Express!

The money saved by Air Express speed is figured in millions—but its cost is counted in pennies. Whether you need steel bolts or bolts of cloth, you can profit from regular use of Air Express. Here's why:

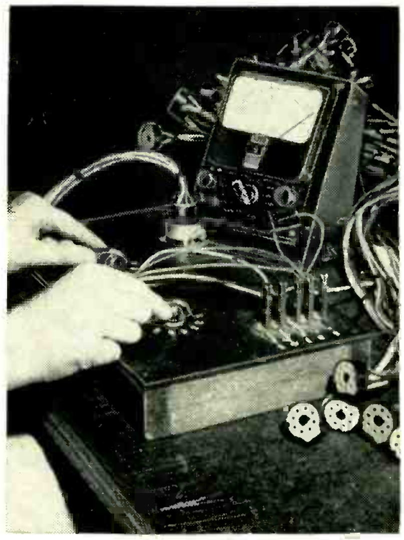
IT'S FASTEST—Air Express gets *top priority* of all commercial shipping services—gives the fastest, most complete door-to-door pick-up and delivery service in all cities and principal towns at *no extra cost.*

IT'S DEPENDABLE—Air Express provides one-carrier responsibility all the way, gets a *receipt upon delivery.*

IT'S PROFITABLE—Air Express service costs less than you think, gives you many profit-making opportunities.

New parcel post regulation affect you? Call your local agent of Railway Express, Air Express Division.

AIR EXPRESS
GETS THERE FIRST



Incoming-inspection setup for picture-tube cables. Carrying-strap buttons of multimeter fit into slots in simple metal stand for holding meter at optimum angle

tification for the clips, so the operator merely matches colors when inserting wires in clips. A mounted octal tube base makes all connections automatically to the socket under test.

Self-Counting Parts Trays

SHALLOW wood trays in standardized sizes up to about 2 feet square are used in the Hawthorne, N. J. plant of Servo-Tek Corp. for transporting and storing component parts of servo amplifiers, small synchros and motors. The trays stack solidly one on top of the other. The number of parts in each tray can be counted almost at a glance by multiplying the number of parts per row in the tray by the number of rows of parts in the tray. Empty trays are furnished to subcontractors, saving packing and rehandling costs on incoming materials.

Plastic Clothespins Serve as Defect Indicators

WHEN an operator on Emerson's moving-belt television assembly line cannot finish her work within the allotted time cycle, perhaps because of a broken terminal or trouble with a joint, she is instructed to clip a colored plastic clothespin to

Good names to know for—

finer electronic metals & alloys

FILAMENT BASE METALS:
- **SYLVALOY**
- **MODIFIED HILO**
- **COBANIC**
- **TENSITE**
- **UNIMET**

CARBONIZED NICKEL:
- **RADIOCARB**
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- **POLICARB**

GRID WIRE:
- **MANGRID**

— BACKED BY YEARS OF SPECIALIZED PRODUCTION

Since the inception of AC radio, Wilbur B. Driver Company has pioneered in the development and production of filament alloys, carbonized nickel and grid wire. Thus it is a logical conclusion that Wilbur B. Driver Company is the dependable source of supply for radio and electronic requirements . . . the choice when materials must be held to exacting and precise specifications.

It's WILBUR B. DRIVER for Critical Tube Alloy Requirements!

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WILBUR B. DRIVER COMPANY

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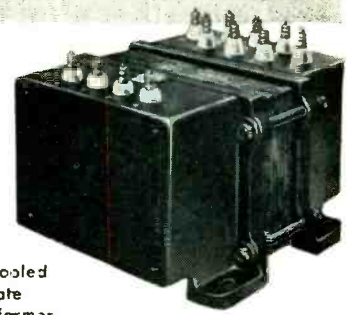
TOPHET FOR TOP HEAT

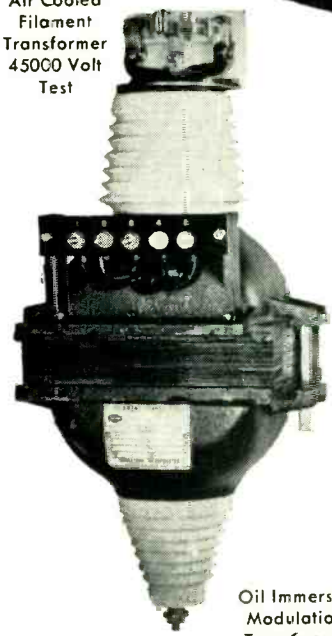
A NAME SYNONYMOUS WITH EXPERIENCE

MAGNATRAN



Air Cooled Plate Transformer

Air Cooled Filament Transformer 45000 Volt Test



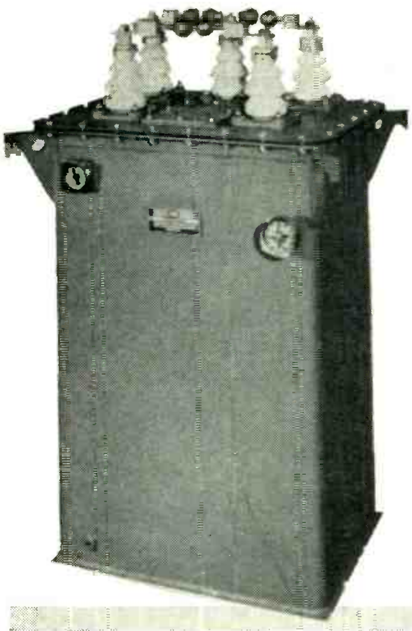
Askarel Immersed Filter Reactor 50000 Volt Test

– all your large or high voltage magnetic equipment can now be supplied and co-ordinated by

ONE DEPENDABLE SOURCE

Magnatran is operated by personnel having unusual and outstanding knowledge in the transformer engineering and manufacturing field. Thus Magnatran, a new name, is backed by reputation and experience requiring little further introduction to the industry. A partial list of Magnatran quality products is shown below. Submit your requirements for our informational details.

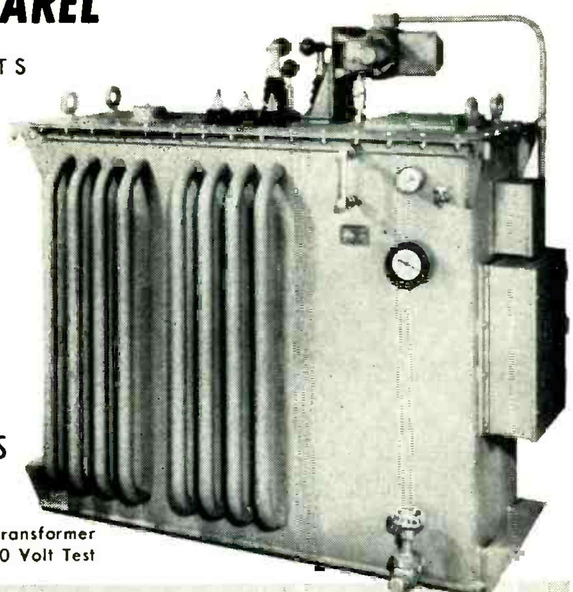
Oil Immersed Modulation Transformer



AIR... OIL... ASKAREL

MAGNATRAN PRODUCTS

PLATE TRANSFORMERS
FILAMENT TRANSFORMERS
FILTER REACTORS
MODULATION TRANSFORMERS
PULSE TRANSFORMERS
DISTRIBUTION TRANSFORMERS
TESTING TRANSFORMERS
PRECIPITATION TRANSFORMERS
GENERAL PURPOSE TRANSFORMERS
HI-VOLTAGE POWER RECTIFIERS



Askarel Immersed 3 Phase Plate Transformer Motor Driven Tap Changer 50000 Volt Test

MAGNATRAN INCORPORATED

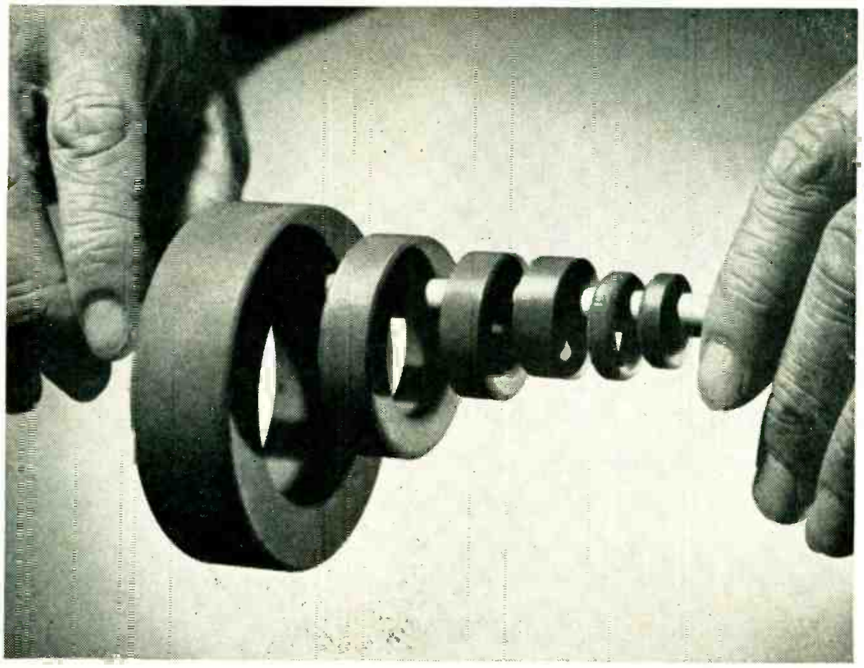
TRANSFORMERS AND ELECTRICAL EQUIPMENT

WALTER GARLICK, JR., PRESIDENT

246 SCHUYLER AVE., KEARNEY, NEW JERSEY

MAGNATRAN

POWDERED-IRON TOROIDS



3.375 in. outside diameter to 0.800 in.

PRECISION-MOLDED Lenkurt Toroids offer exceptional magnetic and temperature stability, extremely low losses and cross-modulation products. They are available in a variety of powdered-iron materials and on extremely short delivery schedules. Costs are low—thanks to new high-speed production facilities now in operation.

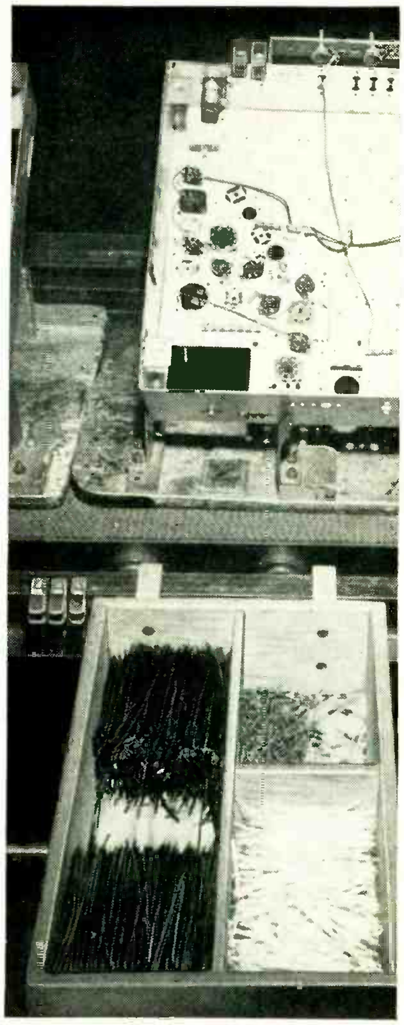
FIVE POPULAR SIZES of toroids are produced rapidly from existing dies, usually are available directly from stock. Lenkurt's magnetic-component engineering group is ready to solve special problems of inductor design, produce special sizes or types of toroids, as well as pot cores, cup cores, or tuning slugs to *your* specifications. *Send for further details.*

LET LENKURT QUOTE on your specific needs for: Toroidal coils — Filters — Powdered-iron cores — Specialized transformers — Variable inductors — and Toroidal transformers, made by Lenkurt Electric Company—*largest independent manufacturer of telephone toll transmission equipment.*

LENKURT ELECTRIC SALES COMPANY

Lenkurt

SAN CARLOS 1, CALIFORNIA



Use of plastic clothespins at top of chassis to indicate incomplete operation. Spare clips are snapped onto conveyor rail at left of small-parts tray

the top of the chassis, directly over the defect.

Each group of 10 to 20 operators is assigned the same color of clothespin. Operators within a group are numbered starting from 1, and their clothespins are correspondingly numbered in white ink. Since the joints and parts assigned to each operator are listed on master charts, the presence of a numbered clothespin on a chart isolates the defect to a small area for quick location by a repairman farther down the line. The clip is removed only after the unfinished work is done or the defect repaired.

No records are kept of clothespin-indicated defects since the operator catches them herself and they are generally not her fault. Inspectors on the line do make a record in duplicate of each inspection-detected error, however. One notation of the error goes on a slip

VOLTAGE REGULATED POWER SUPPLIES

For Industrial and Research Use

MODEL 815

B SUPPLY: 0-600 volts, 200 Ma.

C SUPPLY: 0-150 volts, 5 Ma.

FILAMENT SUPPLY: 6.3 volts AC, 10 Amp., CT.

DC POWER SUPPLY SPECIFICATIONS

REGULATION: ½% for both line (105-125 volts) and load variations.
REGULATION BIAS SUPPLIES: 10 millivolts for line 105-125 volts.
½% for load at 150 volts.
RIPPLE: 5 millivolts RMS.

VOLTS	CURRENT	MODEL
100-325 0-150 Bias 6.3 AC.CT.*	0-150 Ma. 0-5 Ma. 10 Amp.	131
200-500 6.3 AC.CT.	0-200 Ma. 6 Amp.	245
0-300 0-150 Bias 6.3 AC.CT.	0-150 Ma. 0-5 Ma. 5 Amp.	315
0-500 6.3 AC.CT.	0-300 Ma. 10 Amp.	500R
#1 200-500 #2 200-500 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 6 Amp. 6 Amp.	510
0-500 0-150 Bias 6.3 AC.CT.	0-200 Ma. 0-5 Ma. 10 Amp.	515
#1 0-500 #2 0-500 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 10 Amp. 10 Amp.	600

VOLTS	CURRENT	MODEL
0-500 0-150 Bias 6.3 AC.CT.	0-300 Ma. 0-5 Ma. 10 Amp.	615
#1 0-600 #2 0-600 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 10 Amp. 10 Amp.	800
0-600 0-150 Bias 6.3 AC.CT.	0-200 Ma. 0-5 Ma. 10 Amp.	815
0-1000-Ripple 10 mv. 6.3 AC.CT.	0-50 Ma. 10 Amp.	1020
0-1200-Ripple 10 mv. 6.3 AC.CT.	0-20 Ma. 10 Amp.	1220
200-1000-Ripple 20 mv.	0-500 Ma.	1250
0-1000-Ripple 20 mv.	0-500 Ma.	1350
Specify your voltage and current requirements. Regulation available .5%, .1%, .01%.		SPECIAL SERIES

*All AC Voltages are unregulated. All units are metered except Models 131 and 315.

All units designed for relay rack mounting or bench use.

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

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it's
Craftsmanship

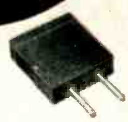
TYPE MC9 RANGE:
1.0 - 10.0 mc
Supplied per Mil type CR-5; CR-6; CR-8; CR-10 when specified.

TYPE AR23W RANGE:
0.080 - 0.19999 mc
Supplied per Mil type CR-15; CR-16; CR-29; CR-30 when specified.

Craftsmanship shows up when the going gets roughest. You can't see it but it's there—in every Bliley crystal.

Such basic quality ingredients as precision and stability depend upon *craftsmanship*. When you buy Bliley you get this extra assurance that can only be supplied by experience.

TYPE BH6A RANGE:
1.4 - 75.0 mc
Supplied per Mil type CR-18; CR-19; CR-23; CR-27; CR-28; CR-32; CR-33; CR-35; CR-36 when specified.



TYPE SR5A RANGE:
2.0 - 15.0 mc
Supplied per Mil type CR-1A when specified.

TYPE TCO-1
Temperature Control Oven.

TYPE BH7A RANGE:
15.0 - 50.0 mc
Supplied per Mil type CR-24 when specified.

Bliley CRYSTALS

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UNION STATION BUILDING
ERIE, PENNSYLVANIA

FOR HIGH-SPEED INDUSTRIAL SOLDERING

Use G-E Calrod* Soldering Irons

HERE'S WHY THEY ARE PREFERRED BY . . .

PRODUCTION MEN . . . because they are built tough for long, continuous production line soldering. With calorized or ironclad tips, they stay clean, solder fast and can be easily disassembled.

MANAGEMENT MEN . . . G-E irons last longer and need less service. Exhaustive tests by some of the world's largest soldering iron users show that G-E irons save them money.

MAINTENANCE MEN . . . because superior features, like the cord-strain insulator which withstands a pull of 35 pounds, makes far less maintenance necessary. When it's occasionally necessary, the dependable G-E cartridge heater slips right out for servicing—just pull a pin.

FOR FREE BULLETIN, GEA-4519, ask your nearby G-E distributor, or write to: Sect. 720-66, General Electric Co., Schenectady, New York.

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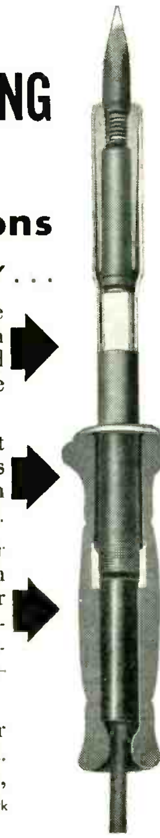

GENERAL ELECTRIC

720-66

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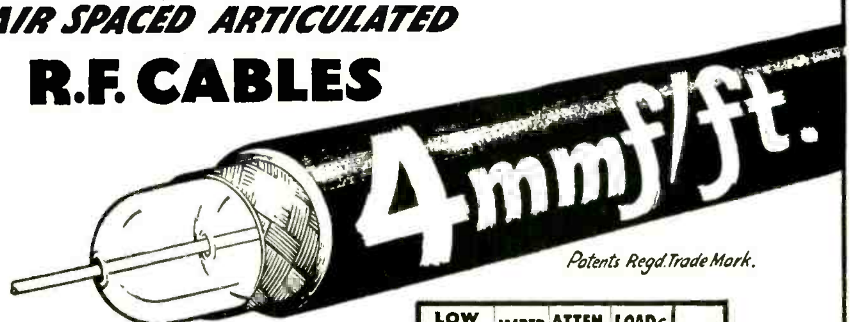
AIR SPACED ARTICULATED R.F. CABLES



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LOW ATTEN. Types.	IMPED. Ohms.	ATTEN. db100ft. of 100 Mcs.	LOADG. K.W. of 100 Mcs.	O.D."
A.1.	74	1.7	0.11	0.36
A 2	74	1.3	0.24	0.44
A 34	73	0.6	1.5	0.88

HIGH POWER FLEXIBLE

LOW CAPAC. Types	CAPAC. mmf/ft.	IMPED. Ohms.	ATTEN. db100ft. 100 Mc/s.	O.D."
C 1	7.3	150	2.5	0.36
PC 1	10.2	132	3.1	0.36
C 11	6.3	173	3.2	0.36
C 2	6.3	171	2.15	0.44
C 22	5.5	184	2.8	0.44
C 3	5.4	197	1.9	0.64
C 33	4.8	220	2.4	0.64
C 44	4.1	252	2.1	1.03

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CABLES: TRANSRAD LONDON.

WORKSHOP ANTENNAS

for SEA-SEARCH RADAR

Among the many military types being developed at the WORKSHOP are radar antennas for sea-search. The ship-borne antenna pictured here is being put through pattern tests on the Workshop range. This 3300-foot range — one of the longest in the country — is typical of WORKSHOP'S outstanding test facilities for military antennas.

Testing Range Transmitter
The transmitting tower is equipped with an 8-foot parabolic antenna and short wave radio for direct communication with the laboratory 3300 feet distant.

PARTIAL LIST OF
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MILITARY ANTENNAS

Radar Bombing
Rocket or Guided Missile
Radar Navigation
Fire Control — Land or Sea
Microwave Communications
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A complete antenna laboratory, staffed by experienced engineers using modern equipment, and the largest production facilities in the industry are available through Workshop. Both Government and industry make extensive use of Workshop for antenna research, design, and production.

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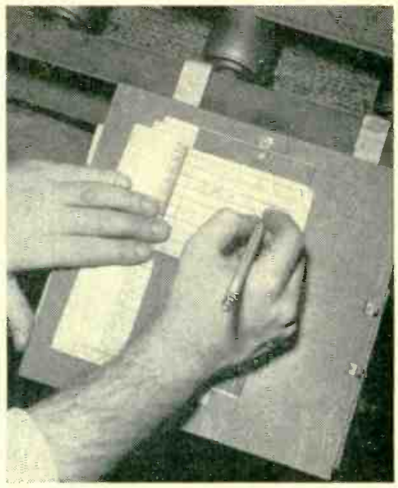
Specialists in High Frequency Electronics
135 Crescent Road, Needham Heights 94, Massachusetts

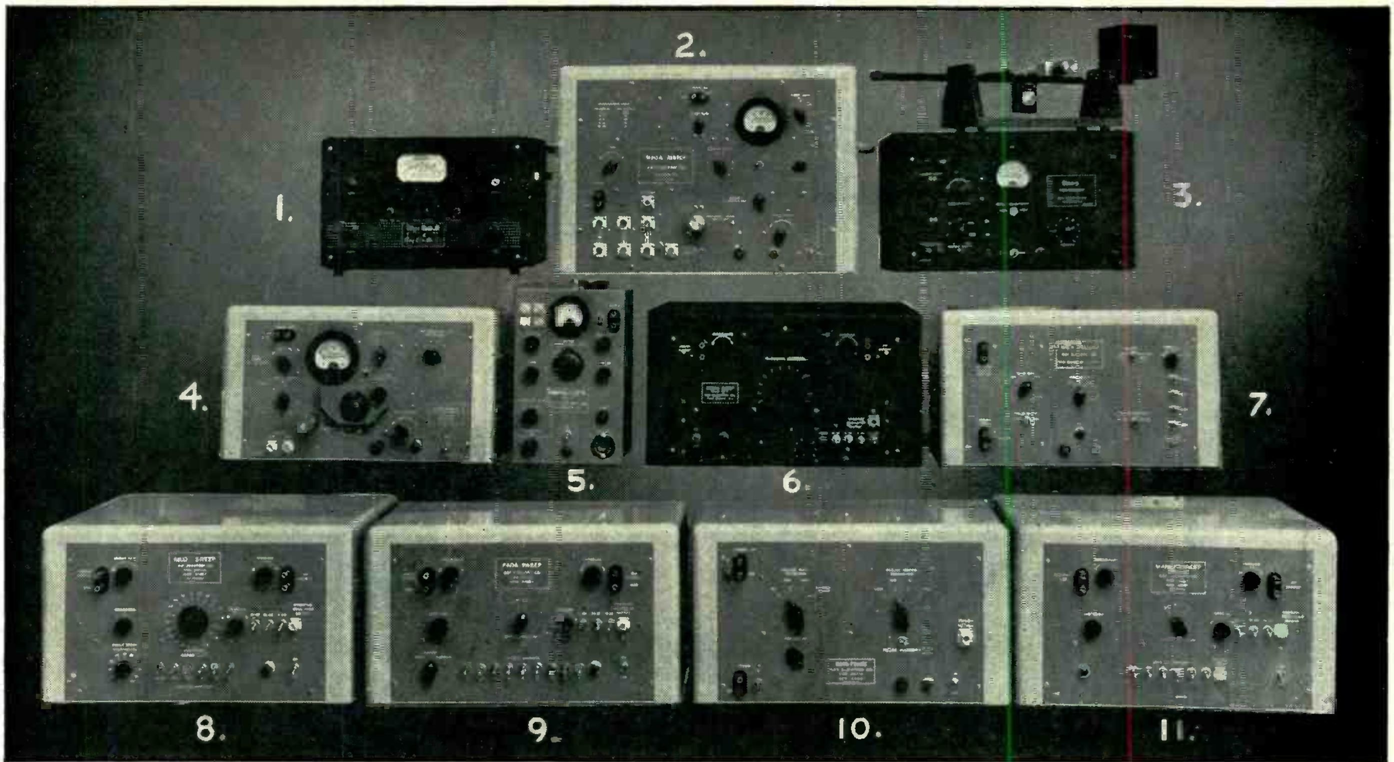


Inspector makes notation of error on small slip of paper that goes inside the chassis

of paper that rides with the chassis from the first inspection position on. The carbon impression goes on a master record kept by the inspector. Each notation includes the number of the responsible operator, so that an incipient epidemic of similar errors can be detected and halted.

The photographs show the method used for obtaining a master record on a single sheet while writing on many different slips. The master record sheet and carbon paper are held in position on a writing board by a spring clip. The 20 lines on the master sheet are numbered from 1 to 20, and the line number is crossed out each time a line is used. When an error is detected, the inspector takes the error slip out of the chassis and holds it over the carbon in such a way that

Copy of error notation appears on next available line of master record sheet



THESE VERSATILE INSTRUMENTS CAN HELP YOU

1. MEGA-NODE SR.

A calibrated random noise source, 100-3000 mcs. Reads noise figure directly on panel meter.

2. MEGA-MATCH UHF Model

Displays reflection coefficient over 30 mc band from 10 to 1000 mcs.

3. MEGA-X

An X-band Signal Source, C.W. or Sweeping 8500 to 9700 mcs.

4. CALIBRATED MEGA-SWEEP

Wide range sweeping oscillator with single dial tuning.

5. ROTALYZER Model WB

Accurate measurements of instantaneous and average RPM as well as torsional vibration.

6. MARKA-SWEEP Model RF-P

An all-electronic sweep generator switch tuned to VHF TV channels. Narrow crystal-positioned pulse-type markers.

7. RADA-PULSER

A pulsed carrier generator for transient response testing of Radar IF amplifiers.

8. KILO-SWEEP

Narrow band sweep from 50 kc to 2 mc with crystal markers.

9. RADA-SWEEP

A wide band sweep generator with markers for aligning Radar IF amplifiers.

10. MEGA-PULSER

Ultra narrow pulse generator.

11. MARKA-SWEEP Model Video

Wide Range video sweep generator covering 50 kc to 20 mc in three bands with crystal markers.

OTHER INSTRUMENTS *(Not Illustrated)*

- **SONA-SWEEP** — Narrow band sweep from 5 kc to 200 kc with crystal markers.
- **MICROWAVE MEGA-MATCH** — Displays reflection coefficient over 30 mc band from 8500 to 9700 mcs.
- **MEGALYZER** — Sensitive visual RF voltmeter and spectrum analyzer.
- **MEGA-NODE** — A calibrated random noise source; 5-220 mc. Reads noise figure directly.
- **MICROWAVE MEGA-NODES** — Calibrated noise sources at microwaves.
- **MICRO-PULSER** — Provides pulses of selectable width over a wide range of repetition rates.
- **MEGA-PIX** — A crystal controlled TV picture and sound RF signal source.
- **ATTENUATORS** — High frequency switchable attenuators.
- **VIBRALYZER** — A vibration and noise frequency analyzer.
- **SONA-GRAPH** — A sound spectograph for the frequency analysis of audio energy.

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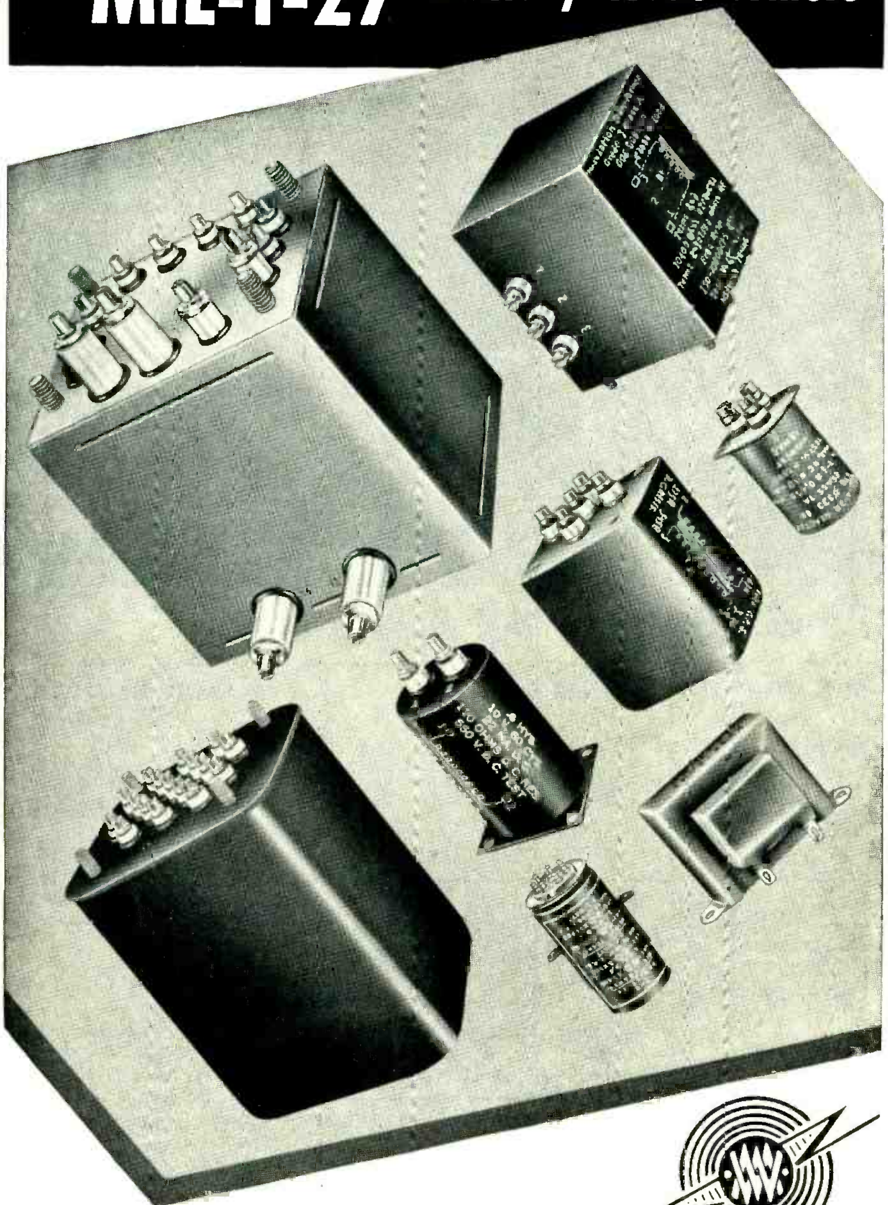
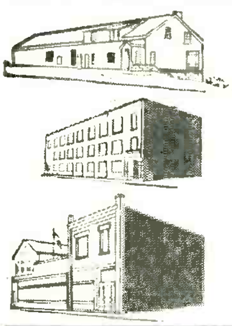
3 Plants Geared for Production of MIL-T-27 Military Transformers



YOU GET THE BEST FROM MID-WEST

TRADE MARK REG. U. S. PAT. OFF.



We are geared for production of fully-approved, MIL-T-27 Transformers and Filter Reacters to meet Military specifications. Our Production includes: HYPERSIL®, or Nickel alloy materials in Hermetically sealed or Fosterite® type transformers.

MIDWEST'S modern plants are staffed by experienced personnel employing the latest equipment and electronic knowledge to produce components of consistent quality for Military and Civilian use.

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Branch Offices:	New York City	Buffalo (Kenmore)	Plymouth, Indiana
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AMERICAN ELECTRIC

400 Cycle

MOTOR ALTERNATOR

WEIGHT: Approx 125 lbs.
SIZE: 22" x 12" x 12"

Designed for production and laboratory high frequency power supply requirements. STRONG—SIMPLE—INDESTRUCTIBLE CONSTRUCTION—No delicate moving parts, brushes or springs to wear out or maintain.

Replaces single large, hard-to-get H-F power supply serving multiple purposes . . . *A bank of these compact, flexible units costs far less, provides individual portable power sources for each project, avoids downtime hazards of single unit!*

Meets power supply requirements for AN-E-19 equipment.

OUTPUT: Up to 1000 Watts single phase 115V or up to 1800 Watts three phase 115/200V. Input: 60 cycle AC.
Total harmonic content under 5%; ± 1% voltage regulation.

WRITE FOR DETAILS!
Larger capacities available.

AMERICAN ELECTRIC MOTORS
TRADE MARK

4811 Telegraph Rd.
Los Angeles 22,
California

Method of supporting writing board on conveyor line and storing spare sheets

its next empty line is opposite the first not-crossed-out line number on the master record. For each error, the number of the responsible operator is also written down. Errors are abbreviated or coded; thus, S 10 C P C means miniature socket No. 10 center pin is cold soldered.

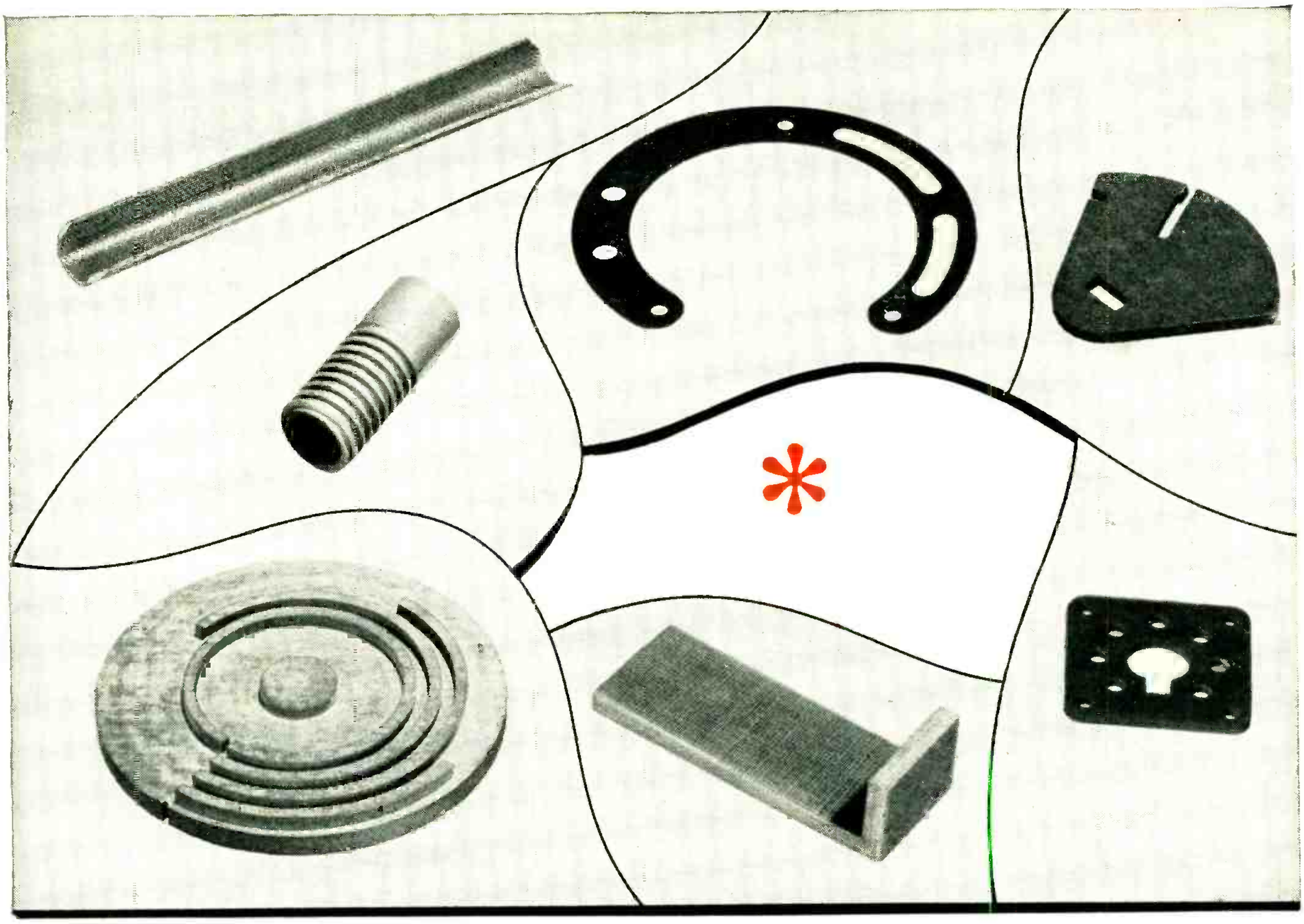
The writing board is hinged to a metal tray that hooks over the near rail of the conveyor and holds a pan in which spare pencils and master record sheets are stored. Spring clips on the board itself hold the pencil being used. Boxes for small parts needed during assembly-line operations have similar strap-iron hooks going over the conveyor rail.

High-Speed I-F Alignment

FAST ALIGNMENT of i-f transformers in receivers calls for some means of attenuating the signal quickly or automatically as the trimmers are peaked.

On Emerson's three-way portable line, attenuation is achieved by pulling the chassis away from a signal-radiating loop with the left hand while adjusting the trimmers with a tool in the right hand. An operator quickly learns to synchronize the movement of the chassis with the change in volume of the modulated signal coming from the speaker on the chassis.

Signals from a central signal cage are fed to a master attenuator box at the alignment position. Here a selector switch gives a choice of



to solve the shortage puzzle

replace key pieces with *Lamicoid®

- High Dielectric Strength
- Low Power Factor
- Heat Resistance
- Low Moisture Absorption
- High Impact Resistance
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- Light Weight
- Tensile Strength
- Resistance to Abrasion

LAMICOID, a thermosetting plastic laminate, has already proved itself for such uses as terminal blocks, panels, dials and many other applications.

The same qualities that make it adaptable to these uses may also provide practical answers to your material shortage problems . . . and perhaps even bring you savings or improvements!

For example, you can obtain LAMICOID in a wide variety of forms and grades which are almost certain to possess the exact characteristics your product requires. This versatility is possible because LAMICOID is produced through the use of many different fillers such as glass, nylon, fabric, paper, etc. with a variety of resins.

LAMICOID is supplied in standard sheets, rods and tubes, or fabricated into parts to your specification. We will be pleased to put our 58 years of experience to work on *your* electrical insulation problems. Send your blueprints and specifications today for a prompt quotation.

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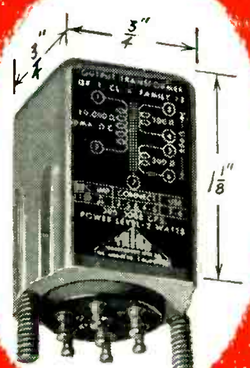
LAMICOID (Laminated Plastic) • MICANITE (Built-up Mica) • EMPIRE (Varnished Fabrics and Paper) • FABRICATED MICA

TRIAD announces

the World's Smallest Hermetically Sealed Transformer



Voice Frequency Audio Transformers of all low-powered types are now available in MIL standard AF case as shown above. Production is limited, but we will be glad to quote on quantities to meet your requirements.

These transformers are available only for use on military contracts.

NOTE: We are tooled for the production of terminals and cases for this transformer. Write for prices.

For specifications and prices on other Triad transformers, write for Catalog TR-51.

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FOR HIGHEST TEMPERATURE APPLICATIONS

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RESISTANCE TO CHEMICALS

capable of withstanding temperatures of 250 centigrade.

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Tinned and Bare Copper Wire.

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TV SPOTS • Designed for Television Studios and Stages

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Paint with Light

Painting with light is the ability to control the light source, in order to emphasize the necessary highlights and the all-important shadows. Only through controlled light can the scene or subject be given the desired brilliance, beauty and third dimensional effects.

Our Specialists...

are always ready to assist and advise your engineering staff, so that your studios and stages will be fully equipped to properly "Paint with Light."

Write for complete specifications and prices of these TV SPOTS. Address Dept. 68.

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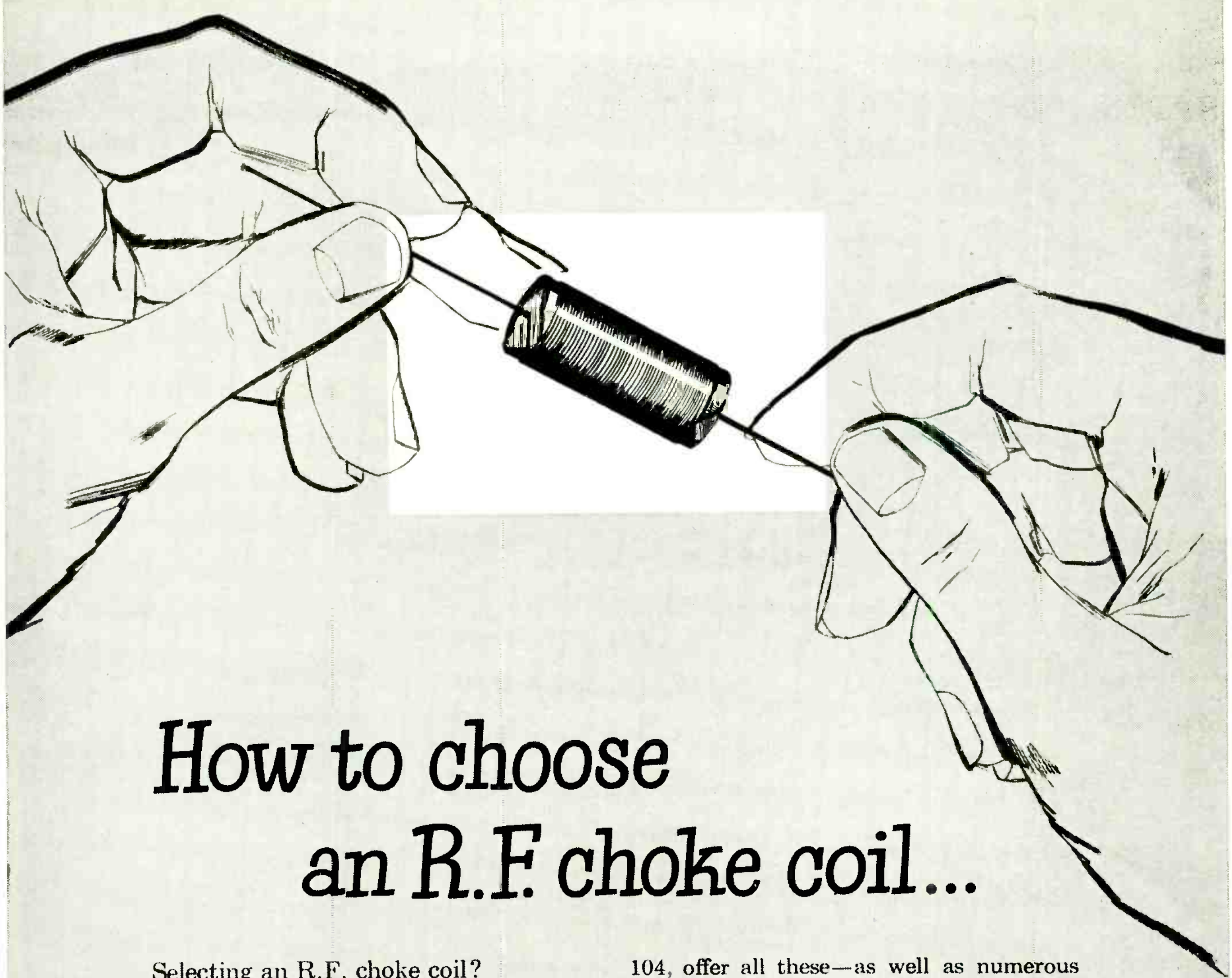

How to choose an R.F. choke coil...

Selecting an R.F. choke coil?

Remember this: coil construction is of primary importance.

Insulated copper wire, for example, is superior to bare wire for the windings. Rugged, molded jackets give longer service than those fastened by glue or other means. Windings soldered to leads, and the elimination of shorted end-turns mean better all round performance.

Jeffers R.F. choke coils, types 101, 102 and 104, offer all these—as well as numerous other advantages. Rugged and compact, they assure uniform results, even under the most difficult circuit conditions.

Jeffers coils are available in such a wide range most laboratories no longer assemble their own. Instead, they carry a full assortment and select from stock, as needed. Results: lower costs, time saved, greater standardization.

Write today for our specification sheets.

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Jeffers Electronics, Inc.
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ceramic capacitors • disc capacitors
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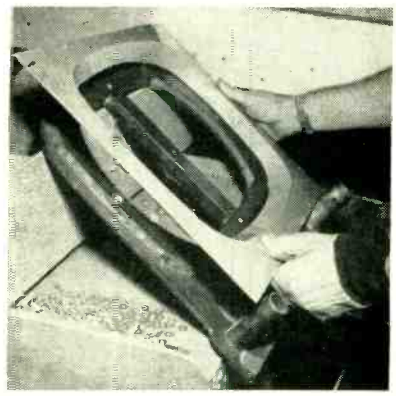
*Patented

Other Speer Subsidiaries: Speer Resistor Corp., International Graphite & Electrode Corp.

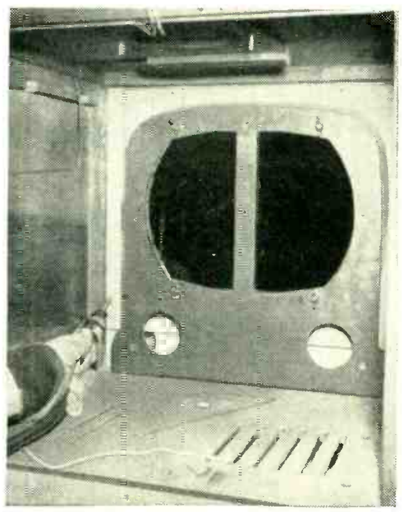
455, 600, 1,450 and 1,620 kc, and screwdriver-type attenuators permit setting the maximum level at which each signal is fed to a fixed loop antenna at the rear of the bench. The selected signal radiates directly into the receiver circuits, as the set's own loop has not yet been connected. A hard maple bench surface is used so the chassis will slide easily back and forth. Trol-E-Duct permits warming up the sets a few minutes on the conveyor belt that brings them into the alignment cage.

TV Chassis-Centering Jigs

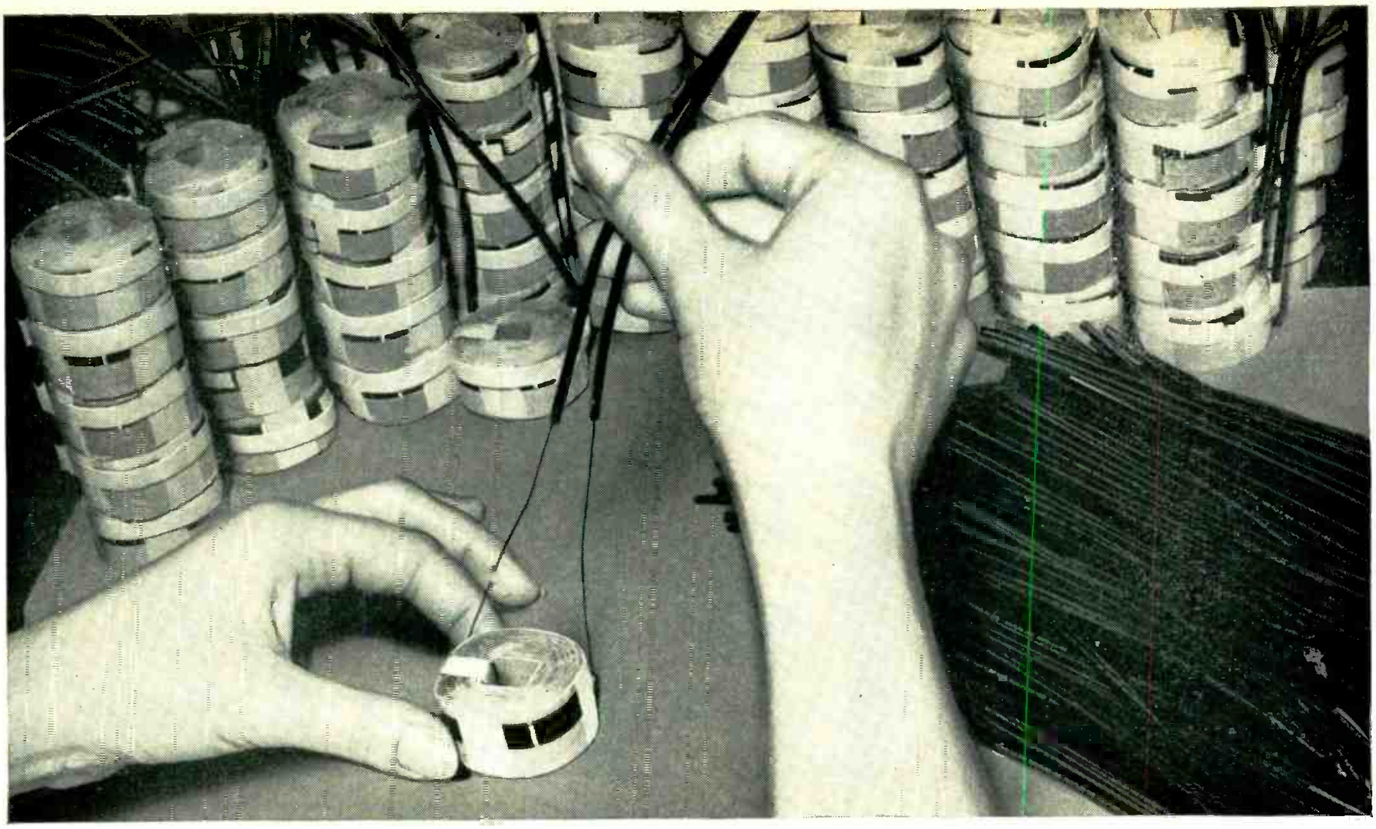
PRECISION centering of each television chassis with respect to the picture-tube mask while installing both in cabinets is achieved with



STEP 1: Placing plastic mask on mask-centering jig. Projecting pipes fit into control holes in cabinet



STEP 2: Fastening mask to wood cabinet with wood screws, using air-operated screwdriver. Pipes on jig project into cabinet holes for controls, centering mask accurately with respect to these holes



Minneapolis-Honeywell eliminates soldering operations . . . by slipping TEMFLEX 105 over coil leads

Quantity use of Temflex 105 flexible plastic tubing effects substantial savings in assembly costs of the RA 117 Protectorelay oil burner control, according to Minneapolis-Honeywell Regulator Company, makers of the famous MH Control Systems and Brown Instruments. Assembly of the control calls for suitable insulation of two lead wires from each of two coils of the type shown in the illustration. Conventional methods would call for clipping off the lead wires close to the coils, and making soldered joints to insulated wires — calling for four soldering operations for each control.

But Minneapolis-Honeywell merely slips a length of Temflex 105 over each lead. RESULT: Soldering operations are eliminated . . . leads are thoroughly insulated, remain flexible . . . assembly costs are cut down.

Service advantages of Temflex 105 — in this and many other applications — are even more outstanding. This Irvington tubing is approved by Underwriters' Laboratories for 90° C operation in oil — *as well as* for continuous operation at 105° C. In addition to this superior oil resistance, Temflex 105 offers good resistance to mineral and coal tar solvents — and prolonged exposure to acids and alkalies has little effect on its initial high dielectric strength of 1200 vpm.

Look to
IRVINGTON
for insulation leadership
INSULATING VARNISHES
VARNISHED CAMBRIC
VARNISHED PAPER
VARNISHED FIBERGLAS
INSULATING TUBING
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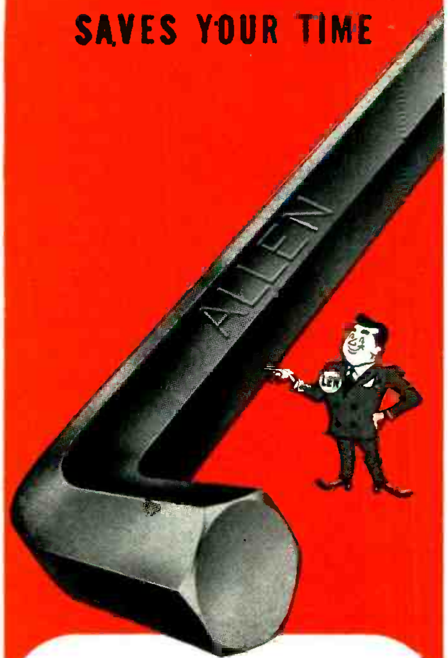

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X-VAR is non-corrosive, non-creeping—leaves wire ready for soldering. Now in use by leading manufacturers of electrical products. Write for FREE SAMPLE for testing.

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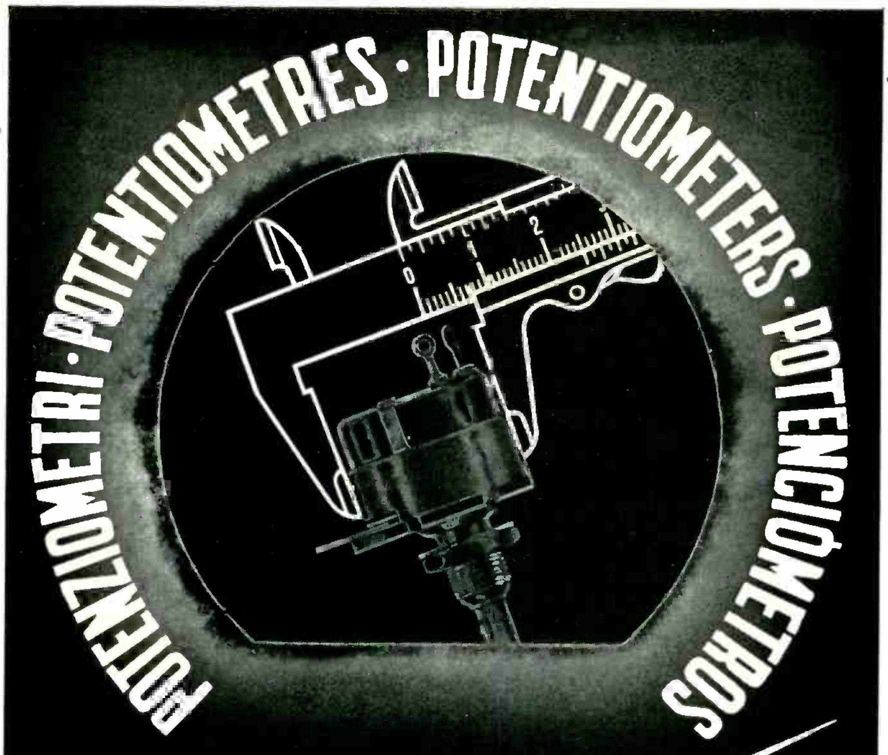

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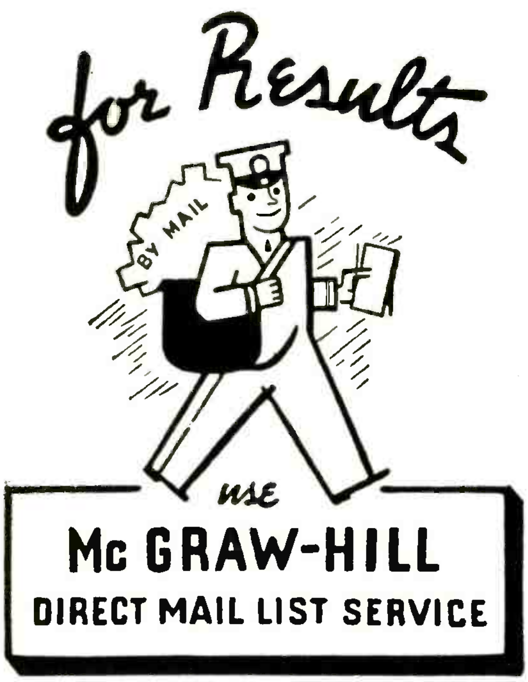

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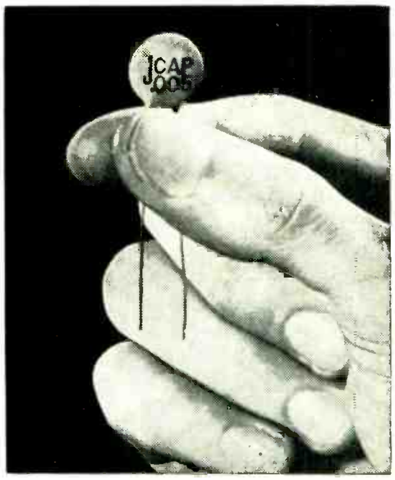
NEW PRODUCTS

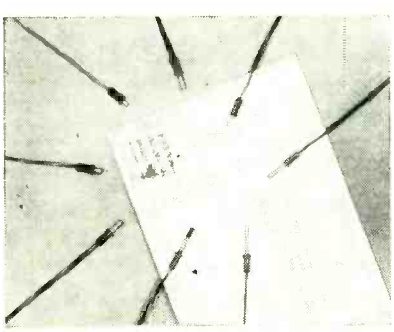
Edited by WILLIAM P. O'BRIEN

Tube and Component Specifications Geared to Military Needs . . . Laboratory Instruments Continue Plentiful . . . Chief Features of Latest Industry Literature Are Outlined



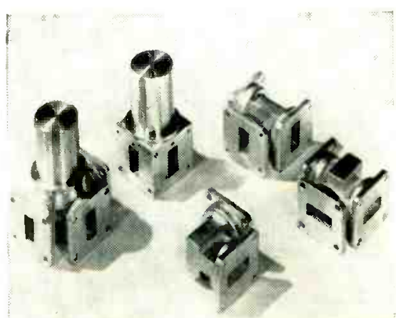
Ceramic Capacitor

SPEER CARBON CO., St. Marys, Pa., is now producing the J-cap, a thin disk ceramic capacitor of unusual physical strength, with dimensions of 0.156 in. maximum thickness and 0.594 in. maximum diameter. Now in mass production is the 0.005-μf 500-v unit. It will easily meet all requirements of the RTMA standards. Ratings are: minimum capacitance, 0.005μf; working volts, 500 v d-c; test voltage, 1,300 v d-c; leakage resistance, over 7,500 megohms; and power factor, less than 2.5 percent.



Subminiature Sliprings

NAER CORP., 631 S. Sepulveda Blvd., West Los Angeles 49, Calif., has developed a wide range of subminiature sliprings that are particularly advantageous where requirements demand mechanical and dielectric strength, insulation and arc resistance, absolute minimum torque friction, and a compact construction with silver, gold, or platinum rings securely molded in place. They are fabricated with Formex magnet wire which, because of the physical properties of its insulating film, plus its coating of NAER L-45 insulation, makes it extremely effective in all communications and industrial electronic equipment. The slip-rings are factory tested to 1,000 v and will fulfill all requirements for rigid standard operations.

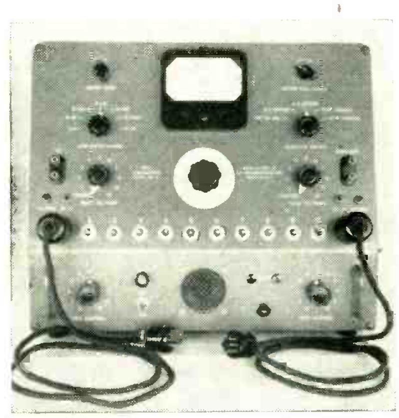


Microwave Components

GENERAL PRECISION LABORATORY, INC., 63 Bedford Road, Pleasantville, N.Y., has announced a line of specialized microwave components for use in radar, telecommunications, microwave experimentation and similar research or production fields. The lightweight, high-efficiency waveguide switch presents a maximum vswr of 1.10 in switched positions, and a vswr during switching interim of a maximum of 1.50. Cross attenuation varies from -25 to -40 db over a 10-percent bandwidth. The block switch complete with motor weighs only 6 oz. The twist-and-turn elbow provides both a bend and a modal rotation through 90 deg, in a unit no larger than a standard 90-deg bend alone.

Two-Way Radio Station

RADIO CORP. OF AMERICA, Camden, N.J. Model CSF-60A desk-type Fleetfone station combines a 60-watt transmitter-receiver and its power supply in a compact cabinet. The cabinet has ample room for mounting a line termination panel to permit remote operation of the transmitter. The equipment permits adjacent channel operation in the 30 to 50-mc band. The receiver has high selectivity, with nearly flat response over the desired modulation range of ±15 kc of the desired signal, and maximum rejection of undesired adjacent-channel signals.



Comparator

A. F. SMUCKLER & CO., INC., 202 Tillary St., Brooklyn 1, N.Y. The RXZ comparator is an instrument specifically designed to reduce the time consumed in the testing and inspection of completed complex electronic chassis, assemblies, sub-

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RAYTHEON RELIABLE RUGGEDIZED

Look at the chart. Keep it for reference. It tells you better than a thousand words why RAYTHEON may be regarded as the No. 1 source of Reliable and Rugged Tubes of *all kinds*.

Type	Description	Controlled Characteristics: Shock	Fatigue vibration	Vibration output	Stabilization	Centrifugal acceleration	5,000 hour life	Heater cycle life	High temperature life	Median control	60,000 foot altitude	Proto-type	Heater Volts	Heater Ma.	Plate Volts	Plate Ma.	Grid Volts	Screen Volts	Screen Ma.	Amp. Fac-tor	Mut. Cond.
Reliable Miniatures																					
CK5654	RF Amplifier Pentode	√	√	√	√			√		√		6AK5	6.3	175	120	7.5	—2.0	120	2.5	—	5000
CK5686	AF-RF Output Pentode	√	√	√	√			√				—	6.3	350	250	27.0	—12.5	250	5.0	—	3100*
CK5725	RF Mixer Pentode	√	√	√	√			√		√		6AS6	6.3	175	120	5.2	—2.0	120	3.5	—	3200
CK5726	Dual Diode	√	√		√			√		√		6AL5	6.3	300	Max. Peak Inv. 330 volts. I_0 = 9 ma. dc per plate						
CK5749	RF Amplifier Pentode	√	√	√	√			√		√		6BA6	6.3	300	250	11.0	R_k = 68 ohms	100	4.2	—	4400
CK5751	High Mu Dual Triode	√	√	√	√			√		√		12AX7	6.3/12.6	350/175	250	1.1	—3.0	—	—	70	1200
CK5814	Low Mu Dual Triode	√	√	√	√			√		√		12AU7	6.3/12.6	350/175	250	10.5	—8.5	—	—	17	2200
Reliable Subminiatures																					
†CK5702WA (6148)	RF Amplifier Pentode	√	√	√	√	√	√	√	√		√	5702	6.3	200	120	7.5	R_k = 200 ohms	120	2.5	—	5000
†CK5703WA (6149)	High Frequency Triode	√	√	√	√	√	√	√	√		√	5703	6.3	200	120	9.0	R_k = 200 ohms	—	—	25	5000
†CK5744WA (6151)	High Mu Triode	√	√	√	√	√	√	√	√		√	5744	6.3	200	250	4.0	R_k = 500 ohms	—	—	70	4000
†CK5784WA (6150)	RF Mixer Pentode	√	√	√	√	√	√	√	√		√	5784	6.3	200	120	5.2	—2.0	120	3.5	—	3200
CK6110	Dual Diode	√	√	√	√	√	√	√	√		√	—	6.3	150	Max. Peak Inverse 420 volts. I_0 = 4.4 ma. per plate						
CK6111	Low Mu Dual Triode	√	√	√	√	√	√	√	√		√	—	6.3	300	100	8.5	R_k = 220 ohms	—	—	20	4750
CK6112	High Mu Dual Triode	√	√	√	√	√	√	√	√		√	—	6.3	300	100	0.8	R_k = 1500 ohms	—	—	70	1800
CK6152	Low Mu Triode	√	√	√	√	√	√	√	√		√	5975	6.3	200	200	12.5	R_k = 680 ohms	—	—	15.8	4000
Rugged Miniatures																					
6AK5W	RF Amplifier Pentode	√	√	√				√				6AK5	6.3	175	120	7.5	—2.0	120	2.5	—	5000
6AL5W	Dual Diode	√	√					√				6AL5	6.3	300	Max. Peak Inv. 420 volts. I_0 = 9 ma. dc per plate						
6AS6W	RF Mixer Pentode	√	√	√				√				6AS6	6.3	175	120	5.2	—2.0	120	3.5	—	3200
6C4W	RF Power Triode	√	√	√				√				6C4	6.3	150	250	10.5	—8.5	—	—	17	2200
6J6W	Dual AF-RF Triode	√	√	√	√							6J6	6.3	450	100	8.5	R_k = 50 ohms	—	—	38	5300
6X4W	Full Wave Rectifier	√	√					√				6X4	6.3	600	Max. Peak Inv. 1250 volts. I_0 = 70 ma. dc.						
Rugged GT Types																					
6J5WGT	General Purpose Triode	√	√	√								6J5GT	6.3	300	250	9	—8.0	—	—	20	2600
12J5WGT	General Purpose Triode	√	√	√								12J5GT	12.6	150	250	9	—8.0	—	—	20	2600
6SN7WGT	Dual Triode	√	√	√								6SN7GT	6.3	600	250	9	—8.0	—	—	20	2600
6X5WGT	Full Wave Rectifier	√	√									6X5GT	6.3	600	Max. Peak Inv. 1250 volts. I_0 = 70 ma. dc.						

The above listing of Controlled Characteristics is based on the requirements and test limits of the applicable JAN-1A test specification.

Note: All dual section tube ratings are for each section. *2.7 watts Class A output. 10 watts Class C input power to 160 mc.

†For simplicity of identification with the prototypes, the type numbers with a "WA" suffix were established at the request of the Armed Services to replace the type numbers in parenthesis previously announced for these types.

Over 300 Raytheon distributors are at your service on these tubes. Application information is readily available at Newton, Chicago, Los Angeles.

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Twin Power Triode

RADIO CORP. OF AMERICA, Harrison, N.J. The 6080 low-mu, high-perveance twin power triode is designed primarily for use as the regulator tube in stabilized d-c power-supply units. It employs a compact design in which special attention has been given to features that improve its strength against shock and vibration. Use is made of a button stem to strengthen the mount structure and to provide relatively wide interlead spacing for reduction in susceptibility to electrolysis. These features contribute to its dependability and suitability for use in military applications. It is also useful in projection tv scanning applications where pulsed plate voltages of high value are encountered.

Trespass Alarm

DONDAR DEVICES, P.O. Box 187, LaÇanada, Calif., has introduced electronic devices that can be used to sound alarm bells or turn on lights, by merely approaching a sensitized area or by touching a sensitized object. Model 100 plugs into a 110-v a-c outlet. Price, including tubes, is $129.50. Model 101, the larger unit, will handle 1,000 w of flood lights without additional relays. Output terminals for 110 v and 8 v are provided on both the momentary circuit and the time-delay circuit, allowing wide flexibility in installation for bells, lights and additional relays. It plugs into

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Check these fabricated materials for applications where high or low temperature, superior electrical and chemical resistance, zero moisture absorption, excellent "memory" and easy machinability are required "specs".

✓ Molded Sheets
Thickness—1/64" to 1/2"
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Diameter—up to 1"
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✓ Molded Rod
Diameter—up to 2"
Lengths—to 12"

✓ Extruded Tubing
Diameter—up to 2"
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✓ Thin Film
(EXTRUDED AS LAY-FLAT TUBING)
Thickness—.002" to .010"
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* KEL-F is the registered trade name for polytrifluorchloroethylene — the high temperature fluorocarbon thermoplastic produced exclusively for commercial use by The Chemical Manufacturing Division of The M. W. Kellogg Company

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Molding Powders, both plasticized and unplasticized; *waxes; oils; greases;* and *dispersions* are available directly from the manufacturer.

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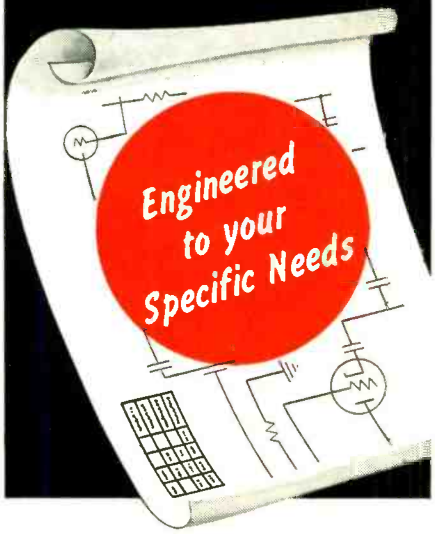
for every application



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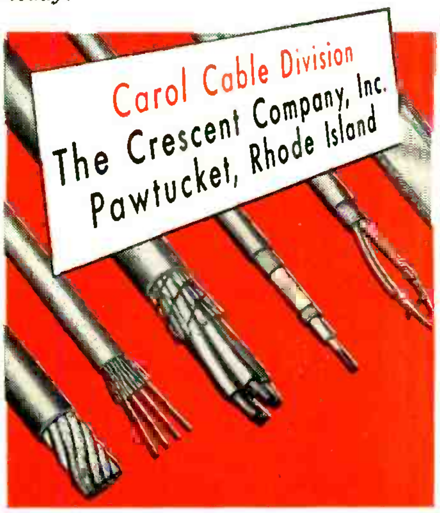

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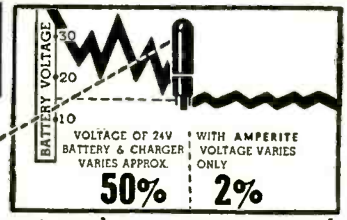

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XCELITE *Hand Tools*

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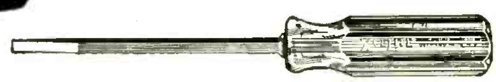

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If your work calls for several different sizes of nut drivers, and Phillips and regular screwdrivers, buy detachable-handle *multiple* sets, rather than individual tools. The "99" set, for instance, is 13 tools for only $10.95. The CK-3 set gives you 6 screwdrivers and a 7/16" nut retainer handle for only $4.35!

CK-3 Set

XCELITE INCORPORATED

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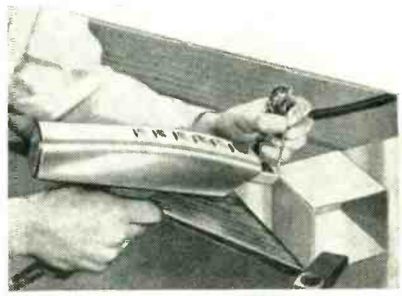
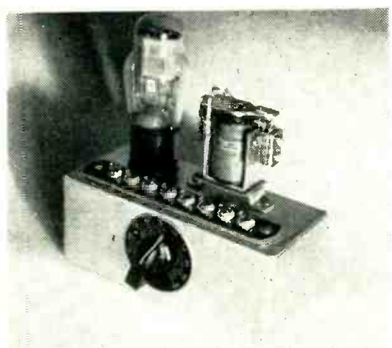
a standard 110-v a-c outlet. Price, including tubes, is $199.50.



Ultrasonic Soldering Iron

EAGLE ENGINEERING CO., 1139 So. Wabash Ave., Chicago 5, Ill. In the new technique developed by the Mullard Electronic Research Laboratories, the hard oxide skin is temporarily destroyed by passing ultrasonic energy through the molten solder. The equipment consists of a strong, portable power unit supplying either a soldering iron or a solder bath for dip tinning small components. There are no controls other than a main switch on the power unit and a trigger switch on the iron.



Electronic Timer

THE TIMETROL CO., P. O. Box 193, Rockford, Ill. Model 701 electronic timer incorporates unique circuit features that provide accuracies within 0.5 percent of time cycle. Time interval is continuously adjustable and accuracy is unaffected by supply voltage fluctuations. The timing cycle is initiated by a contact closure and a spdt relay is operated at the end of the timed interval. Time intervals from 0.05 to 20 seconds can be furnished. Spdt relay contacts are rated at 115 v, 5 amperes, noninductive. The unit operates on 105 or 130 v, 50 or 60 cycles, and it recycles instan-

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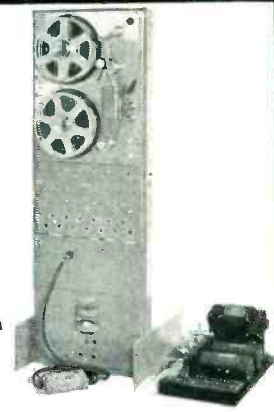
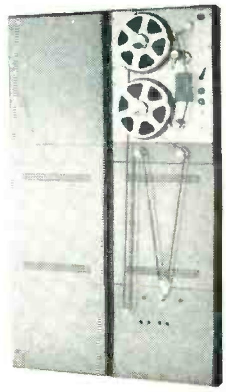


Multi-channel recorder for seismograph data recording in the field with remote control. Custom construction by AMPEX.



Multi-channel continuous loop reproducer. Custom construction by AMPEX.

MODEL 303 is a system which records pulse width modulation on which the pulse width varies from 100 microseconds to 1,000 microseconds with a pulse width accuracy of ± 2 microseconds at 30″ per sec. The period of the pulse repetition rate must exceed the maximum pulse length by at least 75 microseconds.

MODEL 306 is designed to record low frequency data within the spectrum of 0 to 2,500 cycles ± 1 db.

MODEL 307 is specially designed to record and reproduce all frequencies from 100 cycles to 100,000 cycles.

MODEL 375 is a 60 watt Capstan Motor-Power Amplifier driven by a precision, 60 cycle compensated tuning fork.

MODEL S3079 Air-borne recorder operates from 24 volt dc or 400 cycle aircraft supply; self-contained tuning fork frequency stabilizer; 2 speeds: 60″ and 30″; same specs as for Model 307, except record only; can be modified for multi-track recording.

MODEL 500 Low Flutter and Wow of less than .1% peak to peak over the spectrum of 0 to 10,000 cycles is achieved by an exclusive-with-Ampex drive system. Complete specs and data describing this and all other special AMPEX equipment are available on request.

EXCLUSIVE IN CANADA: Canadian General Elec. Co., Ltd., 212 King Street, West, Toronto, Canada.

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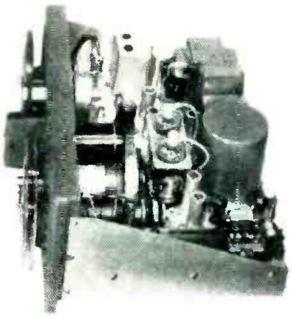
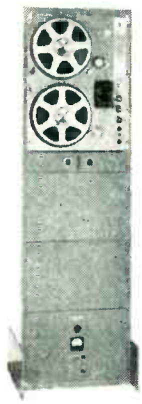
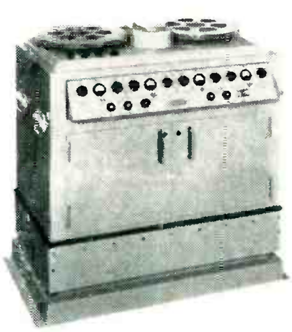


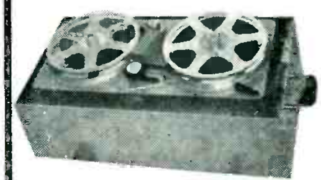
Model S3079 Air-borne recorder; a miniaturized Model 307



Low frequency data recorder. Custom construction by AMPEX.



Model 500 high stability multi-track recorder and playback



Mobile multi-channel shock and vibration data recorder. Custom construction by AMPEX.

For Immediate Details, Wire Or Telephone Collect: PLAZA 7-3091

Audio & Video

PRODUCTS CORP.

730 Fifth Avenue • New York 19, N. Y.

Cable Address: "AUDIOVIDEO"

Please send descriptive data on the following AMPEX models:

303...306...307...375...S3079...500...

My name is:..

My business affiliation:..............................

My position there:.....................................

Mail address:...

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TRAINED MANPOWER IS SCARCE!

Is Your Trained Manpower Bogged Down in the Blind Alley of Routine Jobs?

Among your valuable assets, trained manpower ranks at the very top. Yet if your skilled technicians are tied down to routine testing jobs, you are not only wasting your assets, but you are fanning the spark of dissatisfaction.

All good men earnestly desire advancement. And you *can* advance them to more important responsibilities if you turn over your routine testing to a dependable, highly regarded commercial laboratory.

We can handle your routine testing. In many cases we can actually produce results more promptly than your own laboratories, especially if they are overloaded. Our staffs include engineers, chemists, physicists, biologists, and specially trained technicians. At their disposal is an extensive alignment of scientific equipment.

Let's discuss the matter at your convenience. We are sure we can show you a better way of handling your routine testing.

UNITED STATES TESTING COMPANY, Inc.

Established 1880

1550 Park Avenue, Hoboken, N. J.

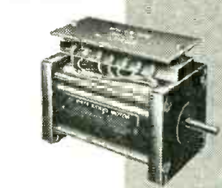
PHILADELPHIA • BOSTON • PROVIDENCE
CHICAGO • NEW YORK • LOS ANGELES
MEMPHIS • DENVER • DALLAS

Member of American Council of Commercial Laboratories

FORD control motors...

for extremely low inertia and high frequency response

10 Watt



Roto
Inertia
0.23 oz-in.^{2}
Weight
4.3 lbs.

HIGH VOLTAGE MOTORS

60 Cycle, 1½-5-10 watt models
Designed specifically for electronic systems—operate directly in the plate circuit of a vacuum tube amplifier.

LOW VOLTAGE MOTORS

60 and 400 Cycle, 2½-5-10 watt models
Recommended for normal two-phase applications.

advantages

- Linear torque—voltage characteristics
- Linear torque—speed characteristics
- Withstand continuous stalling
- High torque efficiency
- Flexibility of mounting

Write for Descriptive Brochure about all Ford Control Motors.

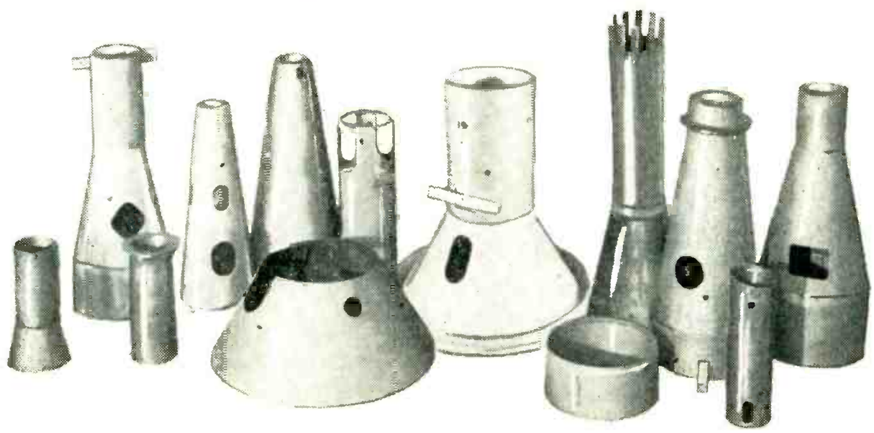
FORD INSTRUMENT COMPANY

Division of The Sperry Corporation

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

MU METAL SHIELDS

FOR MILITARY AND COMMERCIAL APPLICATIONS



Specializing in precision sheet metal fabrication, Multi-Metal produces components to exacting specifications.

Our engineering staff can help solve design and production problems. Your inquiries will receive prompt attention.

VISIT US AT BOOTHS 487-488 AT THE I.R.E. CONVENTION

Multi-Metal Co. 1350 Garrison Ave. New York 59, N. Y.

Every Top Management Man... In Every Industry

SHOULD BE ABLE TO ANSWER THESE QUESTIONS ABOUT A MOST CRITICAL EMERGENCY IN OUR COUNTRY'S AFFAIRS

Q. Why is iron and steel *scrap* a matter of importance to me?

A. Steel for our country's military program and civilian economy is being produced at the annual rate of 107,000,000 tons in 1951 . . . 119,500,000 tons expected in 1952. Steel-making capacity is being increased now to meet those quotas.

What Do I Get For My Scrap?

In addition to being paid for your scrap, you remove nuisance inventory from your plant—saving valuable floor space. Also, you have a better chance of *getting* new steel or steel products. But, *most important*—you help alleviate a dangerous condition threatening our country's capacity to rearm and satisfy civilian requirements at the same time.

Q. How does scrap figure in the production of steel?

A. Steel is composed, generally speaking, 50% of pig iron, 25% of "production" scrap (that is, the scrap which is produced as a by-product of steel-making) and 25% of "purchased" scrap.

Q. Is scrap getting scarce?

A. Yes. The supply of *purchased* scrap is not increasing fast enough to meet the needs of increasing steel production.

Q. What if the needed scrap isn't obtained?

A. Open-hearth furnaces will not be able to operate at capacity. That will mean a loss of steel production . . . and fewer products made of steel.

Q. Why not use pig iron instead of scrap?

A. Every ton of scrap conserves approximately 2 tons of iron ore, 1 ton of coal, nearly ½ ton of limestone and many other vital natural resources—to say nothing of the extra transportation facilities that would be otherwise required.

Q. How can *more* scrap be furnished?

A. By everybody pitching in—as we always do in every emergency—and searching out all possible sources of scrap.

Q. What are these sources?

A. Metal-fabricating plants normally turn over to scrap dealers the scrap left from machining. But there's not enough of this to fill our present enormous need. So everybody—both in and out of the metal-fabricating industries—must sell scrap in the form of *idle metal.*

Every pound of idle metal is needed to keep our steel mills operating at top capacity. Sell your idle metal to a local scrap dealer right away.

What Do I Do *First*?

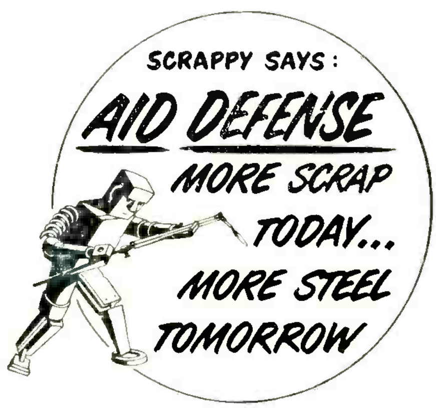
Write for free booklet. It tells how to set up a Scrap Salvage Program in your plant. Thousands of plants are cooperating. Do *your* part now! Address Advertising Council, 25 West 45th Street, New York 19, N. Y.

Q. *We* don't *produce* scrap—how can *we* help?

A. Scrap is any kind of iron and steel that's gathering dust—obsolete machines or structures, jigs and fixtures, pulleys and wheels, chains and track, valves and pipe—*anything* with rust on it or dust on it. Non-ferrous scrap is needed, too.

Q. What do we do with it when we find it?

A. Use your normal channels or get in touch with a recognized scrap dealer.



This advertisement is a contribution, in the national interest, by

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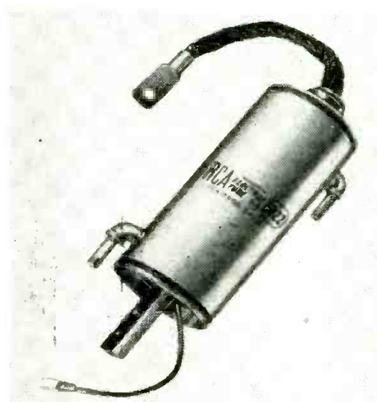
330 WEST 42nd STREET NEW YORK 18, N. Y.

A PUBLIC SERVICE PROJECT — THE ADVERTISING COUNCIL taneously. It is 6 in. long, 3 in. wide and 6 in. high.

Microwave Calorimeters

TRANSPORT PRODUCTS CORP., Gillespie Field, Santee, Calif., has completed development and is in regular production on a line of primary standard microwave calorimeters. The single unit, weighing about 50 lb complete, operates throughout the microwave spectrum with any amount of power measurement from fractional watt to the maximum needed short of the breakdown point of waveguides.

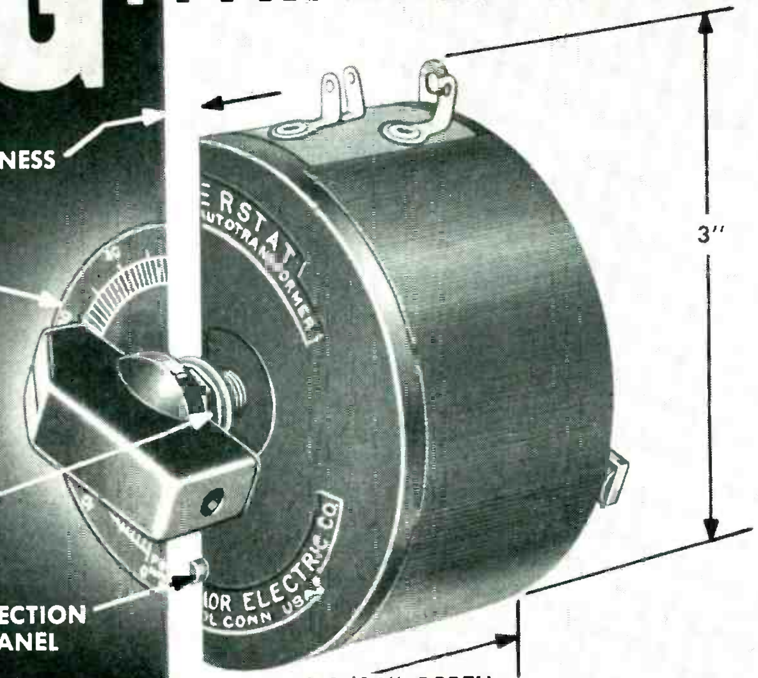


Ignitron

RADIO CORP. OF AMERICA, Harrison, N.J., has announced the 5822 water-cooled, steel-jacketed, mercury-pool-cathode tube of the ignitron type for use in frequency-changer resistance-welding service. In the frequency-changer method of resistance welding, three-phase, 60-cycle power is converted to single-phase power having a frequency of about 5 to 12 cps. This method offers appreciable reduction in kva demand in comparison with that required in single-phase welding. The three-phase circuit balances the

SMALL . . . IN SIZE

BIG . . . in PERFORMANCE



TYPE 10 POWERSTAT

VARIABLE TRANSFORMER

RATED:

INPUT: 120 Volts, 60 Cycles
1 Phase

OUTPUT: 0 - 120/132 Volts,
1.25 Amperes
150/165 VA

APPLICATIONS

of POWERSTAT Type 10 are as innumerable as is the need for a variable a-c voltage control in today's low wattage electric and electronic equipment. It is ideal as the variable a-c voltage component in electronic tube testers; low wattage power supplies and rectifiers; low wattage heaters, furnaces, plastic molding equipment . . . and in any a-c voltage application where 50, 100 and 150 watt rheostats are now being employed.

A COMPACT VARIABLE A-C VOLTAGE CONTROL FOR LOW WATTAGE APPLICATIONS

To date, the many low wattage (50 . . . 100 . . . 150 watts) applications requiring variable a-c voltage control have had to be content with the inefficient, heat dissipating rheostats and other resistance types of control. With the introduction of the new POWERSTAT Type 10, the many advantages of POWERSTAT variable transformers are available for these low wattage requirements. A continuously adjustable output voltage from 0 to 120 or 132 volts is at the fingertips to control loads up to 165 VA. Type 10 does not have to be tailored to the load — it will deliver a variable voltage to any load up to its capacity. Type 10 is highly efficient — *does not* control by dissipating power in the wasteful form of heat. Other features: glass smooth commutator surface . . . advanced winding technique . . . superior core and coil design . . . rugged construction . . . single hole mounting . . . can be installed under a 3" chassis saving valuable space.

For additional information on the new, compact POWERSTAT Type 10, send for Bulletin P252.

Write to: 203 Thure Avenue, Bristol Connecticut

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

. . . and plan to see the new, compact POWERSTAT Type 10 at The Superior Electric display, booths 108, 110 at the I.R.E. Show, March 3-6

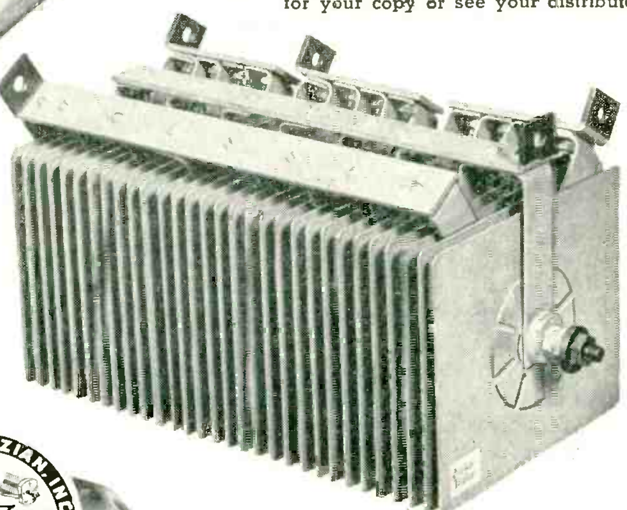
Sarkes Tarzian®

"Centre-Kooled"®

SELENIUM RECTIFIERS

★ JUST OFF THE PRESS!

Most complete book of its kind ever published . . . 80 pages of valuable information about Selenium Rectifiers . . . 48 pages of Radio & Television circuit diagrams . . . 20 pages on Power Rectifiers . . . 3 pages on High Voltage Rectifiers . . . a 7 page cross index replacement guide. Send 50¢ for your copy or see your distributor.



Sarkes Tarzian, Inc.

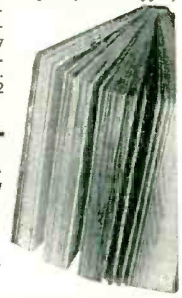
RECTIFIER DIVISION

Dept. E-1, 415 North College Ave., Bloomington, Indiana

Just Published!

TELEVISION ENGINEERING
Second Edition

1. covers the whole television process—from studio to receiver—clearly, and in detail. Treats television technology, operating principles of TV systems, use of equipment. Provides practical working diagrams, complete with values of parts, tube types, etc. covers color TV, intercarrier sound reception, distributed amplification, and many other phases. By Donald G. Fink, Editor, *Electronics*. Second ed., 721 pages, 512 illus., $8.50



SHORT-WAVE RADIATION PHENOMENA

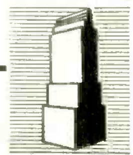
2. Thousands of facts, formulas, and numerical examples providing a thorough understanding of modern and classical wave-propagation concepts. Intensive treatment in 2 volumes explains and shows application of every frequency from those of about 30 megacycles per second to the highest radio frequencies in practical use. By August Hund, Scientific & Tech. Radio Consultant. McGraw-Hill Radio Communication Series, 2 vols. (not sold separately) 1382 pages, 97 tables, 394 illus., $20.00 (available on terms.)

GENERAL NETWORK ANALYSIS

3. A firm foundation for most phases of network analysis, including some of the background for network synthesis. Covers lumped and distributed networks in steady state and lumped networks in transient state—treats series and parallel circuits, magnetic coupling, simpler mathematical properties of generalized network response, Fourier and La Place integral, etc. By Wilbur R. LePage, prof., and Samuel Seely, Prof. & Chairman—both of the Dept. of Electronic Eng., Syracuse U. 516 pages, 288 illus., $8.00

AUTOMATIC FEEDBACK CONTROL

4. Gives information needed for the design and selection of automatic feedback control systems. Covers operation of controls and problems encountered in industry. Shows functional and constructional requirements of instruments. Covers servomechanisms, pneumatically operated controls, temperature regulation, speed governing, pressure flow, and liquid level. By William H. Ahrendt, Pres. Ahrendt Instrument Co., and John F. Taplin, Consulting Eng., Kendall Controls Corp. 420 pages, 378 illus., $7.50



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McGraw-Hill Book Co., Inc.
330 West 42nd Street, NYC 36

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents delivery, and return unwanted book(s) postpaid. (We pay delivery if you remit with this coupon—same return privilege.)

- ☐ 1. Fink—TV ENGINEERING—$8.50
- ☐ 2. Hund — SHORT-WAVE RADIATION — (2 vols.)—$20.00 Payable $5.00 in 10 da., $5.00 mo.
- ☐ 3. LePage & Seely—NETWORK ANALYSIS—$8.00
- ☐ 4. Ahrendt & Taplin—AUTO FEEDBACK CON.—$7.50

(Print) Name ....

Address ....

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

Company ....

Position L-3-52

This offer applies to U. S. only.

Now another

OF OUR PRECIOUS NATIONAL RESOURCES

IS WASTING AWAY

in your plant

It's iron and steel scrap.

Are you surprised to learn that scrap piles furnish just as much steel mill melting stock as iron mines do?

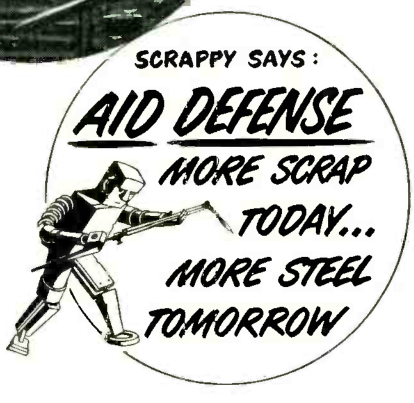
It's a fact. 50% of the melt is iron and steel scrap . . . and some of this scrap is wasting away in *your* plant.

This scrap of yours is needed to help maintain steel production so there will be enough steel for both military and civilian needs.

It's up to you to get idle iron and steel into the mills. Channel it through your local scrap dealer.

Don't delay. The mills need 3000 carloads of scrap a day—every pound counts in this emergency!

NON-FERROUS SCRAP IS NEEDED, TOO!



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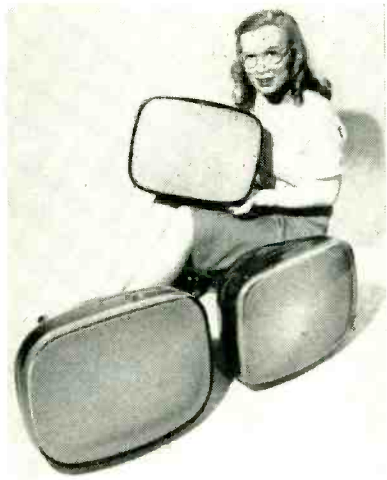
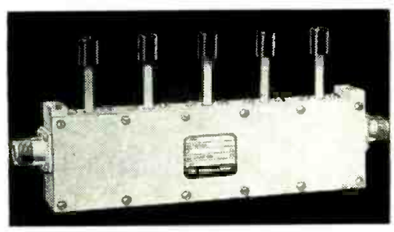
power load and permits improved results in welding aluminum, magnesium and their alloys.



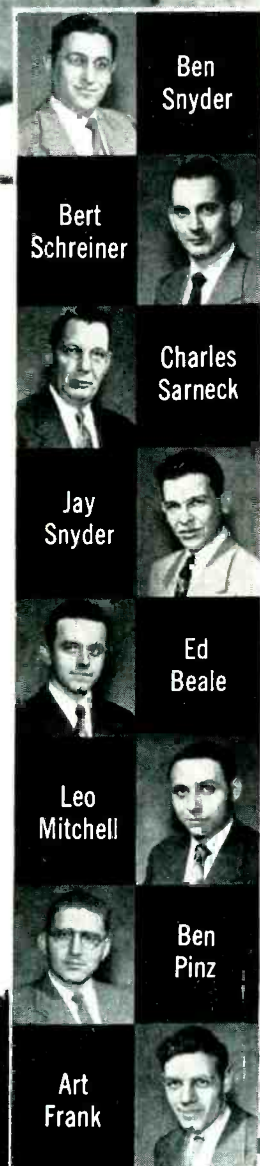
Electrostatic Tubes

GENERAL ELECTRIC Co., Syracuse, N.Y., has announced three additions to its zero-voltage electrostatic tube line. The 17VP4 is a 17-in. tube; the 20HP4-A/20LP4, a 20-in. tube; and the 21FP4-A, a 21-in. tube. All contain the electron gun that makes possible important savings of copper, nickel and cobalt through elimination of the focus coil. All are space-saving glass rectangulars. The 17-in. and 21-in. types have cylindrical faces.



R-F Attenuators

DAVEN Co., 191 Central Ave., Newark, N.J. With two units connected in series, the series RF-550 r-f attenuators are available with losses up to 100 db in one-db steps. The units have a zero insertion loss and have a frequency range from d-c to 225 mc. Standard impedances are 50 and 73 ohms. Resistor accuracy is within ±2 percent at d-c. An unbalanced circuit is used providing constant input and output impedance. Either the UG-58/U or UG-185/U receptacles are supplied with the units. Cable



They're all on *your* team—with just one purpose—to make your purchasing of Electronic Parts & Equipment QUICK, THRIFTY and ENJOYABLE!

Specialists all, they speak *your* language—know what you need and how to get it to you . . . in the shortest possible time.

Get to know them . . . they're *eager* to save you time and money!

HARRISON adds up to an experienced, conscientious staff . . . PLUS nine floors crammed with parts and equipment — *the one source for all your electronic needs!*

"HARRISON HAS IT"

JUST CALL

BArclay 7-7777

"Your *Winning* Number"

P.S.

What's YOUR E.I.Q.?

Find out at our Booth **323** in the I.R.E. Show. High scores win awards!

FREE 1200 PAGE CATALOG!

Purchasing Agents—Chief Engineers—Write on your company letterhead for your big, 1952 Buying Guide!

SINCE 1925 — ELECTRONIC PARTS AND EQUIPMENT DISTRIBUTORS

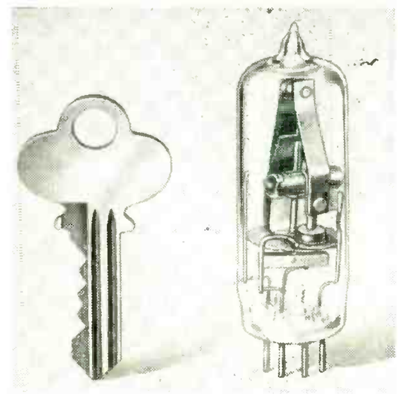
Cable Address — HARRISORAD

HARRISON RADIO CORPORATION

225 GREENWICH ST. (10 West Broadway)

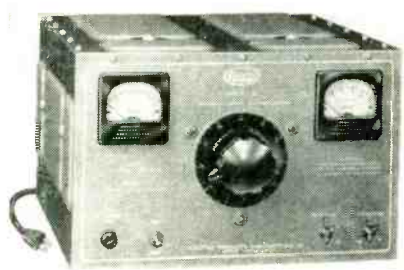
NEW YORK 7, N. Y. • BArclay 7-7777

plugs can also be furnished if required.



Miniature Thermal Relay

THOMAS A. EDISON INC., Instrument Division, West Orange, N. J. Model 207 miniature thermal relay is designed especially for use in airborne electronic equipment. It is hermetically sealed in a T-$5\frac{1}{2}$ glass envelope with a miniature button 7-pin base. Weight is $\frac{1}{2}$ oz, seated height $2\frac{1}{4}$ in., diameter $\frac{3}{4}$ in. Delay periods are from 5 seconds to 120 seconds, standard heater voltages 6.3 v, 27.5 v and 115 v a-c or d-c. Contacts are rated at 2.5 amperes 125 v a-c, or 1.0 ampere 125 v d-c. It is ambient compensated from −60 to +85C.



D-C Power Supply

ELECTRO PRODUCTS LABORATORIES, INC., 4501 North Ravenswood Ave., Chicago 40, Ill. The new model N universal d-c power supply has an output range of 0 to 28 v at 15 amperes. An exclusive feature is the application of selenium rectifiers which increases the rectifier power rating and permits lower cost per ampere output. The unit supplies up to 36 v at 6 amperes. The a-c power is approximately 730 w with a 15-ampere 28 d-c volt load. The a-c hum or ripple at 15 amperes

For *FAST, RELIABLE*
IMPEDANCE MEASUREMENTS

—It's the FTL-42A IMPEDOMETER

Measures Accurately Up to 500 Megacycles

An instrument of outstanding quality and efficiency . . . for research and development . . . rapid production testing and many other applications.

THE FTL-42A, a development of Federal Telecommunication Laboratories, Inc., is a simple, compact, easy-to-use instrument for the measurement of impedance, attenuation, reflection coefficient and standing-wave ratio at frequencies up to 500 megacycles.

Read relative voltages of incident wave, reflected wave and resultant . . . plot diagram of voltages on Smith Chart and impedance can be determined to $\pm 5\%$.

The FTL-42A requires no unusual accessories —only those found in every laboratory and test shop working in the frequency range of the instrument: signal generator with 0.1 volt maximum output, crystal detector, audio amplifier, and output meter. Below 100 megacycles a radio receiver is desirable for its greatest sensitivity.

In addition, the FTL-42A Impedometer can be operated with input power up to several hundred watts when it is desired to drive the load in this manner.

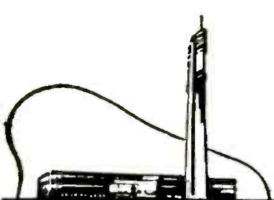
Any signal generator with 0.1 volt maximum into 51.5 ohms output furnishes power for operation.

Crystal detector and audio amplifier with output meter have sufficient sensitivity as a detector above 100 megacycles.

Adapters for $1\frac{5}{8}$-inch line to type N are furnished so that the instrument can be used with flexible cables. It can be used directly with $1\frac{5}{8}$-inch line, or with other sizes of lines or cables by use of various adapters that are available.

Dimensions of cabinet are: $6\frac{13}{16}$ inches long by $5\frac{5}{16}$ inches wide by $5\frac{7}{8}$ inches high. Net weight including adapters is 7 pounds. For complete information, write to Wire and Radio Transmission Systems Division for Brochure FTL-42A.

The FTL-42A Impedometer will be on display at "Federal Hall" (134-138) 1952 Radio Engineering Show, New York City, March 3-6

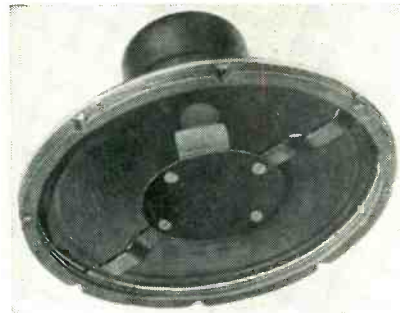


FEDERAL TELECOMMUNICATION LABORATORIES, Nutley, N. J. . . . . a unit of IT&T's world-wide research and engineering organization.

Federal Telephone and Radio Corporation

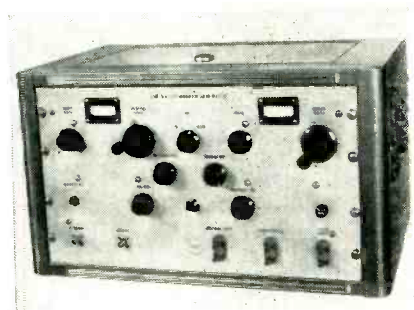
WIRE AND RADIO TRANSMISSION SYSTEMS DIVISION
100 KINGSLAND ROAD CLIFTON, NEW JERSEY
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

FEDERAL TELEPHONE & RADIO FTR — AN IT&T ASSOCIATE is 8 percent, at 10 amperes 5 percent. New literature giving full details is available.



Coaxial Speaker

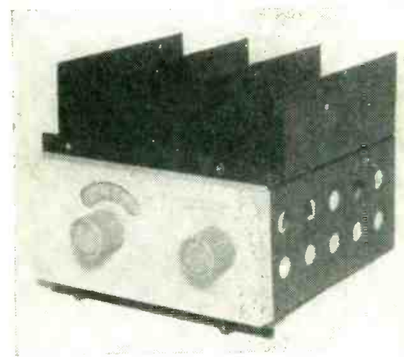
OXFORD ELECTRIC CORP., 3911 South Michigan Ave., Chicago 15, Ill., has announced model CO12JB, a 12-in. coaxial speaker, designed for quality a-m, f-m and tv receivers, as well as monitoring, recording applications and other sound installations. Frequency range is 65 to 15,000 cps; the network crossover at 4,000 cycles; power rating, 10 to 12 watts; input impedance, 8 ohms; size and magnet weight: woofer—12 in., 6.8 oz Alnico V; tweeter—3 in., 1.47 oz Alnico V.



UHF Sweep Generators

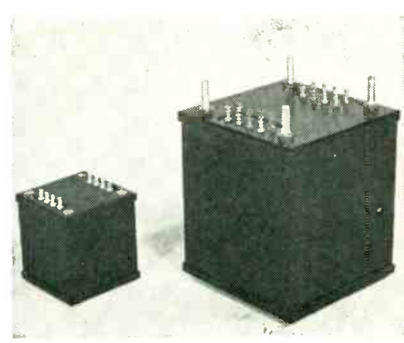
RADIO CORP. OF AMERICA, Harrison, N. J. Two new uhf sweep generators—the WR-40 A (with built-in markers) and WR-41A (without markers)—have been announced. They are of particular interest to research workers and engineers engaged in the developed of uhf tv receivers and other uhf equipment. Both feature continuous tuning from 470 to 890 mc and operation entirely on fundamental frequencies, with no beat notes or harmonics used. They have a continuously variable sweep width from 0 to 45 mc with an amplitude variation of 0.1 db per mc or less

throughout the swept range. Maximum output level of the sweep oscillator is 0.5 v across a 50-ohm load. Facilities are also provided for matching to either a 72 or 300-ohm load.



Airborne Receiver

GERTSCH PRODUCTS, INC., Los Angeles, Calif., is producing model AR-1 receiver, a five-tube miniaturized superhet broadcast receiver designed especially for airborne use where light weight, small size, high sensitivity and good signal-to-noise ratio are needed. Frequency range is 550 to 1,700 kc; sensitivity, better than 5 μv; i-f frequency, 456-kc; power required, 0.625 ampere at 2 v d-c, 0.050 ampere at 250 v d-c. Antenna input impedance is 72 ohms (coax line); audio output voltage, 0 db into a 600-ohm line, 1 mw reference; and weight is 2 lb, 4 oz.



Enclosed Transformers and Chokes

PLESSEY INTERNATIONAL LTD., Ilford, Essex, England, has introduced a range of new, totally enclosed, semisealed units, particularly suitable for use in industrial and test instruments and in communications equipment. These are vacuum impregnated with bitumen varnish, and enclosed in one of five basic sizes of bitumen-filled cases. The electrical properties of the units may be varied in manufacture over a wide range to meet manufacturers' operational requirements. Maximum operating temperature of the transformers is 110 C.

Klystron Power Supply

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N.Y. Model KX is designed to power high power klystron tubes. This supply is an extremely stable low-ripple-content, h-v source. It provides either 300, 400, 1,000 or 1,250 v negative at high current with respect to ground. A 600-v supply at 18 ma is added on to the negative supply to provide repeller bias. Sufficient power is available to drive positive-grid-bias klystron tubes.

Monitor Kinescope

RADIO CORP. OF AMERICA, Harrison, N.J. The new, directly viewed, 7-in. c-r tube 7TP4 is intended for monitor service in connection with theater-tv systems, industrial tv equipment and portable broadcast equipment. It provides a 5⅜-in. × 4-in. picture. Utilizing electrostatic focusing, it features an electron gun of improved design to provide high resolution and good uniformity of focus over the entire picture area. Voltage can be maintained automatically with variation in line voltage and with adjustment of

picture brightness. It also features a metal-backed fluorescent screen that eliminates the need for an ion-trap magnet.

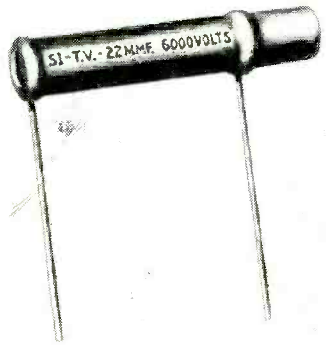
Five-Inch Oscilloscope

TELEVISION EQUIPMENT CORP., 238 William St., New York 38, N. Y. Model T-601B five-in. oscilloscope provides Y-axis response within 3 db from 2 cycles to 12 mc at 10 mv rms per inch deflection sensitivity. The sweep generator provides either recurrent sweeps from 10 cycles to 100 kc or triggered sweeps from 5 μsec to 10^5 μsec. Phasing is provided for 60 cycle sweeps and all sweeps may be synchronized to either positive or negative peaks. Features include front panel availability of sweep sawtooth and retrace pulses for convenience in synchronizing, sweeping or blanking external circuits with the scope.

Fast-Rise Pulse Generator

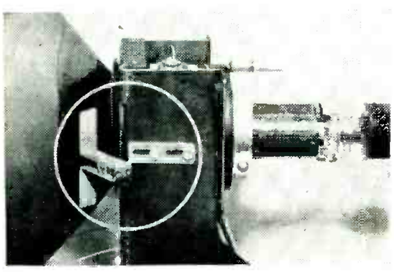
SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass., has announced model 503 fast-rise pulse generator that produces a rectangular pulse having a rise time less than 10^{-9} seconds. The width of the pulse is controlled by the external width cable and may be as short as 2×10^{-9} seconds. Pulse amplitudes from 0.1 to 100 v, of either polarity, may be selected. A single pulse, controlled by an external trigger, or internally controlled repetitive pulses, with repetition rates from 50 to 150 per second, may be produced. The unit is designed for testing the transient response of

wide-band systems, but can also be used for the generation of impulse or continuous spectrum noise for signal-to-noise ratio testing and for narrow-band receiver alignment.



Tubular Ceramic Capacitors

AEROVOX CORP., New Bedford, Mass. Type SI-TV high-voltage tubular ceramic capacitors are of the Hi-Q brand manufactured by the Electrical Reactance Corp., an Aerovox subsidiary, for distribution to and through the latter's jobbers to the service and experimenter trade. These ceramics are available in a 6,000-volt rating and in eleven capacitance values from 4.7 to 47 μμf.



Pin-Cushion Corrector

ALL-STAR PRODUCTS, INC., Defiance, Ohio. The PK-1 two-piece pin-cushion corrector set is designed to eliminate tv image distortion in the corners of the picture tube caused by errors in the deflection fields and in the picture tube geometry either separately or in combination. It consists of a small piece of Alnico V magnet material with correctly designed pole pieces. There are two units in the set for mounting on the deflection yoke mounting bracket on each side of the picture tube. Control of the amount of correc-

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ARE VERY MUCH AT HOME IN A HOT • SPOT

ALLOY	OHMS PER CMF	MAX. OPER. TEMP.	WIRE DIA. RANGE	FORMS†	USES
1000	1000	500° F	0.0056 0.0009	W-R	Compact, stable precision Resistors
ALLOY C	675	1700° F	0.2890 0.0008	W-R	Appliances and Resistors
ALLOY A	650	2100° F	0.0410 0.0010	W-R	High-temp. Furnaces and Resistors
ALLOY 45	294	930° F	0.2890 0.0010	W-R	Precision Applications

† W—wire R—ribbon

★

Whether the heat is literal (up to 2100 F), or figurative in the sense that performance under difficult conditions is a ***must***, we have an alloy for almost any conceivable requirement. The above Table may suggest possible applications to your products.

★

Complete Technical Data are available from Department 17.

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Connections are made through Fanning Strip, on bench or anywhere apart from barrier strip, and quickly slipped into assembly.

Use with Jones Barrier Terminal Strips, Nos. 141 and 142, for 1 to 20 terminals.

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CINCH MANUFACTURING CORPORATION
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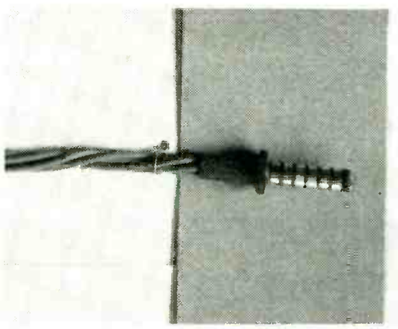
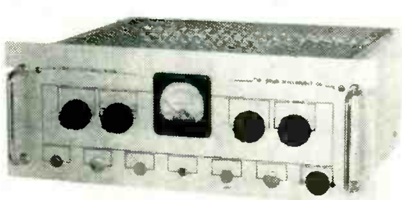
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

tion is obtained by moving the PK-1 toward the face or base of the tube. The PK-1 achieves correction by providing a magnetic field with the same curvature and strength as the error component of the deflection field but in the opposite direction.



Slipring Assemblies

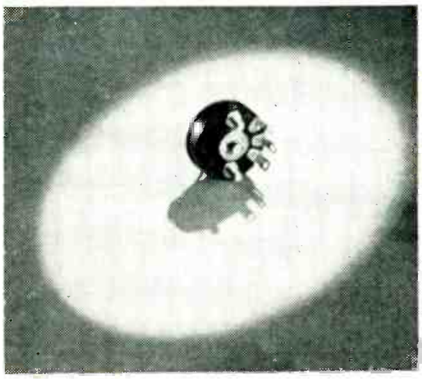
AIRFLYTE ELECTRONICS CO., 21 Cottage St., Bayonne, N.J., offers slipring assemblies ranging from 0.025 in. to 3 in. in diameter with from one to 35 contact rings of silver, gold, platinum or alloys thereof. These units are either molded, plated plastic or stacked, and are finished to a 4-microinch surface with concentricities as low as 0.0005-in. total indicated runout. Voltage breakdown of 50 v per mil of external ring spacing can be held. Picture shows slipring assembly with ring diameter of 0.080 in. and hub of 0.093 in.



Direct-Coupled Amplifier

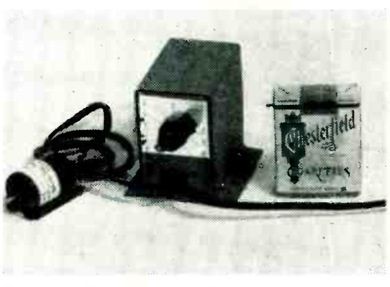
THE BRUSH DEVELOPMENT CO., 3405 Perkins Ave., Cleveland 14, Ohio. Model BL-962 direct-coupled amplifier, designed for use in standard 19-in. rack and having a 7-in. high front panel, was meant to be used with magnetic direct-writing oscillographs in studies of such static or dynamic conditions as strains, displacements, pressures, light intensities, temperatures and a-c or d-c voltages or currents. Volt-

age gain of the instrument is sufficient to give 1 mm of deflection on the oscillograph chart per mv input. When the amplifier is used with the penmotor, the frequency response is essentially linear from d-c to 100 cps. The control panel on the face of the unit contains an attenuator with five factor-of-ten positions, gain control, calibrating meter and controls for determining input voltages.



Radiohm Control

CENTRALAB DIV. OF GLOBE-UNION, INC., 900 E. Keefe Ave., Milwaukee 1, Wis., announces production of the high-torque model I Radiohm control, designed specifically for maintenance of circuit balance under conditions of vibration. This unit is intended especially for equipment used in commercial or government installations where miniature size also is a prime requisite. The unit's torque range is from 2 to 4 oz-in.



Motor Control System

SERVO-TEK PRODUCTS CO., Paterson, N. J., has added to its line a tiny motor speed control system with a companion line of motors. It measures 3 in. × 3 in. × 2 in. The companion motor measures 1⅛ in. in diameter × 1½ in. long. The electronic control unit for unidirec-

Men Who Use Them Know...

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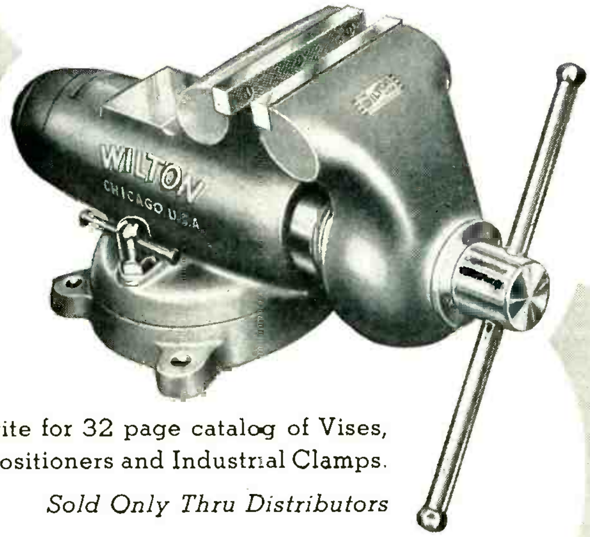
IS THE FINEST NAME IN VISES



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Special CENTRIFUGAL BLOWERS

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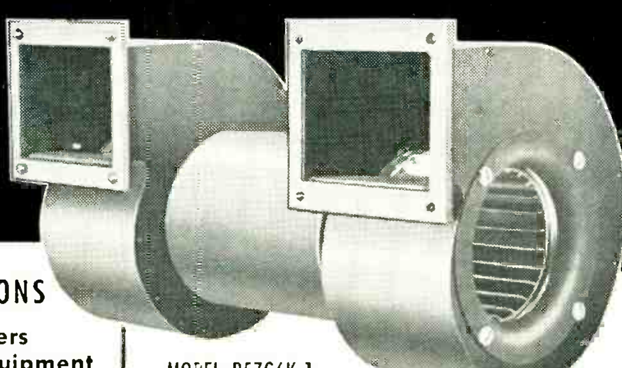
Designed at low cost to meet your specifications. Standard units also available.



MODEL B57G6K-1

APPLICATIONS

- Transmitters
- Radar Equipment
- Amplifier Equipment
- High Ambient Temperatures
- High Humidity Applications

SPECIFICATIONS

MODEL B57G6K-1: 115 volt AC • 60 cycle • single phase • 4 mfd. • 120 CFM at 0.5″ SP—220 CFM at 0″ SP • Silicon impregnated • Fungus proof.

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there's something I never knew before!"

F-11A

Unless you're exceptionally well-informed there are probably lots of things YOU never knew before right here in the advertising pages of this magazine. Alert manufacturers use these advertising pages to get the *news* about their products and services to you . . . quickly and effectively. Their advertisements contain information designed to help *you* do your job better, quicker and cheaper. To be well-informed about the latest developments in *your* industry . . . and to stay well-informed . . . *read all the ads too.*

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HEADQUARTERS FOR INDUSTRIAL INFORMATION

tional operation over an approximate 40 to 1 speed range contains the special electronic circuits, tube and speed control potentiometer. Motor horsepower is approximately 1/250 hp; motor-shaft speed, from 10,000 rpm to 250 rpm. A signal is used in a feedback circuit to counteract speed decrease as a function of increased load torque. The unit operates from the 115 volt, 60 cycle a-c line and finds many laboratory and industrial uses.

Portable Television

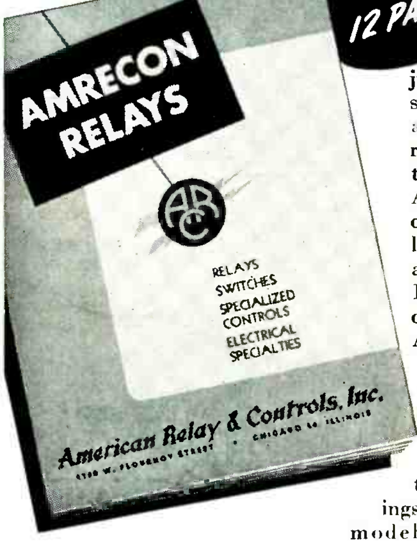
HAROLD SHEVERS, INC., 123 W. 64th St., New York 23, N.Y., has available the portable Gotham television measuring 19 in. × 17 in. × 10 in., and weighing 29 lb. Picture tube is the General Electric 8½-in. type. Tuning is done with two controls. All other controls are accessible through a front flap. It is instantly convertible to uhf and has standard components throughout. List price in airplane cloth is $199.95.

Continuously Variable Delay Line

ADVANCE ELECTRONICS CO., P. O. Box 394, Passaic, N. J. Type 302 distributed-parameter line is capable of providing continuously variable time delay from zero to 0.6 μsec. Some of its advantages are complete freedom of time jitter, very fast rise time, no limit on repetition frequency, greater bandwidth and excellent transient response. Characteristic impedance is 960 ohms nominal. Attenuation in db per 100 millimicrosecond delay is: approximate zero below 1 mc, 0.3 at 5 mc, 0.95 at 10 mc, 1.3

NEW! AMRECON
RELAY CATALOG

12 PAGES



This useful catalog shows just how to go about selecting a relay, with all the information required to fit the unit to the application! Also describes the complete AMRECON line, with illustrations and data on each of 10 basic models (including both D.C. and A.C. types) and their variations. Includes a discussion of snap-action and latching relays; screw terminal types; plug-in mountings; hermetically sealed models, and other data.

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American Relay & Controls, Inc.
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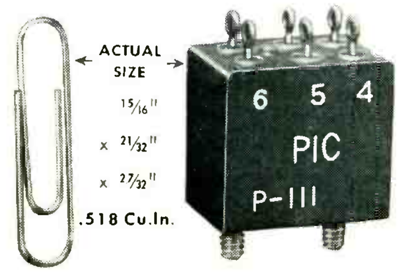
PIC* *Ferrite* Pulse Transformer



Fits in Half the Space!

Features: Shorter Rise Time
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Complete Interchangeability
with Conventional Transformers

Other Ferrite transformers designed to your circuits or specifications

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Quick, Expert Service on RCA Tubes

ALLIED maintains in stock *for quick shipment,* the world's largest distributor inventory of RCA special-purpose tubes—*of all types.* We specialize in supplying the needs of industrial, broadcast, governmental and other users. To save time, effort and money—phone, wire or write to ALLIED. Fill *all* your needs quickly from the *complete, dependable* electronic supply source.

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Valuable guide to selection of proper RCA tube type replacements. Lists 1600 tube types. Write for FREE RCA Guide No. 37-046.

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Refer to your ALLIED Catalog for *all* electronic supplies—parts, tubes, test instruments, tools, audio amplifiers, accessories—available from the world's largest stocks. Write today for your FREE copy of the *complete* 212-page ALLIED Catalog.

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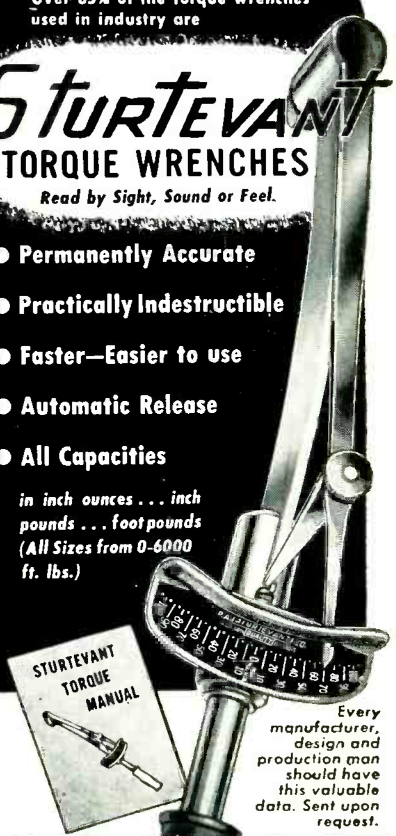

- Permanently Accurate
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- Faster—Easier to use
- Automatic Release
- All Capacities

in inch ounces . . . inch pounds . . . foot pounds (All Sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

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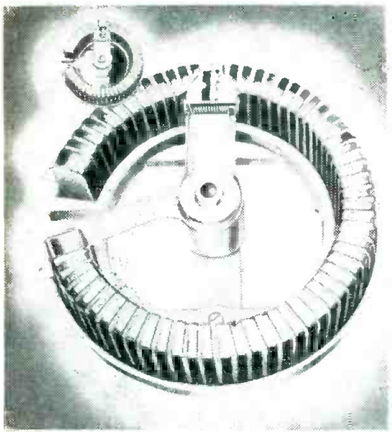
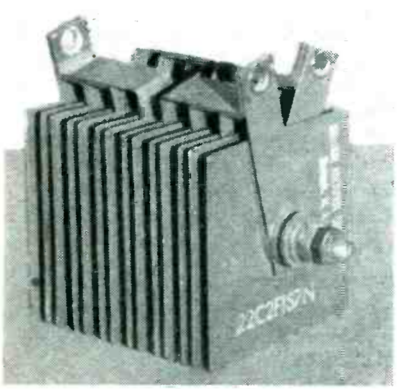
ADDISON QUALITY ILLINOIS

at 20 mc and 1.5 at 30 mc. A descriptive bulletin is available.



Power Rheostats

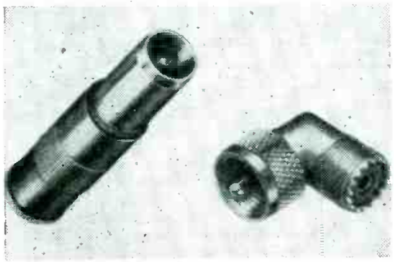
P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis 6, Ind., has placed in production a line of vitreous enamel power rheostats. The rheostats will be available in seven sizes, ranging from 50 to 500 w. They will be interchangeable with the vitreous enamel power rheostats produced by the rest of the industry, but feature an exclusive patented hinged contact arm that insures long life and freedom from burn-outs.



Selenium Rectifiers

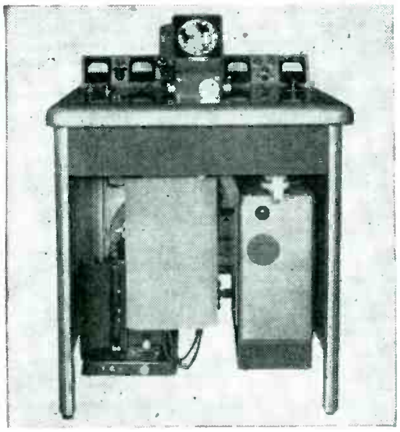
KOTRON RECTIFIER CORP., 54 Clark St., Newark 4, N.J., produces rectifier cells from 1 by 1 in. to 5 by 6 in. assembled in all circuit arrangements for any voltage or current considerations. The company's newest product is a selenium cell with capacity to withstand 60 volts rms. All cells are custom processed to various controlled blocking voltages and current densities. The

company mass produces rectifier cells especially for use in magnetic amplifiers. These cells at 20 volts rms have a blocking-to-conducting resistance ratio of approximately 1,600 to 1 in all cell sizes.



Coax Connectors

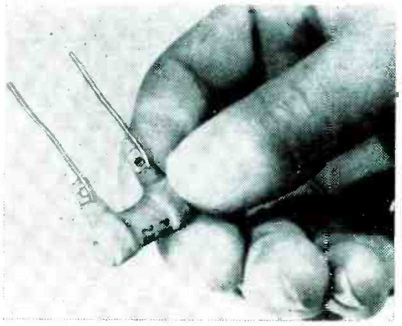
TRANSRADIO LTD., 138A Cromwell Rd., London, SW7, England, has developed a new series of precision coaxial connectors. Five groups are available to fit any coaxial outside diameter from 0.36 in. to 1.03 in. They may be had in elbow, straight and T-form type cable plugs. The series also includes a few types of U.S. JAN connectors.



Electron Microscope

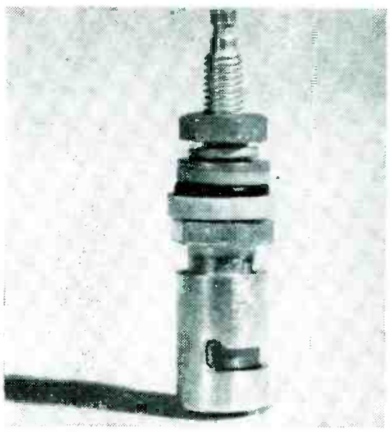
FARRAND OPTICAL CO., INC., Bronx Blvd. & E. 238th St., New York 66, N. Y. Model ESTI electrostatic electron microscope features a resolving power of 30 angstrom units, freedom from astigmatism, ease of alignment, distortionless image at all magnifications, and consistent high image quality at direct magnifications up to 20,000 times. High voltage is continuously variable up to 30 kv. The power supply consists of a 60-cycle transformer, rectifier and doubler circuit. Overall design of the equipment has been

made in the interest of ready access to the component units, including the electron gun, the specimen holder and manipulator, the plate holder, the power supply, the gage system and the lenses.



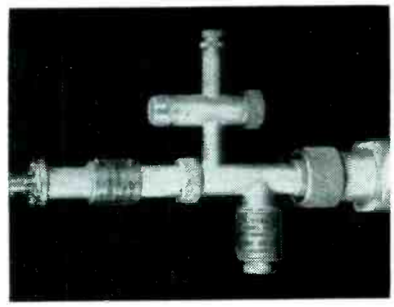
Wire-Wound Resistors

CLAROSTAT MFG. CO., INC., Dover, N. H. Type PR5F Greenohms—5-watt fixed wire-wound resistors with the characteristic inorganic cement coating—are now available in the increased resistance values of 8,000, 8,500, 9,000 and 10,000 ohms. In the series A-C 10F or 10-watt Greenohms, the 9,000-ohm value has been added between the 8,500 and 10,000-ohm numbers.



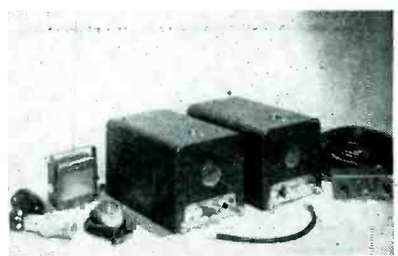
Binding Post

KINGS ELECTRONICS CO., INC., 40 Marbledale Road, Tuckahoe, N. Y. Model K952 binding post incorporates the quick-disconnect principle with a spring-loaded action and stainless-steel locking jaws. Teflon insulation throughout provides low dielectric loss, no moisture disturbance, no carbon tracking and the maintenance of mechanical properties in the binding post temperature application range of 67 F to 149 F. Complete moisture sealing is effected on the chassis itself by a special Teflon and rubber combination.



Coaxial Crystal Mixer

EMPIRE DEVICES, INC., 38-25 Bell Blvd., Bayside 61, N.Y., has developed model CM-107 fixed-tuned coaxial crystal mixer. Input vswr is better than 2 to 1, without adjustments, for all frequencies within the nominal frequency range. Local oscillator power requirements is 10 mw. Oscillator injector is adjustable to accommodate large variations in oscillator power. Local oscillator rejection at i-f output is better than 30 db. Frequency ranges in the standard models run from 225 to 2,600 mc.



Mobile Radio

GENERAL ELECTRIC CO., Syracuse, N. Y., has announced new 25 to 50-mc mobile radio communications equipment for operation in both 20-kc and 40-kc channel widths and featuring quadra-tuned i-f transformers in the receivers. Five high-Q tuned circuits between the antenna and first converter improve reception and reduce interference. Using the 20-db quieting method, the receiver for 20-kc operation has selectivity of 100 db down at ±20 kc. By the same method, the 40-kc receiver has selectivity of 100 db

Military Radio
and the
Radio Engineering Show

EXHIBITS

A major feature of the Radio Engineering Show, March 3–6, 1952 at Grand Central Palace, New York, will be a cooperative IRE-Exhibitor display of Military Radio Equipment.

This exhibit occupies 2448 sq. ft. in a large island on the fourth floor at the Palace. 21 firms exhibiting in the Show are supplying complete apparatus, and nearly 200 other exhibitors are represented by components and materials, etc., in this display.

SESSIONS

Most of the 42 Technical Sessions and Symposiums of the 1952 I R E Convention have Military importance. However, nine have direct Military Radio Information. These Are:

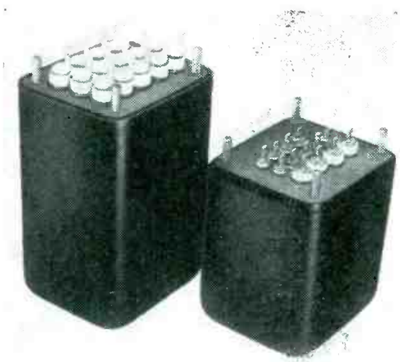
March 3, pm	New Developments in Telemetering
March 4, am	Microwaves I "Waveguides A"
March 4, pm	Microwaves II "Waveguides B"
March 5, am	Symposium: Digital Computors in Control Systems
March 5, pm	Radar and Radio Navigation
March 5, pm	Symposium: Magnetic-Core Memory Devices for Digital Computors
March 6, am	Symposium: Integration of Electronic Equipment with Airframe Design
March 6, am	Digital Computors
March 6, pm	Reliability of Military Electronic Equipment

Cooperation

is making this Military Radio Exhibit a great achievement, reflecting properly the importance of Military Radio to our industry. Credit goes to many exhibitors, to the Technical Papers Committee, and to members of the MR Exhibit Committee, including W. W. MacDonald, well known to readers of Electronics.

Registration: Members, $1., Non-Members, $3.

down at ±30 kc. The 30-w transmitter has standby battery drain of 2.3 amperes and transmitting drain of 38 amperes at 6.3 v. The 60-w, 6.3-v transmitter has standby battery drain of 3.2 amperes and transmitting drain of 50 amperes. Receiver battery drain is 6 amperes at 6.3 v, and 3 amperes at 12.6 v.

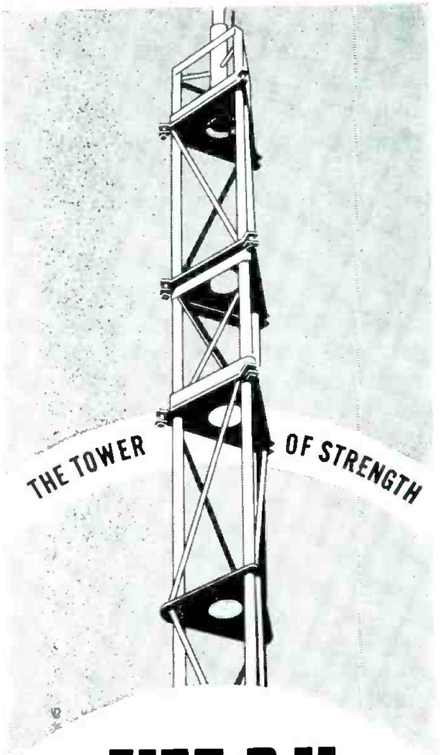


Electrical Insulation

JOHNS MANVILLE, 22 E. 40th St., New York 16, N. Y., is now offering Quinterra type 3, an asbestos-base, silicone-treated, high temperature electrical insulation. It is a class H insulation, as defined by AIEE standards, for service at a temperature of 180 C. It is used for both interlayer and wire wrapping insulation, and is adaptable to a wide range of electrical devices including air-cooled, inert gas and silicone-filled transformers. The picture shows the savings in space and materials made possible in similarly rated transformers. The transformer at the right is built using silicone-treated Quinterra type 3 insulation.

Double Pulse Generator

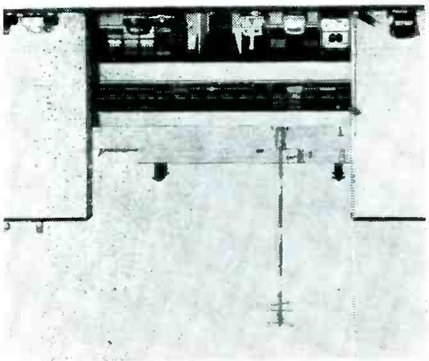
BERKELEY SCIENTIFIC CORP., 2200 Wright Ave., Richmond, Calif. Model 903 double pulse generator is designed for general laboratory



VEE-D-X

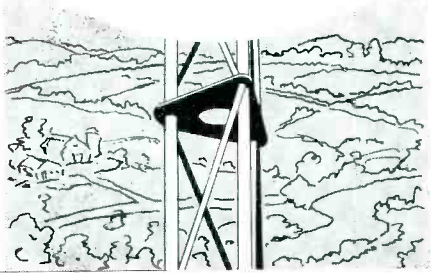
Sectional Tower

MOST ECONOMICAL FOR
MICROWAVE · FM · TV
COMMUNICATIONS · RADAR

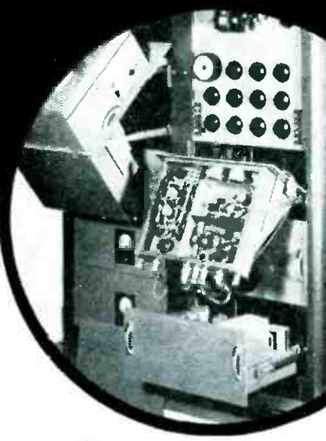


Pan American World Airways installation at Idlewild. Tower carries one 40 mc ground-plane antenna, six half-wave vertical 100 mc antennas, two weather instruments and a full set of obstruction lights.

THE LaPOINTE-PLASCOMOLD CORP.
WINDSOR LOCKS, CONN.



STAR of the SHOW



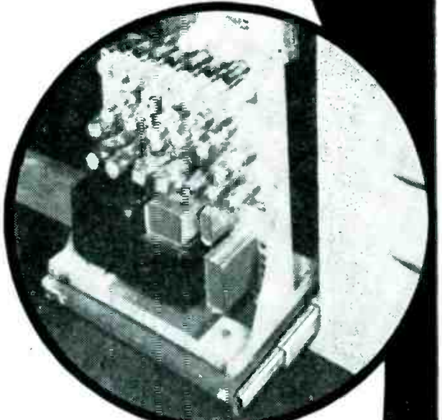
Automatic Transmission Measuring Set, developed by Bell Telephone Labs. Units are suspended on Grant Slides. Slides permit chassis to be inverted for servicing.

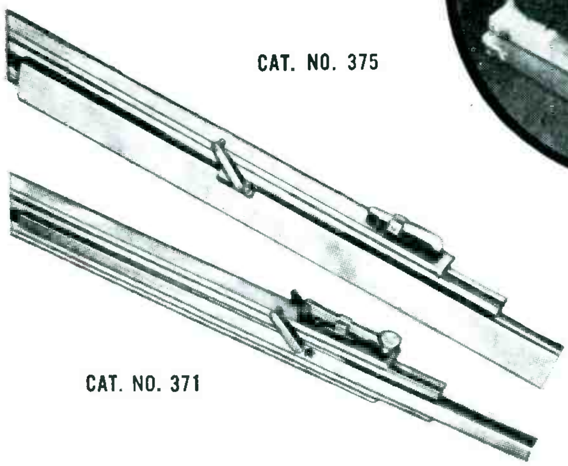
Typical cabinet installation used by Sperry Gyroscope Co., Great Neck, N. Y. All units are supported by Grant Electronic Equipment Slides which yield quick accessibility for repair and maintenance.

GRANT
Electronic
SLIDES

Three section slide, progressive action type. Locks in extended position only. Tripping mechanism controls unlocking. Load capacity: Up to 200 lbs. — CAT. NO. 375

Three section slide, progressive action type. Locks in extended position only. Thumb release controls unlocking. Load capacity: Up to 200 lbs. maximum — CAT. NO. 371





CAT. NO. 375

CAT. NO. 371

The Dumont Telecruiser, a mobile TV station, features Grant Electronic Equipment Slides as a component part for simplified servicing.

Grant's Engineering and Research Departments are available for consultation on individual requirements.

The foremost name in Sliding Devices

GRANT PULLEY & H'DW'E CO.
31-87 Whitestone Parkway, Flushing, N. Y.

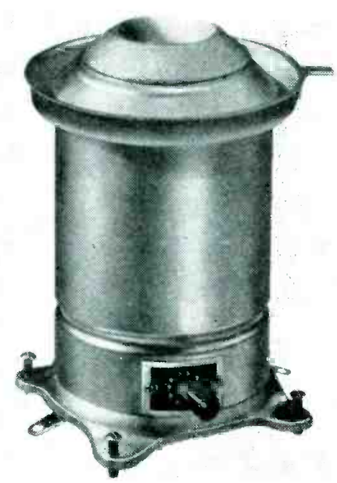
Meet us at I. R. E. Show Booth 462 Grand Central Palace, N. Y.

work. It produces either single or double pulses such that the amplitude and width of each pulse is continuously and individually variable. The unit is capable of producing either positive or negative pulses. The amplitude of negative pulses is individually and continuously variable from 200 v maximum into a 1,000-ohm load and 10 v maximum into a 50-ohm load. Amplitude of positive pulses is continuously and individually variable from 50 v maximum into a 1,000-ohm load and 2.5 v maximum into a 50-ohm load. Separation of the pulse pairs is continuously variable from 0 to 10 μsec and can be read directly on a calibrated knob on the front panel. Rise time of the pulses is 0.035 μsec and decay time less than 0.15 μsec. Pulse width is individually variable from 0.1 to 1.8 μsec. Repetition rate is internally controllable from 1 to 1,000 pulses per second.

Electronic Flasher

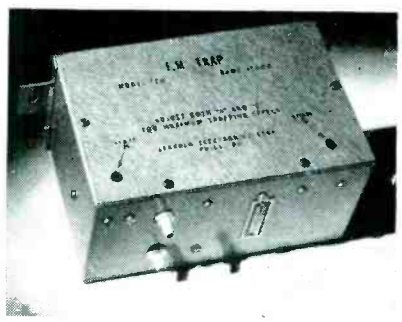
HALEDY ELECTRONICS CO., 57 William St., New York City 5, N. Y., recently announced a lightweight, portable electronic signal flasher without moving parts or filaments to burn out. The flasher, of cold cathode tube design, emits a sharp brilliant flash of light clearly visible for approximately a mile. It weighs 8½ lb. The unit uses a set of three standard 90-volt batteries in series. An off/on switch as well as an outside knob to control the number of flashes per minute is provided. A

clear or colored precision Fresnel lens protects the lifetime cold-cathode tube.



Solder Pot

DEE ELECTRIC CO., 1101 N. Paulina St., Chicago 22, Ill., has announced a new model thermostatically controlled solder pot that features a deeper crucible 4⅛ in. deep × 1¾ in. diameter, for tinning Formvar wire and long leads. An adjustable thermostat makes possible close control over solder temperature for rapid and precision work. Dependency on constancy of line voltage is eliminated. It is available in 4 temperature ranges: model 41, maximum 1,200 F, minimum 800 F; model 42, maximum 1,000 F, minimum 700 F; model 43, maximum 800 F, minimum 500 F; and model 44, maximum 600 F, minimum 400 F.



High-Q Traps

JERROLD ELECTRONICS CORP., N. E. Corner 26th & Dickinson Sts., Philadelphia 46, Pa., has introduced a new line of high-Q traps designed for use between the tv antenna and receiver to eliminate adjacent channel and f-m interference. They are

OLD-FASHIONED SATURABLE REACTORS

had a lot of desirable characteristics. But there were a lot of jobs for variable inductances that they just couldn't do.

AT THE I.R.E. SHOW LAST YEAR

we introduced a new member of the saturable reactor family: the C.G.S. INCREDUCTOR.

WE KNEW OUR INCREDUCTOR*

could do a lot more jobs than its ancestor—the saturable reactor. But we didn't know it would be called on so rapidly to solve so many vexing problems in such diversified fields.

EVEN IF THERE WEREN'T ANY

security regulations—we couldn't begin to name all the different kinds of jobs that engineers have been turning over to C.G.S. INCREDUCTORS this past year.

SINCE THE LAST I.R.E. SHOW

we have been busy filling orders for our standard INCREDUCTOR variable inductance units and for INCREDUCTORS with special characteristics for unusual jobs.

HERE ARE SOME OF THE REASONS

so many jobs are being done better with C.G.S.

INCREDUCTORS:

(1) Greater change in inductance: 400 to one—as much as 600 to one in special applications.

(2) Smaller size—higher inductance values.

(3) Higher frequency operation (in the megacycles) with good efficiency and high Q.

The INCREDUCTOR has all of these advantages plus all the desirable characteristics of old-fashioned saturable reactors—such as continuous smooth change in inductance without moving parts.

OF COURSE WE'LL BE BACK

at the I.R.E. show this year. We invite you to visit us at our booth N-4 to watch a demonstration of the INCREDUCTOR, or to discuss your specific problem and how the INCREDUCTOR may help you solve it. We would like you to see our other C.G.S. products too.

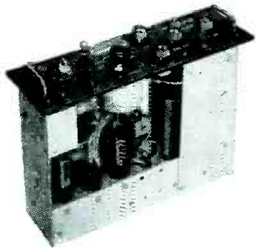
C.G.S. LABORATORIES, INC.
391 Ludlow Street, Stamford, Conn.

* Trade Mark for our variable inductors.

SANBORN

RECORDING EQUIPMENT

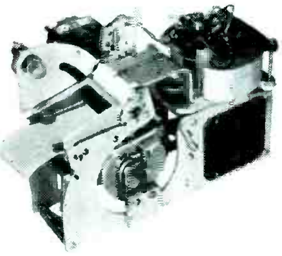
AMPLIFIERS



GENERAL PURPOSE—AC operated driver amplifiers: comprising three direct coupled push-pull stages.

STRAIN GAGE—Modulated carrier type for use with strain gage and resistance thermometer elements; strain gage, differential transformer, and variable reluctance transducers.

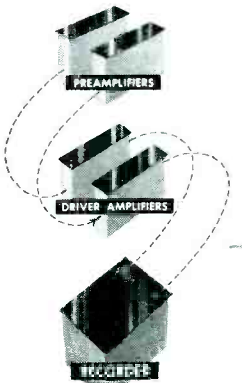
RECORDERS



ONE-, TWO-, AND FOUR-CHANNEL. Permanent records produced by inkless, heated stylus on plastic coated paper in true rectangular coordinates. May be used in ANY position. Extremely rugged.

SEPARATELY or in COMBINATION

INTERCHANGEABILITY of Preamplifiers and Amplifiers permits recording of many different types of phenomena.



Any of the recording channels in the three systems at the right may include *either* a Strain Gage or General Purpose Amplifier, or the latter in combination (in 2-, and 4-channel systems) with either AC or DC Preamplifiers. For, any of the Amplifiers or Preamplifiers provided for in a system may be quickly *removed* from its place in the system and as quickly *replaced* with an alternate type.

SINGLE-CHANNEL Recording Systems—comprising *either* a General Purpose or Strain Gage Amplifier in combination with a one-channel Recorder Assembly. Standard paper speed at 25 mm/sec., slower speeds available. Paper width 6 cm with 5 cm recording area.

TWO-CHANNEL Recording System—Two channels operate independently of each other, but record simultaneously. Eight paper speeds. Timing and coding. Each channel 5 cm. recording width.

FOUR-CHANNEL Recording System—Up to four phenomena on one record, using the same principles and methods as the two systems above. Eight paper speeds. Provision for use of 4-, 2-, or 1-channel recording paper.

Write for completely descriptive, illustrated catalog.

SANBORN COMPANY
CAMBRIDGE 39
MASSACHUSETTS

available in four models. Model TLB covers the low-band tv channels 2 through 6, from 54 to 88 mc; model THB traps out adjacent channel interference on high band tv channels 7 through 13, from 174 to 216 mc; interference from f-m stations is trapped by using model TFM, covering the 88 to 108-mc range; and model T Special is built on order to eliminate interference in bands other than vhf tv and f-m. The traps consist of bridged T networks with variable series and shunt inductance circuits. With both circuits tuned to the signal to be trapped the undesired signal is attenuated by a minimum of 50 db. The tv channel to be received is attenuated by a maximum of only 2 db. Each trap is priced at $25.00.

Branching Networks

THE DAVEN CO., 191 Central Ave., Newark, N. J., announces availability of the series 1130 branching networks. The multiple input and output networks are used to equalize incoming signal levels in multichannel mixers and similar broadcast equipment, and to combine two or more incoming lines into a single outgoing line or to divide one incoming line into two or more outgoing lines. They may be obtained in either balanced H or unbalanced T circuits. The resistors are of the precision wire-wound type with accuracy of ± 2 percent. The multiple networks frequency range is from 0 to 50 kc for most values.

Proportional Counter

NUCLEAR MEASUREMENTS CORP., Indianapolis, Ind., has designed and

built the model PC-3 decade scale proportional counter for clinical and production applications. It counts alpha, beta and gamma rays. Some reasons for its high precision and versatility are found in built-in automatic controls — a precision automatic preset interval timer; rapid-reset six-digit register with coincidental reset and switch; and automatic gas-purge cycle. Maximum counting rate is 1,000,000 counts per minute. High-voltage supply is 750 to 2,500 v regulated. Multiple purpose chambers accept a sample up to 2¼ in. in diameter.

Electronic Recorder

TINIUS OLSEN TESTING MACHINE Co., 1022 Easton Rd., Willow Grove, Pa. The new Model 51 electronic recorder incorporates the high-speed and accuracy inherent in the electronically controlled null balancing system which utilizes specially adapted Atcotran differential transformers built into the housing. This null system rotates the recorder chart drum in direct proportion to the strain or deformation of the specimen under test. The testing machine produces a stress coordinate by horizontal movement of the nonclog pen of the recorder. Sensitivity of the instrument is 0.05 percent of full scale for each range; accuracy of strain coordinate is ±½ division (0.2 percent of full scale); accuracy of stress coordinate is equal to that of the testing machine.

Button Capacitors

SPRAGUE ELECTRIC Co., North Adams, Mass. A new series of button ceramic capacitors for vhf and uhf applications has the tiny disk capacitor element buried in a recess in the head of a threaded fastener. They offer advantages including: minimum ground inductance of a fixed value for better uniformity, allowing higher circuit gains to be used; and a short and radially uniform bypass path to ground and lug terminals and tube socket height to provide sturdy tie points for multiple connections while maintaining short, uniform

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330 W. 42nd St.
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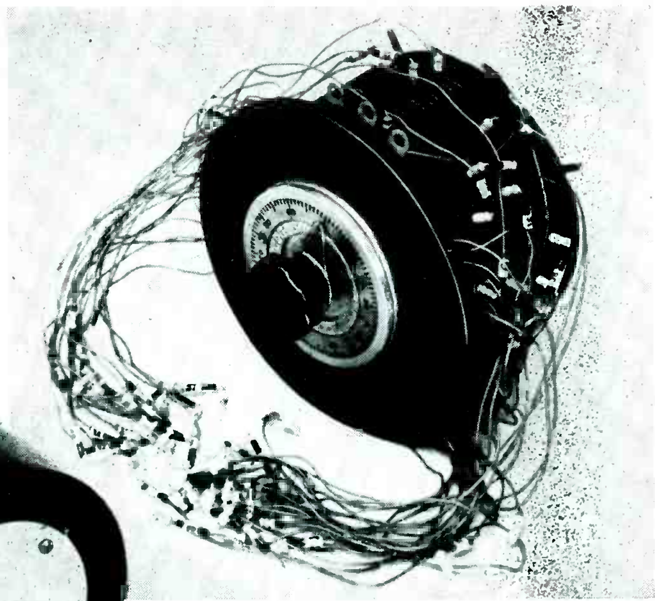
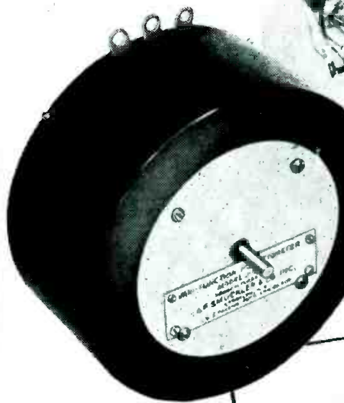
The First *HAND-ADJUSTABLE* Electrical Cam—





ACCURACY ± .025%

VARI-FUNCTION POTENTIOMETER MODEL J-15

±.1% TO ±.025% FUNCTIONAL CONFORMITY

30, 45, OR 60 ADJUSTABLE TAPS

RESISTANCE VALUES FROM 10 OHMS TO 200,000 OHMS

±.5% OR BETTER TOTAL RESISTANCE TOLERANCE

2 TO 15 TURNS ROTATION

EXCELLENT RESOLUTION AT LOW RESISTANCE VALUES

DIAMETER 5 7/8" DEPTH 2 5/8" WEIGHT 2 LBS.

DIAL OPTIONAL

GANGING POSSIBLE

DOUBLE SHAFT EXTENSIONS

Ideal for Analogue Computers, Radar, Guided Missiles, Servo Controls, Industrial applications, Laboratories, etc.

The J-15 is a functionally adjustable potentiometer. It will produce a voltage output as a desired function of shaft rotation.

The exclusive features of the J-15 and all other models of the Vari-Function Potentiometer are *unequalled accuracy* and *functional adjustability*.

Complex voltage functions may be factory set or set by the user quickly and easily to an accuracy of .025%.

The J-15 is especially suited for linear applications of utmost accuracy because it can be adjusted to compensate for inherent winding non-linearity and external loading effects.

Write, wire, or phone us if you have a problem of non-linear compensation calling for adjustability or extreme accuracy. Bulletins available on J-15 and other models.

AFSCO

A. F. SMUCKLER & CO., INC.
Electronic and Communication Engineers and Manufacturers
202-208 TILLARY ST., BROOKLYN 1, NEW YORK

lead lengths. The units are rated at 500 v d-c in values up to 1,000 μμf depending on characteristics. Bulletin 605 giving complete engineering details is available on letterhead request.

Sealing Compounds

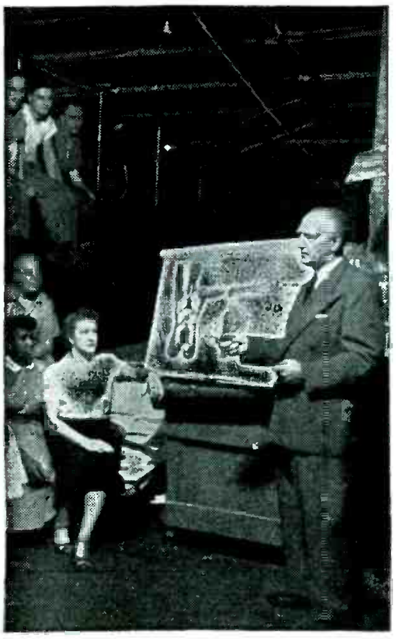
H. V. HARDMAN CO., INC., 571 Cortlandt St., Belleville, N.J. The new line of Permo potting and sealing compounds is particularly recommended for special high electrical resistance where retention of viscosity over wide temperature ranges is necessary. They have been found ideal for the casting and sealing of electronic parts, batteries, transformers, coils, capacitors and many types of electrical parts. Free samples are available from the manufacturer.

Amplifier & Recorder

EDIN CO., 207 Main St., Worcester 8, Mass., announces a new combination 8004 ink-writing galvanometer in conjunction with a compensated direct-coupled amplifier. This combination provides the user with a response of 0 to 400 cps with a tolerance ± 20 percent with records appearing directly in ink, chart speeds from 0.1 to 625 mm per second. The instrument is available in any number of channels up to 24. This amplifier and recorder combination opens a new field of application in the field of strain gage vibration, surface analysis and many other applications.

Signal Generator

COMPAGNIE GENERALE DE METROLOGIE, Chemin de la Croix-Rouge, Annecy, France. Model 917 signal generator covers from 50 kc to 50 mc in six ranges. Stability is ±0.05 percent with ±10-percent power supply voltage variation. A special feature is the seventh range of 420 to 500 kc for i-f stage alignment. Output is 1 μv to 0.1 v modulated or unmodulated r-f and 10 μv to 1 v a-f, and is taken through a calibrated attenuator system. A germanium diode eliminates meter



On the job!

Our volunteer speakers are saving thousands of lives *today* . . . in factories and business offices . . . at neighborhood and civic centers . . . at social, fraternal and service group meetings all over this land . . . by showing people what they can do to protect themselves and their families against death from cancer.

To find out what you yourself can do about cancer, or if you want us to arrange a special educational program for your neighbors, fellow-workers or friends, just telephone the American Cancer Society office nearest you or address a letter to "Cancer," care of your local Post Office. One of our volunteer or staff workers will be on the job to help you.

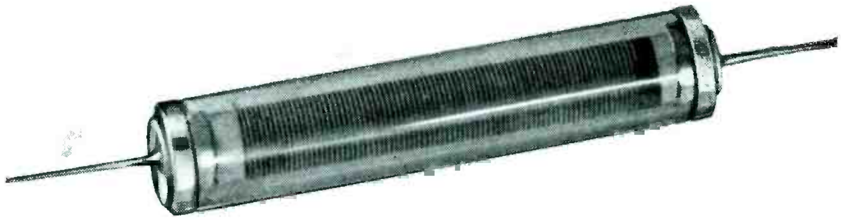
American Cancer Society

Phaostron

CARB-OHM

A DEPOSITED CARBON RESISTOR

HERMETICALLY SEALED



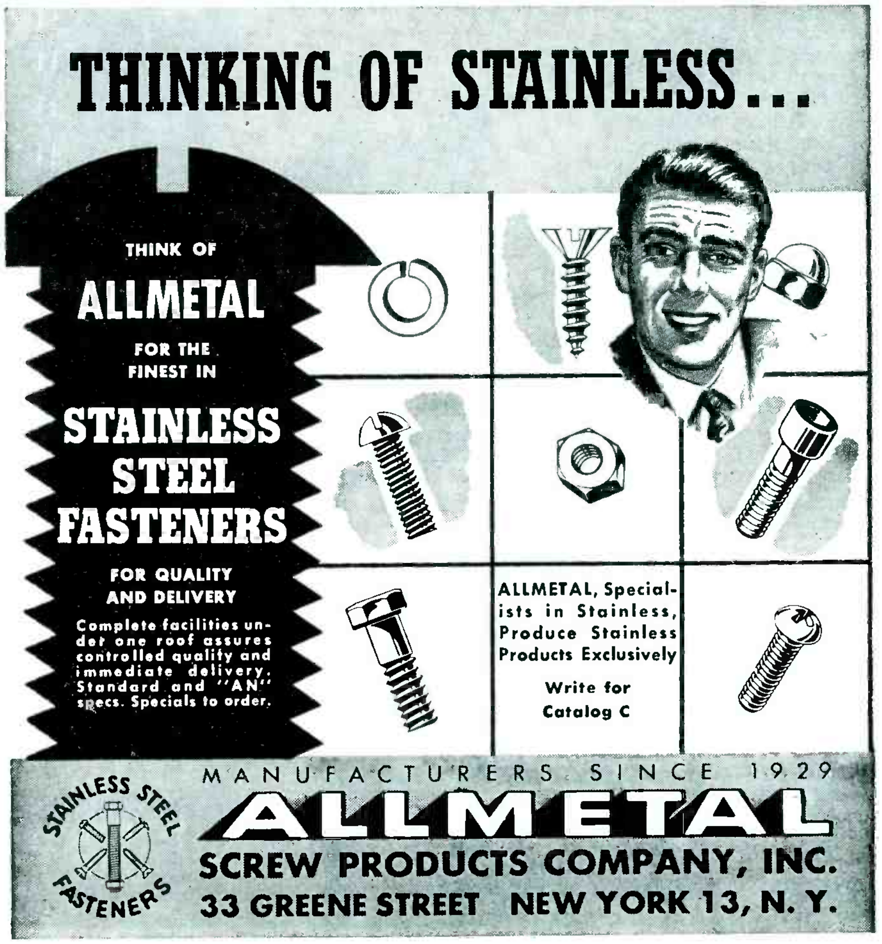
For high frequency applications, where high values of resistance are essential or power dissipations up to 2 watts are required, Hermetically Sealed *CARB-OHM* Resistors provide environment free performance.

Manufactured under license arrangements with Western Electric Company, Inc.

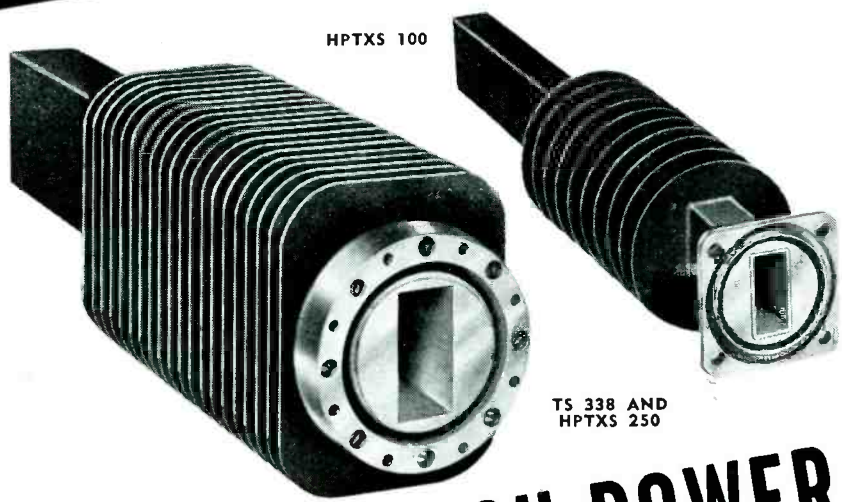
Technical information available upon application

ENVIRONMENT FREE ELECTRICAL EQUIPMENT by *Phaostron*

PHAOSTRON COMPANY, 151 PASADENA AVE., SO. PASADENA, CALIF., CL 6-2171

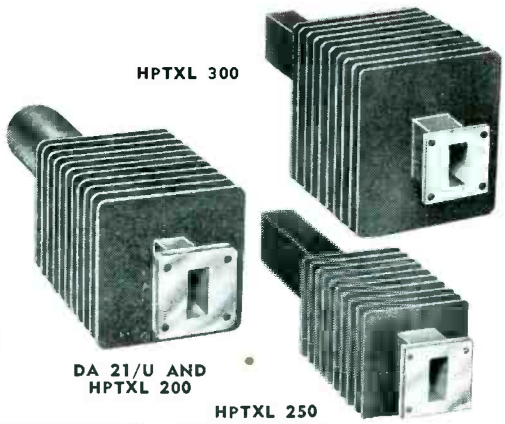


ELECTRO IMPULSE



Waveguide HIGH POWER TERMINATIONS

These waveguide loads use waveguide walls which are poor conductors. Such construction facilitates more effective removal of the heat generated in the load, and is not as subject to pulsepower breakdown (arcing) as are the designs which use filling materials in the waveguide. The lossy material consists of a mixture of Portland cement and graphite, which adequately handles the termal shock, is highly durable, and provides a highly adhesive bond to the metal waveguide walls.



Type	DA21/U	TS338	HPTXS250	HPTXL250	HPTXL200	HPTXS100	HPTXL300
Freq. Range	7–10KMC	2.4–3.7 KMC	8.2–12.4 KMC	7–10KMC	7–10KMC	8.2x12.4 KMC	7–10KMC
Waveguide	1¼"x⅝"	1.5"x3"	½"x1"	1¼"x⅝"	1¼"x⅝"	½"x1"	1¼"x⅝"
Nominal* Power Dissipation	280 Watts	1000 Watts	250 Watts	250 Watts	200 Watts	100 Watts	350 Watts
Maximum V.S.W.R.	1.15	1.1	1.15	1.15	1.15	1.15	1.15
Size	11⅝x 3½x3½	24x5⅝x 5⅝	10⅞x 3½x3½	11⅞x 3½x3½	11¼x2¾x 2¾	9x2" diameter	11¼x4½x 4½
Weight	6 lbs.	13 lbs.	3¼ lbs.	3¼ lbs.	2 lbs. 4 oz.	14½ oz.	5¼ lbs.
Flange	UG 51/U	UG 438/4	UG 40/U	UG 51/U	UG 138/U	UG 40/U	UG 51/U

* Without the use of water or forced air cooling.

ELECTRO IMPULSE Laboratory

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electronics BUYERS' GUIDE

is the ONE BOOK

THE ONLY ONE OF ITS KIND

in which design engineers and purchasing agents will find a complete, accurate, and up-to-date list of the manufacturers of all types of electronic and allied products . . . components and complete equipment.

*

Keep it handy for ready reference throughout the year.

*

When buying or requesting product information from it be sure to mention it.

zero drift. Tubes used are American miniatures 6J6 and 6X4. Any a-c power supply from 110 v to 230 v, 25 or 60 cps, may be used.

SWR & R-F Power Meters

M. C. JONES ELECTRONICS Co., 96 North Main St., Bristol, Conn., announces a new line of small, portable r-f power and swr meters. Model MM700 series Micro Match operates at power levels of 0.1 to 1,200 watts over the frequency range of 30 to 2,000 mc. The instrument weighs less than 2 pounds and requires no external source of power. It is designed for use in making laboratory measurements and for monitoring both transmitter and antenna performance in the field.

Literature

Diffusion Pumps. Distillation Products Industries, Rochester 3, N.Y. A new data sheet describes and charts the characteristics of type MCF diffusion pumps. It points out that this series of all-metal fractionating pumps is recommended for evacuation of large electronic tubes, particle accelerators and other devices requiring an ultimate pressure of less than 10^{-5} mm Hg. The pumps described range in size from a 2-in. diameter model suitable for exhaust of c-r tubes to pumps several feet in diameter used on giant synchrocyclotrons and linear accelerators.

Insulating Materials. General Electric Co., Pittsfield, Mass. Bulletin CD1-35 describes the company's various types of electrical insulating materials. Properties and applications of varnishes, Glyptal alkyd resin insulating finishes, varnished cloths and tapes, sealing and filling compounds, and silicone insulating materials are given, with accompanying photographs.

Color-Code Chart. Centralab Division of Globe-Union Inc., Milwaukee, Wisc. Printed in eleven colors with over 3,300 color dots or marks, the new color-code chart will be found useful by electronic engineers, in research and educational laboratories, by purchasing and production men, by radio and tv service engineers, and by distributors of electronic equipment. Color coding outlined on the chart includes that of transformers, battery cables, antennas and ground leads, telephone switchboard cable, RTMA and JAN mica, paper and ceramic capacitor values, standard values of fixed composition resistors, miscellaneous capacitors and resistors, electrodynamic speakers, and radio and tv chassis. The chart is 36 in. high × 30 in. wide.

Machine Screws. The Progressive Mfg. Co., Torrington, Conn. Catalog No. 19 is a 16-page treatment of a line of machine screws and specialties. Types of screw heads and methods of measurement are illustrated. Tables show different types with diameters and threads per inch. Machine screw-nut thread dimensions and standard weights are included.

Servo Amplifier Data. Servomechanisms Inc., Post & Stewart Avenues, Westbury, N.Y., has released two data folders on the SA104H and SA112H servo amplifiers. Both units described are miniaturized, hermetically-sealed, plug-in electronic amplifiers designed to control a 400-cycle, two-phase motor. Complete technical descriptions, block diagrams and application information are included.

Regulated D-C Power Sources. Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. A new catalog giving full descriptions and up-to-the-minute ratings and specifications of the entire line of standard Nobatrons (electronically regulated d-c power sources) is now available. Also included in the catalog is a comprehensive discussion of circuit theory and a description, with diagrams, of some of the many ways in which Nobatrons can be used.

TV Antenna Catalog. The LaPointe Plascomold Corp., Windsor Locks, Conn. A Spanish edition

of the Vee-D-X catalog entitled "La Linea de Antenas de Television mas completa y Potente del mundo" was recently issued. Designed for distribution in Mexico, Cuba and South America, the catalog includes illustrations and complete information on practically all Vee-D-X products.

Grounding Sheath Connectors. The Thomas & Betts Co., Inc., 66 Butler St., Elizabeth, N.J. Data sheet S5 contains complete technical information on a new grounding sheath connector—a two-piece compression-type connector made for terminating and grounding braided shields on wire and cable used in radar, critical radio and a-f circuits and for uhf work, for any electronics use requiring shielded conductors. Manual and power tools and method of installation are fully covered.

Motor Generator Sets. Bogue Electric Mfg. Co., 52 Iowa Ave., Paterson 3, N.J. Bulletin 440 describing a complete line of 400-cycle motor generator sets with extremely good waveform output and with very low percentage of harmonics is now available. The motor generator sets described are widely used in laboratories and factories and in industrial operations for testing electronic equipment and operating h-f motors, marine and aircraft power supplies, high-speed machine tools and radar equipment.

H-F Insulators. American Lava Corp., Chattanooga 5, Tenn., has issued the useful new bulletin 512 giving JAN-1-8 numbers cross indexed with its own numbers on Alsimag high-frequency insulators. It will be especially helpful to any design engineer, estimator or purchasing agent dealing with electrical or electronic equipment for the armed services. The insulators are illustrated and line drawings and dimensions are shown. Mechanical and electrical properties of the materials are given in detail.

Breaker-Type D-C Amplifier. Liston-Becker Instrument Co., Inc., 20 Beckley Ave., Stamford, Conn., has issued a brochure dealing with the model 14 ultrasensitive breaker-

Time to move in on the NUCLEAR ENERGY FIELD

"Ground Floor" Space Available to Alert Manufacturers

Everybody talks about the weather, but until the "rain makers" no one did anything about it. One can almost say the same about the nuclear energy field. Everybody talks about how big its potentials are, but only a comparatively few manufacturers are doing anything about it.

The industry is young – practically starting and there's still time for alert manufacturers to get in on the ground floor. A start now will provide that available ground floor position – one that will prove of inestimable value in the future. An established name, plus a proven product, will be the mainstays when the industry reaches its expected expansion.

If an established and recognized position in the field is half as important as manufacturers believe, it is doubly true today in the nuclear field. The alert manufacturer can move in now and take his position up front.

It's BIG today—Bigger tomorrow

Yes, nuclear energy is a big field – 7 billion dollars big. But there are two other important things. It promises to be bigger and it will be wider in scope and application. The future also foresees general industry taking over more and more the practical development of the scientific, power and medical applications. Therein lie the plus profits of tomorrow.

If your products fall within any of the basic classifications that follow . . .

Air Cleaners	Ceramics	Motors
Amplifiers	Chronographs	Ovens
Analyzers	Containers	Phosphors
Balances	Controls	Plastics
Bearings	Detectors	Power Supplies
Bellows	Electron Tubes	Pyrometers
Blowers	Gages	Resistors
Bridges	Generators	Shielding
Burners	G-M Apparatus	Test Chambers
Bushings	Insulators	Testers
Cameras	Ionization Chambers	Tile
Capacitors	Metals	Timers
Carboys	Mixers	Transformers
Centrifuges	Monitors	X-Ray

to mention only a few

Then **you can sell it most effectively in the nuclear field through . . .**

For further information on the scope of the nuclear market, consult any NUCLEONICS representative for additional data. Complete data on the new enlarged NUCLEONICS is also available from him or write direct to our New York office.

NUCLEONICS

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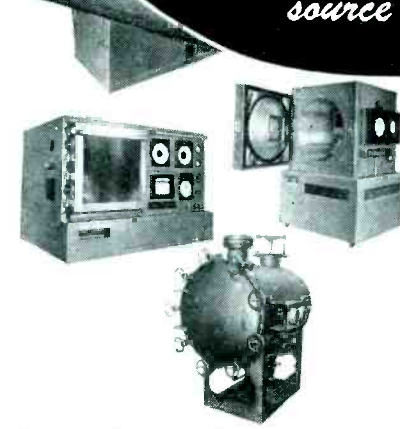
now a COMPLETE TYPE TESTING LABORATORY *from* ONE *source*



Bowser is the only manufacturer today who can provide a COMPLETE line of type testing equipment, custom engineered to individual requirements. Bowser environmental simulation units meet all MIL, JAN, USAF, AN and other Government specifications for testing equipment.

In addition to a complete range of standard models, Bowser can provide special equipment, with special accessories if necessary, to meet individual requirements of temperature, humidity, altitude, sand and dust etc. Bowser's Engineering staff invites you to take advantage of their long continuous experience, the most versatile in the field.

✓ CHECK AND MAIL TODAY

BOWSER TECH. REFRIG., Terryville, Conn.

Send information on test equipment checked:

- ☐ High Temperature ☐ Fungus Resistance
- ☐ Low Temperature ☐ Rain and Sunshine
- ☐ Temperature Shock ☐ Sand and Dust
- ☐ Humidity ☐ Immersion
- ☐ Altitude ☐ Explosion Proof
- ☐ Walk-In Rooms ☐ Vapor Tight
- ☐ Special Engineering

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BOWSER

TECHNICAL REFRIGERATION

DIVISION BOWSER INC.

TERRYVILLE • CONN.

type d-c amplifier. The amplifier described, having very high zero-stability and very low noise-level, is being used extensively for the replacement of suspension-type galvanometers and for recording or controlling operations involving measurements in the microvolt and fractional microvolt regions.

Precision Instrument Parts. Instrument Components, Inc., 181 Lawrence St., New Hyde Park, N.Y., has available a catalog covering Belock precision instrument parts. The parts described are electromechanical subassemblies, and include mechanical and electrical limit stops, precision gearing, differentials in two sizes, high speed magnetic clutches, mounting brackets and grid plates. The catalog should prove of interest to engineers, developers and producers in the field of servos and automatic controls as well as in the field of analog computers.

Industrial Instruments. Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Wayne and Windrim Aves., Philadelphia 44, Pa. Catalog No. 5000, consisting of 28 pages, describes the principal instruments, control devices and related components manufactured by the company. Specifications of approximately 100 measuring and control instruments and valves are outlined. Included are several new designs including the differential controller and Tel-O-Set controller family.

Electrometer Shunt. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio, has released a 2-page bulletin on its model 2001 electrometer shunt that permits quick conversion of the company's model 200 electrometer to a micro-microammeter. The bulletin lists specifications, and includes connection diagrams for numerous exacting measurements of current, such as insulation leakage in ion chambers and photoelectric cells.

Flexible Shafts. S.S. White Industrial Division, 10 E. 40th St., New York 16, N.Y., has announced publication of the third edition of its flexible shaft handbook. The 256-

HUGHES

Research and Development Laboratories

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page reference manual provides a comprehensive and authoritative picture of the range and scope of flexible shafts in transmitting power and remote control and gives full details on their construction, selection and application. The current edition covers changes and developments that have been made in the flexible shaft field since 1944. An appendix of engineering tables and data adds to the value of the handbook as an essential part of any engineering library. Copies of the handbook are being offered to designers, engineers and purchasing agents who write for a copy on their company letterhead.

Beam Pentode. Lewis and Kaufman, Inc., Los Gatos, Calif., has available a technical data sheet describing the type 4E27 beam pentode. The tube is illustrated and described with dimensions, operating curves and electrical details. Figures for typical operation and maximum ratings are given for the tube in service as a class-C r-f power amplifier and oscillator, a class-C r-f doubler amplifier, and a class-A a-f amplifier and modulator.

Static Magnetic Memory. Wang Laboratories, 296 Columbus Ave., Boston 16, Mass., has published a pamphlet on its static magnetic memory, a radically new number storage device. Chief applications and full technical data concerning the unit are given.

Pickups. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif. Pickups and how to choose them—the answers to critical application questions regarding amplitude and accelerations; frequencies; nature of motion and range of temperature are contained in technical bulletin 1503. The pickups described are widely used as primary sensing units in vibration and acceleration studies. Attached to the machines or structures under test, the pickups discussed convert the motion to a varying, proportional voltage which may then be read on vibration meters, in terms of amplitude and frequency; viewed

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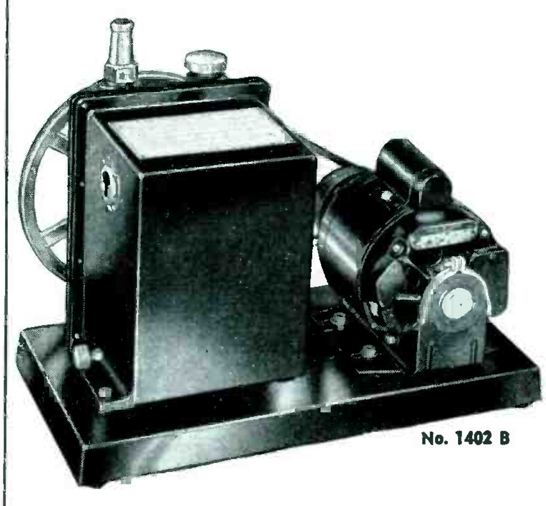

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on an oscillograph screen, or recorded permanently by a multichannel recording oscillograph.

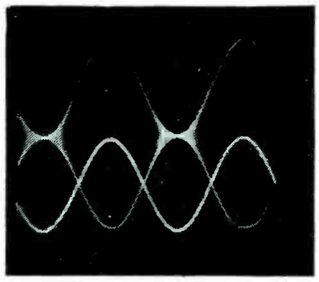
Voltage Regulator. C. J. Applegate & Co., 1816 Grove St., Boulder, Col. A single-sheet bulletin covers the model 112 d-c voltage regulator that is designed to deliver extremely well regulated and filtered power from an unregulated d-c source. The unit described, a complete self-contained type requiring only a power source, will control as much as 200 ma. Complete technical specifications are included.

Mobile Radio Equipment. Link Radio Corp., 125 W. 17th St., New York 11, N.Y. Three recent bulletins cover the Expediter line of adjacent-channel equipment for operation in the 25 to 50-mc range. The type 2750-30DR-A1 affords 30 watts r-f output; type 2750-60DR-A1 gives 60 watts r-f output; and type 2750-10VR-A1 affords 10 watts r-f output. Principal characteristics and specifications for each are given.

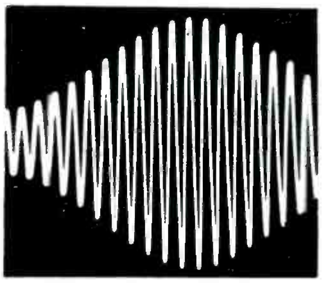
Plastic Coatings. Juel Corp., 333 N. Santa Anita Ave., Arcadia, Calif. A recent bulletin discusses the many advantages of encapsulation of components in protective plastic encasements. The castings described are available in a wide variety of types, from extremely flexible to very brittle. The company's complete facilities for encapsulating, imbedding and laminating are shown.

Flexible Shafting. F. W. Stewart Mfg. Corp., 4311 Ravenswood Ave., Chicago 13, Ill., has issued a 64-page book on flexible shafting. It shows with graphic illustrations many applications in a wide variety of industries. The advantage of flexible shafting and method of application are fully described. There are also illustrated many types of end fittings, casings, adapters and shaft combinations that apply to the variety of standard sizes and types of shafts available.

Porcelain Specialties. Star Porcelain Co., Muirhead Ave., Trenton, N.J., has released a 24-page brochure giving a complete descrip-



320 kc modulated 400 cps; audio on second beam.



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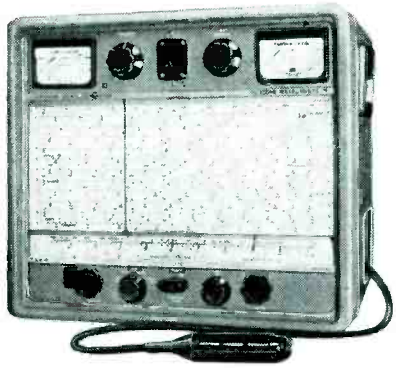

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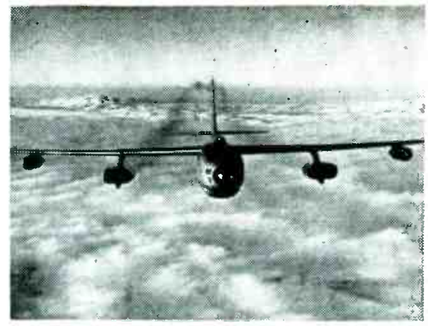

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tion of various ceramic bodies that are used principally in the manufacture of electrical and electronic equipment. It contains suggestions for good ceramic design as well as tables giving complete data on physical properties and application information. There is also a section picturing and describing the research, engineering and production facilities as well as the steps taken to control the quality of the company's custom-made porcelain specialties.

Hermetically-Sealed Thermostats. Stevens Mfg. Co., Inc., 69 South Walnut St., Mansfield, Ohio, has announced an illustrated bulletin on its neoprene-protected bimetal thermostats. Hermetically sealed MH disk type and CH strip type units are described along with suggested applications. Bulletin L-4609 illustrates the operating principles and shows in detail dimensional drawings of the styles available for use where contamination is a problem. Ratings and construction data are tabulated for both types.

Compensated Radiation Detector. Brown Instruments Division, Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. The 28-page catalog 9300 completely describes the line of Radiamatic pyrometers. Included are sections on operation, theory, constructional features, engineering specifications, accessories and typical applications. Many photographs and line drawings supplement the written information.

Dry-Type Transformers. Allis-Chalmers Mfg. Co., 935 S. 70th St., Milwaukee, Wis. The proposed AIEE guide for the use of openly ventilated dry-type transformers with Class B insulation is contained in the 8-page bulletin 61X7088B. The guide gives general recommendations on installation, inspection, storage, maintenance and operation. It includes distribution and power dry-type transformers in ratings above 50 kva and above 600 v, cooled by natural draft or forced draft.

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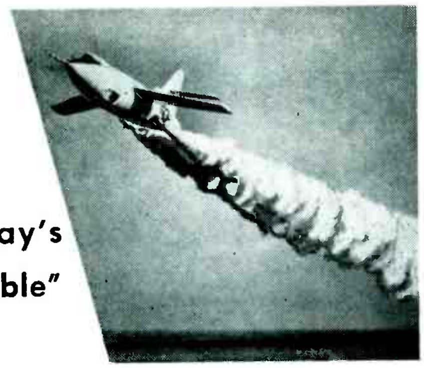

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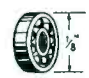

America's first and only fully *ground* miniature ball bearings, Micro makes possible design refinements unheard of only a few years ago. With 85 sizes and types from 3/8" down to 1/8" o.d. and in tolerance ranges of ABEC-5 and above, Micro bearings offer tremendous opportunities to minimize space, weight and friction and at the same time to retain high capacity. Yet Micro precision ground bearings actually cost less than comparable *unground* miniatures.

Write for Technical Bulletin No. 50

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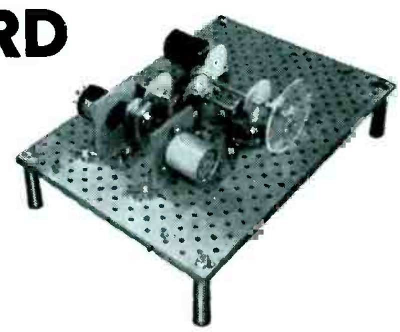

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News From The Field

Edited by WILLIAM P. O'BRIEN

Industry Announces Transfers and Promotions

SEVERAL companies in the electronics industry have recently announced staff reorganizations involving top positions. Among the more current we note the following:

Bell Telephone Laboratories organization changes promote three former IRE award winners. **Ralph Bown,** director of research there since 1946 and holder of the IRE's Medal of Honor, was appointed vice-president in charge of research. Two holders of the Morris Liebmann Memorial Prize have also advanced: **H. T. Friis,** from director of radio research to director of research in high frequency and electronics, and **W. H. Doherty,** from director of electronic and television research to director of research in electrical communications.

The Permoflux Corp. of Chicago has named **Eugene Roeske,** at one time product designer of aircraft radar equipment for Motorola Corp., to head its new transformer core division. **George Adams,** formerly with RCA, has been appointed factory superintendent to take charge of the production of loudspeakers, transformers and various electronic equipment manufactured by Permoflux.

Radio Corp. of America reports two changes. **Douglas Y. Smith** leaves the post of manager of the company's Lancaster, Pa., tube manufacturing plant to take over as manager of sales operations for the RCA Tube Department. **Earl M. Wood,** for the past 10 years manager of manufacturing at the Lancaster plant, succeeds D. Y. Smith as plant manager there.

Three new appointments have been announced by Allen B. Du Mont Laboratories, Inc. **Kenneth A. Hoagland,** with the organization for 11 years, has been named assistant manager of the Cathode-Ray Tube Division. **Nicholas DeFalco,** associated with the company since 1947, is now manager of the receiver quality control department. **Bernard Tullius,** formerly senior engineer at Radio Engineering Labs in Long Island City, N. Y., was recently appointed sales engineer for Du Mont's transmitter division. He will act as a sales and technical counselor to the company's clients, aiding them in planning, laying out and installing uhf and vhf transmitter equipment, coordinating transmitter design and construction, and supervising field work of many kinds.

Other position changes making news among engineers are the following:

Lauriston C. Marshall, former professor of electrical engineering at the U. of California, and head of the Microwave Laboratory operated at Berkeley, has been named director of Link-Belt Company's new Physical Testing and Research Laboratory at Indianapolis, Ind.

Steven E. Lasewicz, after 29 years with the Horton-Bristol Co. as chief engineer, is now production manager of the LaPointe Plascomold Corp., Windsor Locks, Conn.

Ferdinand W. Schor, previously associated with Hallicrafters Co., has been made chief engineer in charge of military engineering for Motorola, Inc., Chicago, Ill.

S. Norman Crawford, with GE since 1941, was recently named designing engineer for power electronic equipment in the company's tube department.

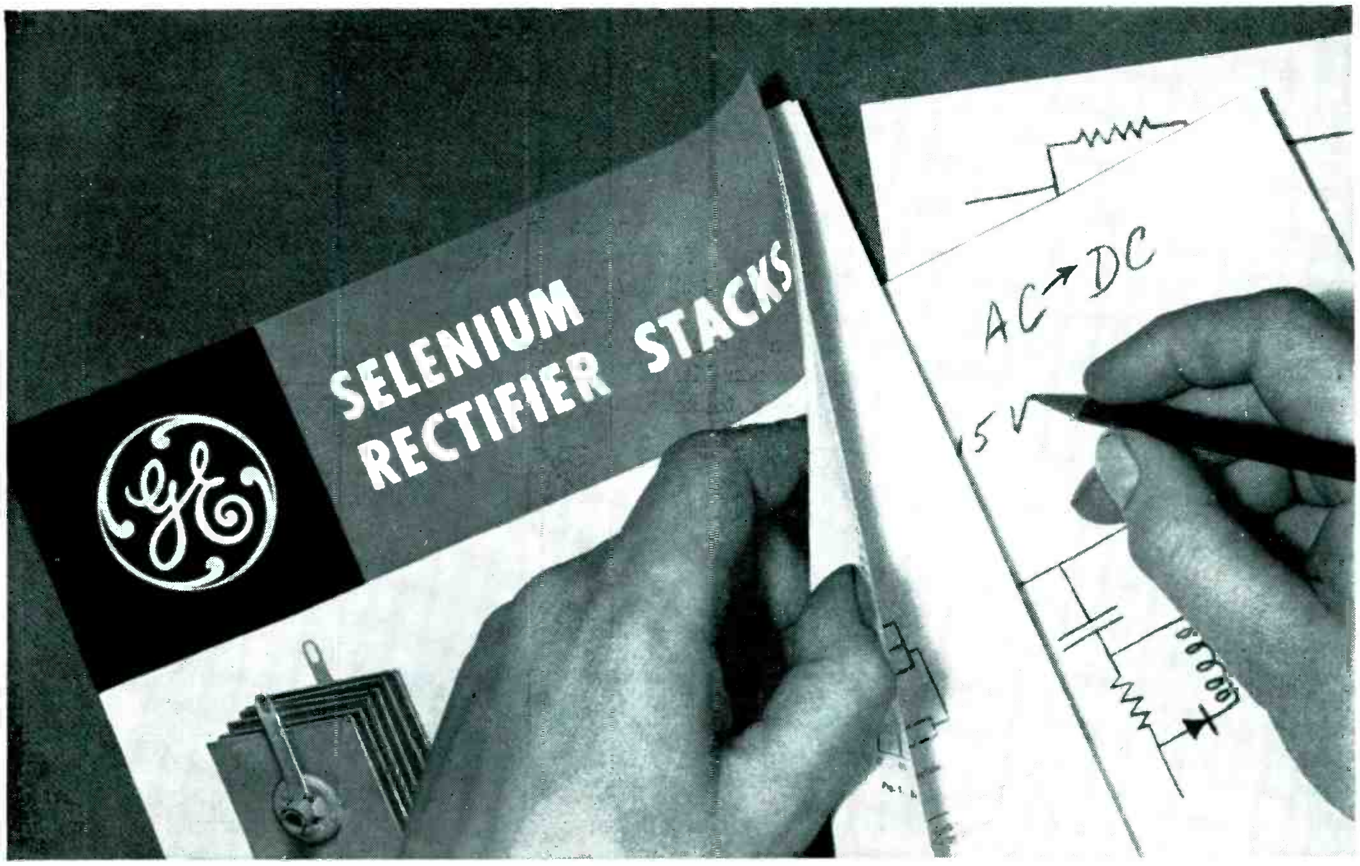
J. W. Phillips, formerly design and development engineer for the Electronic Tube Corp., Chestnut Hill, Pa., has been appointed a development engineer at The Riverside Metal Co., Riverside, N. J.

Irwin Weinstein, formerly assistant chief engineer of Sarkes Tarzian, rectifier division, has joined the staff of Electronic Devices, Inc., Brooklyn, N. Y., as assistant sales manager.

Charles E. Ellis, formerly assistant to the president, Ford Instrument Co. Div. of the Sperry

AUDIBLE SILENT MUSIC IN OPERATION

Inventor of the first silent electronic organ, N. D. N. Belham, science master at the Mid-Essex Technical School, Chelmsford, England, makes adjustments at the electric unit which operates the instrument. Up to 24 keyboards can be used, supplied from one tone unit in the console. Pupils can all play different pieces and listen to themselves on the earphones, while no sound is heard elsewhere. The teacher can listen in to any of the players, speak to them, correct their mistakes and play the correct version back to them



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One of the most important and widely used metallic rectifier devices is the selenium stack. New applications where improved G-E selenium stacks are best suited are continually being discovered.

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TABLE OF CONTENTS

General Electric Co., Section 461-21, Schenectady 5, N. Y.

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GENERAL ELECTRIC

Corp., has been appointed director of quality control there. Prior to joining the company last year he was an independent consulting engineer heading his own firm.

Erie Resistor Corp., Erie, Pa., has realigned its staff by moving two key executives. **Byron B. Minnium,** formerly vice-president in charge of engineering and research, is now vice-president and general manager of the Electronics Division. **Gordon Groth,** with the company as vice-president since July 1951, has been named vice-president and general manager of the Plastics Division.

Manufacturers Expand Facilities

ELECTRONIC plant development in the west continues to progress in factories geared either to production on defense contracts or for civilian markets or both. Here are some examples:

The Sierra Electronic Mfg. Co., San Carlos, Calif., recently completed a 10,000-sq ft expansion for the production of high-powered radio transmitters for the Navy.

Hoffman Radio Corp. has added 38,000 sq ft to its No. 5 plant at 6200 So. Avalon Blvd., Los Angeles, Calif., for tv set manufacturing.

Varian Associates, San Carlos, Calif., manufacturers of klystrons, will soon erect a million-dollar research lab in South Palo Alto, Calif.

International Rectifier Co. recently opened a new plant at 1521 E. Grand Ave., El Segundo, Calif. Main product is selenium rectifiers.

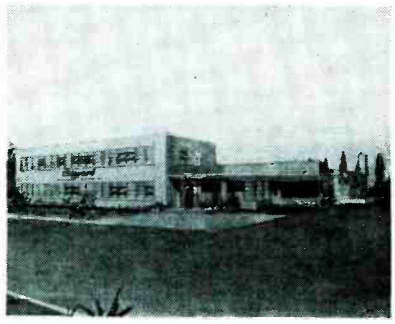
Establishment of a Pacific Coast application engineering office and radio noise suppression laboratory to better serve the growing electronics and aircraft industries of Southern California has been announced by the *Sprague Electric Co.,* manufacturers of capacitors and radio interference filters.

Construction of a major unit for the production of polyethylene resins has just been announced as an addition to the Texas City plant of *Carbide and Carbon Chemicals Co.,* a Division of Union Carbide and Carbon Corp.

Standard Cable Corp. of Chickasha, Oklahoma, with two plants in full operation producing combat telephone wire for Armed Service use, has also leased a third plant to meet commercial consumer requirements.

Company doings noted in the midwest are as follows:

Clippard Instrument Laboratory, Inc., Cincinnati, will soon move to a modern plant at 7350 Colerain Ave. between Mt. Airy and Groesbeck, Ohio, to keep pace with increased demand for test instruments, r-f coils, windings and subassemblies.



Sketch of new Clippard plant

As a part of a general expansion program, *The Reliable Spring and Wire Forms Co.,* Cleveland, Ohio, has moved into larger quarters in its present building for the increased manufacture of military electronic gear.

Plans for a new and larger manufacturing plant at 3601 Howard St., Skokie, Ill., were recently announced by *Ohmite Mfg. Co.,* Chicago, Ill., makers of electrical control equipment.

Multi-Tron Laboratory, Chicago, Ill., has moved to new and greatly enlarged quarters at 4624 W. Washington Blvd. in that city. The firm is engaged in electronic research and in the design and manufacture of special-purpose tubes, electron gun mounts, precision assemblies for vacuum tubes, and in tool and die fabrication.

To house its rapidly growing communications and electronics division, *Motorola Inc.,* Chicago, Ill., has purchased a 200,000-sq ft plant at 4501 Augusta Blvd., in Chicago.

The Fusite Corp., manufacturers of glass-to-steel hermetic terminals, has just occupied a new factory at 6028 Fernview Ave., Cincinnati, Ohio, providing 16,000 sq ft of floor space as compared with 7,000 in the old Carthage Ave. plant.

Admiral Corp., radio, tv and appliance manufacturer, has purchased the *Molded Products Corp.,* of Chicago, custom molders of plastics. The new plant, located at 4533 W. Harrison St., will be operated as a subsidiary of Admiral.

In the east the following company activities are reported:

Robertshaw-Fulton Controls Co. has purchased all the capital stock of the *Fielden Instrument Corp.,* Philadelphia, Pa. The corporation will continue to manufacture the Fielden line of industrial control instruments.

Microwave Associates, Inc., 22 Cummington St., Boston, Mass., will expand its operations in research, development and manufacture of microwave tubes, components and systems. The expansion program will be financed through the proceeds received from the sale of common stock to *United Paramount Theatres, Inc.,* which will own 50 percent of the outstanding common stock subsequent to the sale. Dana W. Atchley, Jr., coordinator of technical research, United Paramount Theatres, Inc., will become president of the enlarged company.

Kepco Laboratories, Inc., manufacturers of voltage-regulated power supplies and specialized electronic equipment, will soon house its production, research and development facilities in a new building at 131 Sanford Ave., Flushing, N. Y.

Electrical Reactance Corp. has been formally merged with the *Aerovox Corp.,* and will henceforth be known as *HI-Q Division, Aerovox Corp.,* Olean, N. Y.

Bomac Laboratories Inc., Beverly, Mass., engaged in the development and production of microwave tubes and devices, has completed a major expansion program making available 35,000 sq ft of floor space for manufacturing purposes.

IRE Convention Program

"FORTY YEARS SETS THE PACE" is the keynote of the 1952 IRE National Convention to be held on March 3, 4, 5 and 6 at the Waldorf-Astoria Hotel in New York City. Commemorating the 40th anni-

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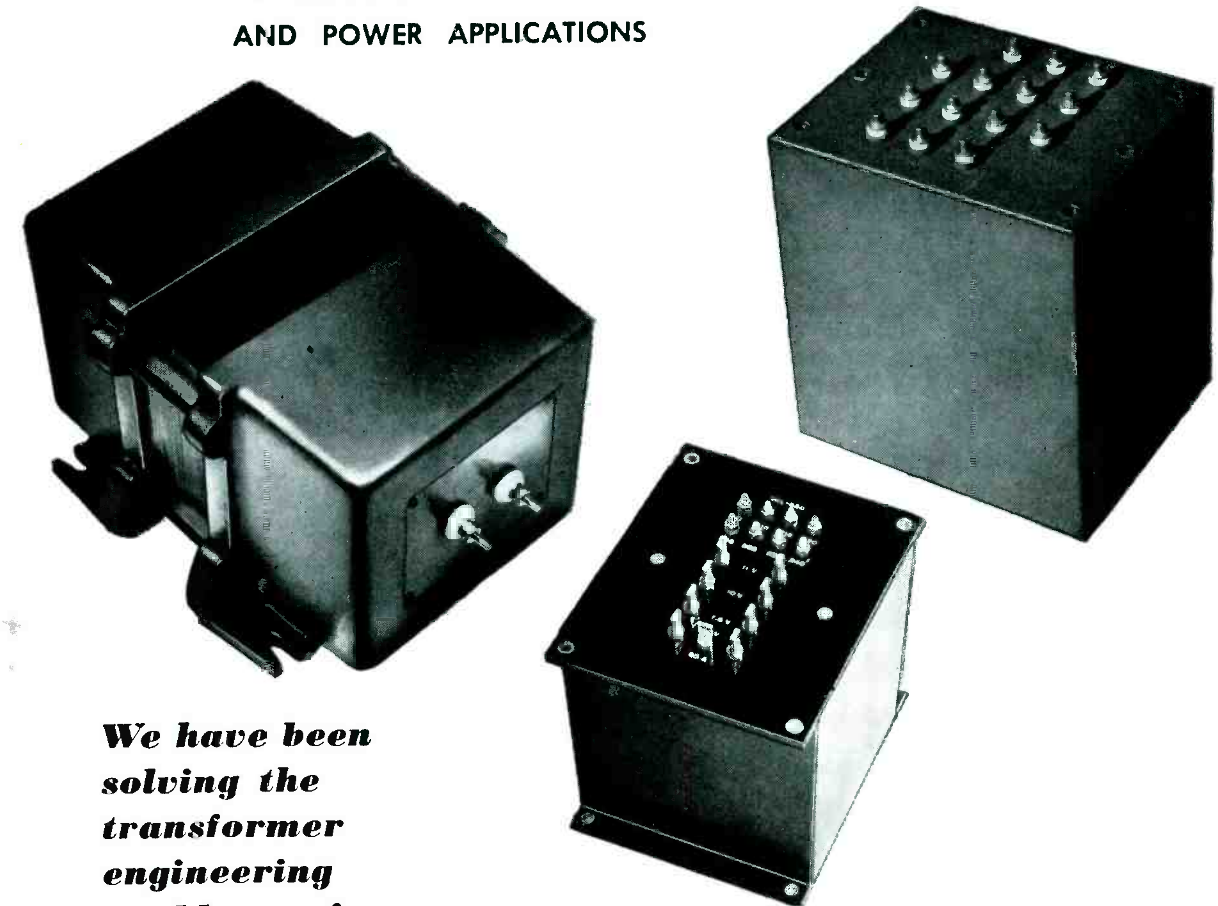

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versary of the Institute, an outstanding program of technical sessions, Professional Group symposia and exhibits has been arranged. Sessions of the technical program will be held at the Waldorf, the Belmont Plaza and the Grand Central Palace. Six sessions and symposia are being held simultaneously each morning and afternoon with the exception of Monday morning, when the Annual Meeting will take place at 10:30 A.M. at the Waldorf.

Technical sessions are listed as follows:

Monday Afternoon, March 3

Symposium: SUBAUDIO INSTRUMENTATION

Direct Synthesis Applied to Subaudio-Frequency Instrumentation, by J. Moore.
Generating Equipment for Subaudio Frequencies, by E. H. Gamble.
Subaudio-Frequency Instrumentation in Seismographic Work, by W. M. Rust, Jr.
Oscillographic Instrumentation for the Subaudio Field, by P. S. Christaldi.

Symposium: MANAGEMENT OF RESEARCH AND DEVELOPMENT

Papers by W. R. G. Baker of GE; R. D. Bennett of NOL; G. N. Thayer of Bell Labs; and R. I. Cole of Griffiss AFB.

Symposium: TRANSISTOR CIRCUITS
Transistor Operation: Elements
(a) Equivalent Circuits, by J. A. Morton.
(b) Parameter Measurement, by V. P. Mathis.
(c) Stabilization of Operating Points, by R. F. Shea.
Transistor Band-Pass Amplifiers, by R. P. Moore.
Transistor Oscillators, by J. S. Schaffner.
Transistor Pulse Circuits, by J. H. Felker.

INFORMATION THEORY I—CODING PROCEDURES

Efficient Coding, by B. M. Oliver.
Television-Signal Statistics, by E. R. Kretzmer.
Coding with Linear Systems, by J. P. Costas.
Predictive Coding, by P. Elias.
Experiments with Linear Prediction in Television, by C. W. Harrison.

AUDIO

Microphones for the Measurement of Sound-Pressure Levels of High Intensity over Wide-Frequency Ranges, by J. K. Hilliard.
An Instrument for Measuring the Time-Displacement Error of Recorders, by E. N. Dingley, Jr.
A Method for Measuring the Changes Introduced in Recorded Time Intervals by a Recorder/Reproducer, by J. F. Sweeney.
Application of Electric-Circuit Analogies to Loud-Speaker Design Problems, by B. N. Locanthi.
A Sound-Survey Meter, by A. Peterson.

Symposium: NEW DEVELOPMENTS IN TELEMETERING

New Developments in Telemetering, by C. H. Hoeppner.
Recent Advances in Magnetic Recording for Telemetering Applications, by W. T. Selsted.
Fairchild Model 150 Telemetering Data Recorder, by C. F. Kezer.
Recording Telemetering Data, by M. V. Kiebert.
Telemetering by Pulse-Code Modulation, by B. D. Smith.

Tuesday Morning, March 4

INSTRUMENTATION I—HIGH-FREQUENCY INSTRUMENTATION

VHF Q—Measurement Techniques, by D. M. Hill.
A High-Sensitivity Method for Measur-

ing Conductance and Capacitance at Radio Frequencies, by W. C. Freeman, Jr.
A Mean-Square Vacuum-Tube Voltmeter, by L. A. Rosenthal and G. M. Badoyannis.
A New Technique for the Evaluation of Leakage and Radiation from Signal Generators, by W. A. Stirrat.
A Wide-Band Sweep Generator, by F. P. Blecher.

TELEVISION I—GENERAL A

Gamma-Correction in Constant-Luminance Color-Television Systems, by S. Applebaum.
The Specification and Correction for Nonlinearity of Cathode-Ray Tubes, by R. C. Moore.
AFC-Circuit Analysis and Design, by G. D. Doland.
Frame Synchronization for Color Television, by D. Richman.

CIRCUITS I

Network Alignment Technique, by J. G. Linvill.
Network Analysis by a new Semi-Automatic Computer, by R. L. Bright and G. H. Royer.
Network Analysis by Two New Computers, by D. Herr.
Network Response Characteristics Using the Complex Plane Scanner, by J. R. Ragazzini and G. Reynolds.
Resonance Characteristics by Conformal Mapping, by P. M. Honnell and R. E. Horn.

INFORMATION THEORY II—NOISE STATISTICS AND SIGNAL DETECTION

Discussion of a Method of Expanding Noise Autocorrelation Function in a Power Series, by F. W. Lehan.
A Proposal for the Determination of Coherence in a Signal Field, by B. S. Melton and P. R. Karr.
The Response of Linear Systems to Random Noise, by B. Gold.
Optimum Methods of Noise Elimination, by C. N. Klahr.
Optimum Techniques for Detecting Pulse Signals in Noise, by D. L. Drukey.

MICROWAVES I—WAVEGUIDES A

Microwave Wiring, by D. D. Grieg and H. Englemann.
Simplified Theory of TEM Propagation Along Conductor-Ground-Plane Transmission Systems, by F. Assadourian and E. Rimai.
Microwave Components for Conductor-Ground-Plane Transmission Systems, by J. A. Kostriza.
Method for Open Waveguide Standing-Wave Measurements, by S. W. Attwood and G. Goubau.
New Guided-Wave Techniques for the Millimeter Wavelength Range, by A. G. Fox.

Symposium: TELEVISION BROADCASTING: AUDIO AND VIDEO SYSTEMS

Fixed and Mobile Tv Lighting, by E. Fiorentino.
The Transient Response of Tv Transmitter-Receiver-Systems, by J. Ruston.
Measurement of Tv Field Intensities by Helicopter, by J. Preston.
A High-Power Uhf Klystron for Tv Service, by J. J. Woerner.
An Ultra-High-Frequency Television Transmitter, by E. G. McCall and P. T. Tissot.

Tuesday Afternoon, March 4

INSTRUMENTATION II—ELECTRONIC MEASUREMENTS A

Measurement of Impedance and Admittance, by B. Salzberg and J. W. Marini.
Accurate RF Microvolts, by M. C. Selby.
Automatic Switching Applied to Inter-electrode Capacitance Measurements, by R. E. Graham.
Measurements of Millimeter Radiation with the Pneumatic Heat Detector, by H. Theissing, H. J. Merrill, and J. M. McCue.
Automatic Smith-Chart Impedance Plotter, by K. S. Packard.

TELEVISION II—COLOR

Requisite Color Bandwidth for Simultaneous Color-Television Systems, by K. McIlwain.
Colorimetric Electronics, by F. J. Bingley.
The Generation of Compatible Color Signals for Research and Field Testing, by J. Fisher.
A Universal Scanner for Color Tele-

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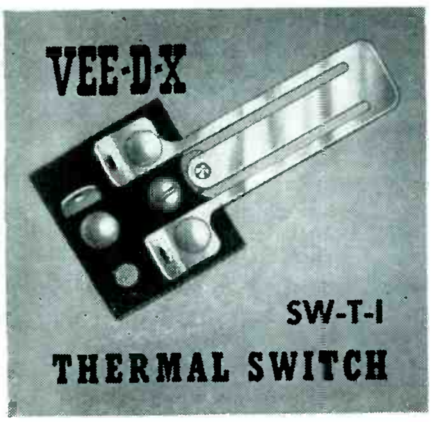

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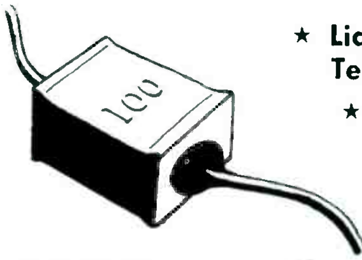

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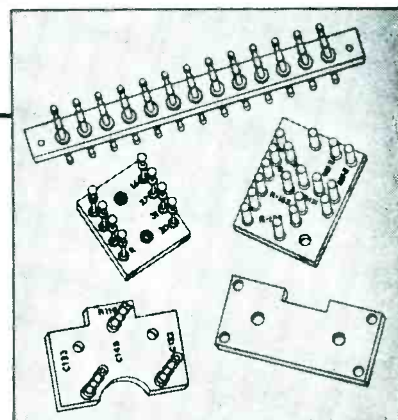

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vision, by G. R. Tingley, R. D. Thompson and J. H. Haines.

Vestigial Sideband Transmission of the Color Subcarrier in NTSC Color Television, by W. F. Bailey.

CIRCUITS II AND INFORMATION THEORY III

Networks for Determination of Power-Spectra Moments, by S. H. Chang and W. H. Lob.

Nonlinear Filter Design on Maximum-Likelihood Basis, by T. G. Slattery.

Optimum Linear Shaping and Filtering Networks, by R. S. Berkowitz.

A Generalized Theory of Filtering and Multiplexing, by L. A. Zadeh and K. S. Miller.

Filter Transfer-Function Synthesis, by G. L. Matthaei.

Filters of Maximum Bandwidth-Impedance-Ratio Product, by T. J. O'Donnell and E. M. Williams.

A Band-Pass Filter Using Simulated Transmission-Line Elements, by A. D. Frost and C. R. Mingins.

MEDICAL ELECTRONICS

New Electronic Techniques for Spectrophotometry, by C. C. Yang.

Application of Microwaves in Physical Medicine, by J. F. Herrick.

Design Problems in the Absolute Oximeter, by R. H. Taplin.

Television Microscopy in the Ultraviolet, by V. K. Zworykin, L. E. Flory, and R. E. Shrader.

Recording Multi-Axial Projection of Vectorcardiograms; the Axostat, by B. P. McKay, W. E. Romans, D. A. Brody, and R. C. Little.

Continuous Integrating Counting-Rate System for Radioactivity, by M. Berman and S. Vacirca.

MICROWAVES II—WAVEGUIDES B

Nonuniform Transmission Lines, by J. G. Gurley.

The Optimum Piston Position for Coaxial-to-Waveguide Transducers, by W. W. Mumford.

Broad-Band Ridged and Flatguide Components 10-40 kmc/sec, by S. Hopfer.

Step-Twist Waveguide Components, by H. Schwiebert and H. A. Wheeler.

Waveguide Matching Technique, by W. C. Jakes, Jr.

Symposium: TV STATION CONSTRUCTION AND THEATER CONVERSION

The New WOR-TV Studio and Transmitter Building at 60th Street and Columbus Ave., New York City, by J. R. Poppele.

New Building and Technical Facilities at WCAU-TV, Philadelphia, by J. Leitch.

The WFAA-TV Plant, Dallas, Texas, by C. L. Dodd.

Theater TV Conversions.
NBC Program, by A. Walsh.
CBS Program, by A. B. Chamberlain.
ABC Program, by J. M. Middlebrooks.

Tuesday Evening, March 4

Symposium: PRESENT STATUS OF NTSC COLOR-TELEVISION STANDARDS

A panel of leading color-television engineers will discuss the most recent work of NTSC panels toward the preparation of standards for the NTSC color-television system. The discussion will include any available results of the field tests currently being conducted under such standards.

Wednesday Morning, March 5

INSTRUMENTATION III—ELECTRONIC MEASUREMENTS B

A Raster-Sweep Oscillograph for Precision Time Measurements, by H. B. Steinhauser.

Precision Automatic Time-Measurement Equipment, by D. W. Burbeck and W. E. Frady.

A Rotating-Beam Ceilometer System, by R. H. Guenthner and L. W. Foskett.

A Polar-Coordinate Cathode-Ray Oscillograph for Use with the Rotating-Beam Ceilometer, by M. T. Nadir and M. B. Kline.

An Electronic Fringe Interpolator for an Optical Interferometer, by R. D. Huntoon.

TELEVISION III—GENERAL B

The Problem of Interlace in Television Receivers, by J. de Leon.

A Method of Evaluating the Performance of a Television Picture Tube and its

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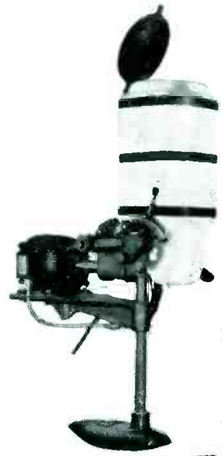

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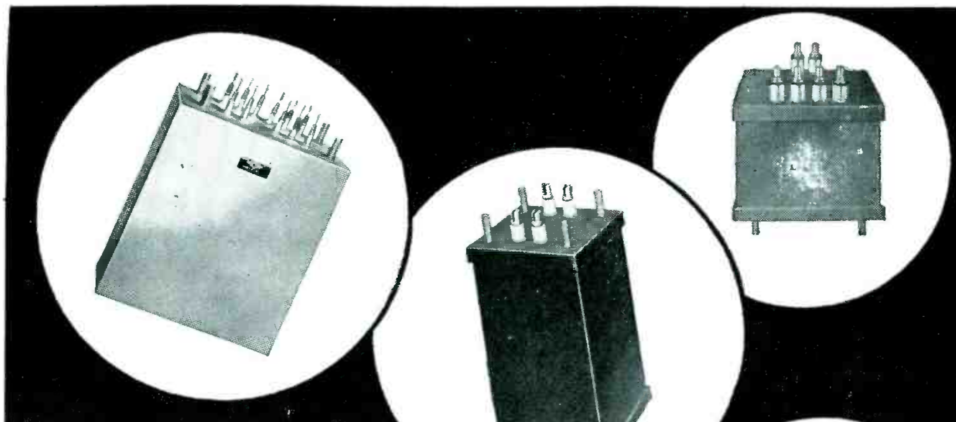

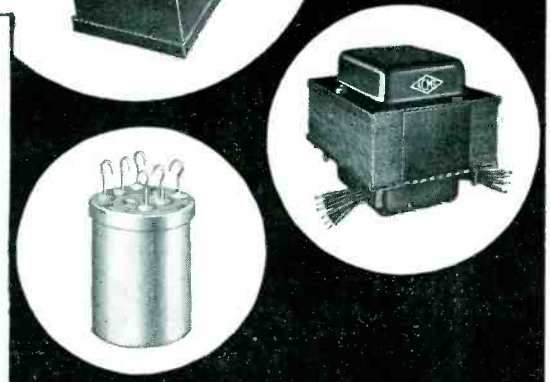

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TRANSFORMERS

Associated Components, by J. Green.
Characteristics and Performance of Television Clamping Circuits, by A. J. Baracket.
Color-Television Synchronizing—Generator Circuits, by I. Krause, A. J. Baracket, and H. Dell.
Printed Unit Assemblies for Television, by W. H. Hannahs and N. Stein.

CIRCUITS III

The Effective Bandwidth of Video Amplifiers, by F. J. Tischer.
Transient Response of Cathode Peaked Video Amplifiers, by J. H. Mulligan, Jr.
Variable Bandwidth-Amplifier Design for High Rate of cutoff and Large Bandwidth Variations, by M. Dishal.
Coupling Circuits Having Flat-Amplitude Characteristics, by A. B. Macnee.
Oscillator Systems Controlled by Phase-Detector Reactance Tube, by J. C. Tellier and G. W. Preston.
Essential Insertion Loss, by D. R. Crosby.

PROPAGATION

The Polarization of Vertically Incident Long Radio Waves, by J. M. Kelso, H. J. Nearhoof, R. J. Nertney, and A. H. Waynick.
Radio Transmission Beyond the Horizon in the 40-4,000 Mc Band, by K. Bullington.
Tropospheric Propagation Data on Frequencies Between 29 and 1,047 Mc at Distances Far Beyond the Horizon, by G. R. Chambers, J. H. Chisholm, J. W. Herbstreit, and K. A. Norton.
Statistical Fluctuations of Radio Field Strength Far beyond the Horizon, by S. O. Rice.
Some Considerations in the Use of Highly Directional Antennas on Sources of Comparable Angular Size to the Beamwidth, by D. O. McCoy.

MICROWAVES III—FILTERS AND CIRCUITS

Further Transmission Analysis of Hybrid Rings, by H. T. Budenbom.
Resonant Cavity Band-Pass Filters—Practical Adustment to Predicted Performance, by D. DeWitt, M. Klein, and T. J. Potts, Jr.
Synthesis of Narrow-Band Direct-Coupled Filters, by H. J. Riblet.
On High-K Dielectric Cavities, by H. M. Schlicke.
A Dual-Channel Colinear Rotary Joint, by E. O. Hartig.

Symposium: DIGITAL COMPUTERS IN CONTROL SYSTEMS

Digital Computers in Control Systems, by J. W. Forrester.
Coders, by R. P. Mork.
Data Transmission Links, by P. Pontecorvo.
The Digital Computer as a Control Element, by C. R. Wieser.
Display Elements, by B. S. Benson.

Wednesday Afternoon, March 5

ANTENNAS I—GENERAL

Optimum Patterns for Arrays of Non-isotropic Sources, by G. Sinclair and F. V. Cairns.
A Geometrical Method of Analyzing the Effects of Site Reflections on Direction-Finding Systems, by G. A. Deschamps.
The Radiated Fields of Pulse-Excited Dipole Antennas, by C. S. Roys.
An Experimental Investigation of the Corner Reflector Antenna, by E. F. Harris.
An Omnidirectional Slot Antenna Array, by A. J. Hoehn and S. I. Cohn.

Symposium: UHF RECEIVERS I

UHF Hybrid Ring Mixers, by W. F. Tyminski and A. E. Hylas.
UHF Tuners, by M. F. Melvin.
The Design and Performance of a Compact UHF Tuner, by H. F. Rieth.
A UHF-VHF Turret Tuner for Television Receivers, by A. Cotsworth, M. Beier, J. Bell, and J. White.
An 82-Channel Turret Tuner, by A. M. Scandurra.
RF Performance of a New Uhf Triode, by H. W. H. Chalberg.

CIRCUITS IV

Dispersion in Transmission Systems, by M. J. DiToro.
Network Synthesis for Specified Transient Response, by W. H. Kautz.
Transforms for Linear Time-Varying Network Functions, by J. A. Aseltine and D. L. Trautman.
Parallel-Tuned Circuit Periodically

Switched to a D-C Source, by L. J. Giacoletto.
A Highly Accurate Variable Time-Delay System, by Y. P. Yu
RC Time-Delay Circuit of Very High Time Constant, by R. G. Roush.

ELECTRON TUBES I—POWER AND GAS TUBES

Method for Prediction of Magnetron Characteristics Relating Frequency and Operating Anode Voltage to Power Output, by H. W. Welch, Jr.
A New Pulse Klystron Amplifier for the 960-1,215 Mc Region of Air Navigation Aids, by C. Veronda.
Uhf Power Tubes, by P. T. Smith.
High-Frequency Performance of Electron Multipliers, by R. R. Law, D. A. Jenny, and F. H. Norman.
Factors Affecting Life of Hydrogen Thyratrons, by M. R. Zinn.

RADAR AND RADIO NAVIGATION

Design of Small Radar Line-Type Modulators with A-C Charging Circuits, by J. F. Clayton and S. J. Krulikoski, Jr.
High-Quality Picture-Display Unit, by R. T. Petruzzelli.
Analysis of an Automatic Radar Range-Tracking System, by E. F. Grant.
The Wind-Finding Radar System, by A. D. Emurian.
Power Requirements for Long-Range, Narrow-Band Navigation Systems in the Low-Frequency Bands, by N. Marchand, A. Jacobs and D. Cawood.

Symposium: MAGNETIC-CORE MEMORY DEVICES FOR DIGITAL COMPUTERS

An Analysis of Magnetic Delay Line Operation, by E. A. Sands.
Design of a High-Speed Shift Register Using Magnetic Binaries, by M. Fishman.
Magnetic-Core Matrix Switches, by K. H. Olsen.
Static Magnetic Matrix Memory and Switching Circuits, by J. Rajchman.
The Ferro-Resonant Flipflop, by C. L. Isborn.

Thursday Morning, March 6

ANTENNAS II—MICROWAVES A

Gain of Electromagnetic Horns, by E. H. Braun.
A Rapid-Scan, Circularly Symmetrical Pillbox Antenna, by W. Rotman.
Method for Side Lobe Reduction, by C. J. Sletten.
Tolerances on Paraboloidal Reflectors, by J. Ruze.
Design of Dielectric Walls for Optimum Transmission, by R. M. Redheffer and B. Galvin.

Symposium: UHF RECEIVERS II

Practical Tv Antennas for Uhf Reception, by E. O. Johnson.
Amplifiers for Uhf Distribution Systems, by T. Murakami.
Comparison of Present-Day Uhf and Vhf Television Receivers, by R. A. Varone.
Round-Table Discussion: Relative Aspects of the Various Methods of Uhf Tuning — Introductory Remarks — W. B. Whalley; Moderator—L. Winner.

FEEDBACK CONTROL

Stability Theorems for Feedback Systems, by J. F. Koenig.
Stabilization of Nonlinear Feedback Control Systems, by R. L. Cosgriff.
Rate-Limited Control System Noise, by I. H. Van Horn and R. G. Wilson.
Experimental Studies for Servomechanisms, by A. V. Cohee.
AFC System Analysis by Electromechanical Analogue, by D. Leed.

ELECTRON TUBES II—UHF, SMALL TUBES

A High-Gain Klystron Amplifier for Relay Systems, by G. Bernstein.
F-m Distortion in Reflex Klystrons, by T. Moreno and R. L. Jepsen.
The Measurement of Cathode Interface Impedance, by H. B. Frost.
Uhf Amplifier Tube for Television Tuners, by C. E. Horton and H. Hsu.
Microwave Conversion and Detection Employing Electron Tubes, by A. Bronwell, J. May, and C. Nitz.

Symposium: THE INTEGRATION OF ELECTRONIC EQUIPMENT WITH AIRFRAME DESIGN

The Integration of Electronic Equipment with Airframe Design, by A. F. Coombs and C. W. Dix.
The Unique Airplane Environment Ef-

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- a cumulative editorial index to ELECTRONICS, 1940-1949 inclusive
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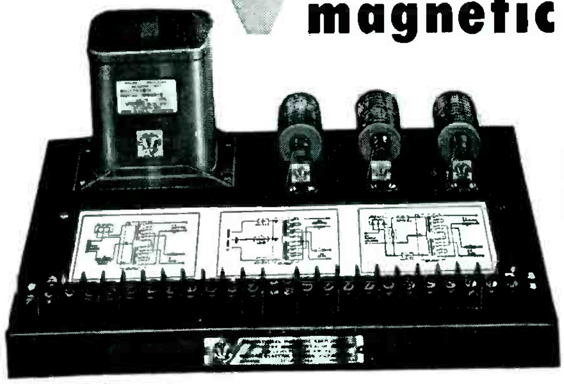

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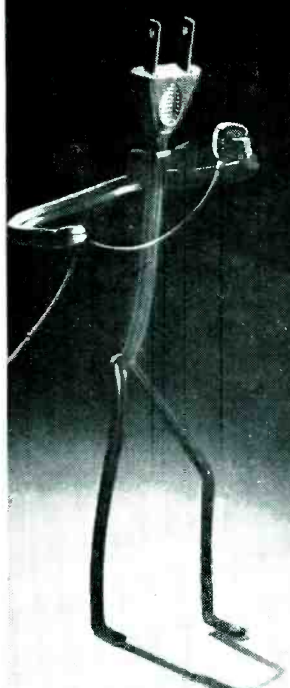

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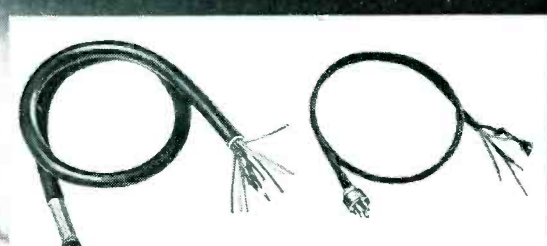

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fect on Electronic Equipment, by D. T. Geiser.
Electronic Parts for Airborne Requirements, by F. E. Wenger.
Heat Dissipation from Airborne Electronic Equipment, by L. Possner.

DIGITAL COMPUTERS

The CADAC, by W. E. Dobbins.
Analysis of Control Systems Involving Digital Computers, by W. K. Linvill.
Frequency Analysis of Digital Computers Used in Control Systems, by J. M. Salzer.
A Very Rapid Access Memory Using Diodes and Capacitors, by A. W. Holt.
The Charactron, J. T. McNaney.

Thursday Afternoon, March 6

ANTENNAS III—MICROWAVES B

A Microwave Luneberg Lens, by G. D. M. Peeler, D. H. Archer, and K. S. Kelleher.
Radiation from Metal-Loaded Waveguides Terminated in a Ground Plane, by R. E. Webster and M. H. Cohen.
Mutual Coupling between Slot Radiators, by M. J. Ehrlich, C. W. Curtis, and R. G. Fawcett.
Off-Axis Characteristics of Paraboloids and Spheres, by K. S. Kelleher.
A Broad-Band Axially Symmetric Vertex Feed, by F. L. Hennessey.

RADIO COMMUNICATION SYSTEMS

A Radio-Relay System Employing a 4,000-Mc Three-Cavity Klystron Amplifier, by J. J. Lenehan.
An Fm Microwave Radio Relay, by R. E. Lacy and C. E. Sharp.
Nonsynchronous Pulse Multiplex System with Random Sampling, by J. R. Pierce and A. L. Hopper.
Exalted-Carrier and Single-Sideband Diversity Receivers, by M. G. Crosby.
Counter Circuit for a Broad-Band Multiplex Receiver, by A. R. Vallarino, H. A. Snow and C. Greenwald.

CIRCUITS V

Analysis of Measurements on Magnetic Ferrites, by C. D. Owens.
Magnetic Amplifier Performance Analysis, by D. Lebell and B. Bussell.
Barium Titanate Properties, by A. I. Dranetz.
A Ferroelectric Amplifier, by H. Urkowitz.
Germanium Diode Transient Response, by J. H. Wright.
Germanium Diode Testing Program, by D. J. Crawford and H. F. Heath.
Analysis of Crystal Diodes in the Millivolt Region, by W. B. Whalley, N. P. Salz, and C. Masucci.

ELECTRON TUBES III—
CATHODE-RAY TUBES

The Anatomy of Contrast Range in Cathode-Ray Tubes, by J. H. Haines and R. E. Mueller.
The Selfocus Picture Tube, by A. Y. Bentley, K. A. Hoagland, and H. W. Grossbohlin.
A New High-Speed Cathode-Ray Tube, by H. J. Peake and R. W. Rochelle.
The Deflectron—A New System for Electrostatic Deflection, by K. Schlesinger.
Field Plotting as a Tool in Deflection-Yoke Design, by E. Sieminski.

Symposium: WHAT'S NEW IN MOBILE RADIO

Mobile Radio Problems Resulting from New Techniques, by E. L. White.
Application of Voice-Frequency Tone Signalling to Mobile Radio Systems, by C. L. Rouault.
Dispatcher's Wayside-to-Train Radio-Control System, by S. D. Burton.
New Developments in Army Mobile Communication Equipment, by J. H. Durrer.

Symposium: RELIABILITY OF MILITARY ELECTRONIC EQUIPMENT

Discussion of the Complexity and Unreliability of Military Equipment and the Need for Simplification and Increased Life, by A. S. Brown.
Maintenance Minimization in Large Electronic Systems, by W. D. McGuigan.
The Reliability Problems in Missile Development, by A. C. Packard and R. Weller.
Application Engineering for Improved

Electronic Reliability in Guided Missiles, by W. T. Summerlin.

Mobile Army Broadcasting

THE ARMY'S mobile radio station now being used in Korea was described in ELECTRONICS last month (p 316). Units involved, designed for Psychological Warfare Teams, were developed, as to specifications, by the Signal Corps.

This station was built by Gates Radio Co. of Quincy, Ill. Other major units were procured from the Hammerlund Corp. and Pan Adapter Co. of New York and the Magnecord Corp. of Chicago, Ill. The project was coordinated by Coles Signal Laboratory, Red Bank, N. J.

CCIR Codes for Reporting Signals

ALTHOUGH FCC does not require their use, the new international SINPO and SINPFEMO signal-quality reporting codes are being published for the convenience of communicators, particularly those handling international traffic.

A signal report shall consist of the code word SINPO or SINPFEMO followed by a five or eight-figure group respectively rating the five or eight characteristics of the signal code. The letter X shall be used instead of a numeral for characteristics not rated. Although the code word SINPFEMO is intended for telephony, either code word may be used for telegraphy or telephony as may be desired. The overall rating for telegraphy shall be interpreted according to the table of Signal Quality Criteria.

SINPO Signal Reporting Code

	S	I	N	P	O
Rating Scale		Degrading effect of			
	Signal Strength	Interference (QRM)	Noise (QRN)	Propagation disturbance	Overall readability (QRK)
5	Excellent	Nil	Nil	Nil	Excellent
4	Good	Slight	Slight	Slight	Good
3	Fair	Moderate	Moderate	Moderate	Fair
2	Poor	Severe	Severe	Severe	Poor
1	Barely audible	Extreme	Extreme	Extreme	Unusable

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5	Excellent	Nil	Nil	Nil	Nil	Excellent	Maximum	Excellent
4	Good	Slight	Slight	Slight	Slow	Good	Good	Good
3	Fair	Moderate	Moderate	Moderate	Moderate	Fair	Fair	Fair
2	Poor	Severe	Severe	Severe	Fast	Poor	Poor or nil	Poor
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3 Fair	Marginal. Single Start-stop Printer	50 wpm Morse
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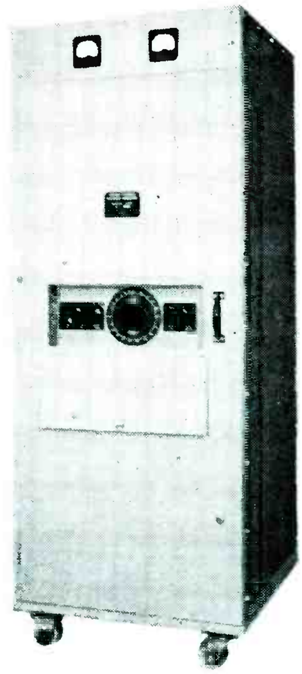

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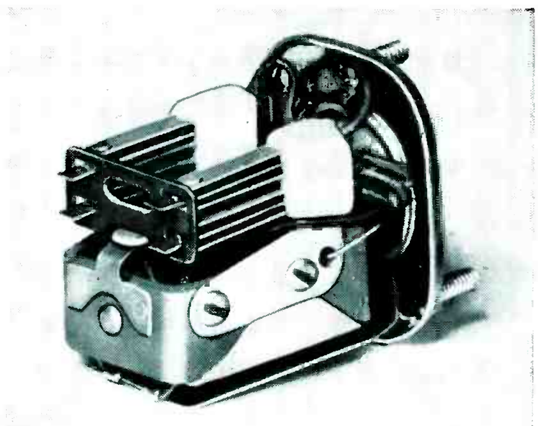

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Synthesis of Electronic Computing and Control Circuits

BY THE STAFF OF THE COMPUTATION LABORATORY. *Harvard University Press, Cambridge, Massachusetts, 1951, 278 pages, $8.00.*

THIS book, published as Volume XXVII of the Annals of the Computation Laboratory of Harvard University, is a most welcome addition to the series.

The book deals entirely with digital computing circuits, considering no analog devices. (The reviewer is using the definition of digital computer published in *IRE Proceedings*, March 1951, page 273.) The control circuits mentioned in the title are of the type in which all of the relevant information is handled in digital form, rather than of the type associated with servomechanisms.

There are thirteen chapters and an appendix. The introduction (Chapter I) and the next six chapters deal principally with methods of deriving vacuum-tube circuits to perform specified logical functions, or switching functions as they are properly called here.

Computing circuits in electronic digital computers possess only a small number of states of energization. In a binary computer, this number is two, in that a computing circuit may only be energized or not energized. Basically, a switching function is an expression relating the state of energization of a given point in a computing circuit to the states of energization of a number of given points in some other computing circuits. The sets of states of energization of these given points are called the variables of the switching function. Vacuum-tube circuits which perform switching functions have been named vacuum-tube operators (Chapter II). With the possible exception of information-storage units as such, all information-handling parts of an electronic digital computer consist essentially of operators of this kind. Of course, this remains true regardless of the purpose of the information handled—whether it be computer control information or problem information—and regard-

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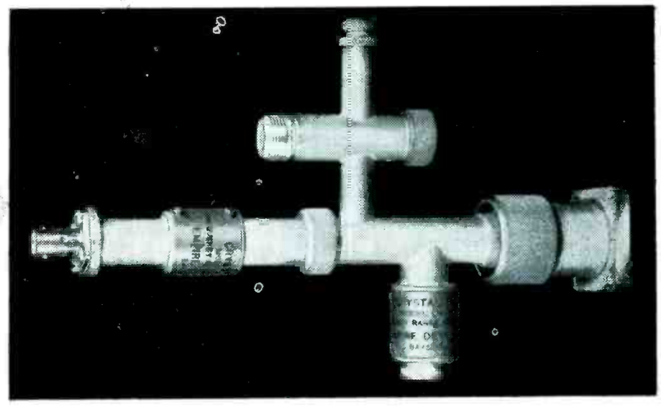

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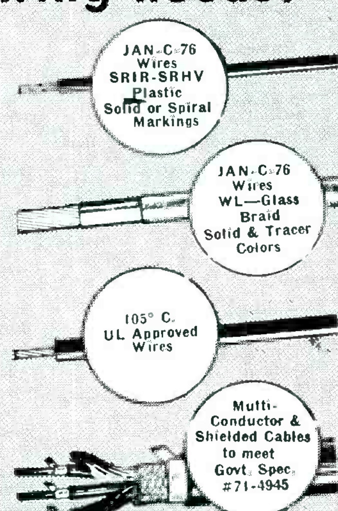

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less of whether this information be numerical or not.

Switching functions of two and three variables are discussed in detail in Chapter III. A vacuum-tube operator corresponding to each of all the possible switching functions of these variables is described which is believed to be minimal (containing a minimum number of control grids).

Switching functions of n variables are treated in Chapter IV and useful V.T. operators are also mentioned. Chapter V concerns minimizing charts, which are ingenious graphical devices for the determination of minimal V.T. operators. For small values of x, this technique is most useful. The authors point out, however, that the complexity of the charts increases quite rapidly with increasing x. They add: "The manipulation of functions of large numbers of variables, then, must await further theoretical development, and probably the construction of mechanical aids."

Chapter VI deals with pyramids and rectangles, circuits which produce 2^n outputs from n inputs. Chapter VII treats multiple output circuits, outlining a number of helpful techniques.

With the exception of Chapter IX, which concerns time variables, and Chapter XI, which presents an interesting discussion of coding systems, the remainder of the book consists of an extensive treatment of the major computing components of digital computers. Triggers, rings and digit counters are discussed in Chapter VIII, rectifiers and associated circuits in Chapter X, while Chapters XII and XIII deal effectively with adders, accumulators and multipliers.

The Appendix contains a discussion and tabulation of the switching functions of four variables. A large number of clear illustrations appear throughout the book, and many well-chosen and instructive examples are given.

It is interesting to note that Boolean algebra is not explicitly used in this book. Instead, methods involving only common algebra are developed and used for the derivation of the results presented. As Professor Aiken points out in the preface, this procedure has the ad-

vantage of involving only familiar concepts.

One feels, however, that mathematicians may, not unreasonably, object to this approach. Switching functions are Boolean polynomials, pure and simple. The exclusive use of the postulates of common algebra in the derivation of minimal forms of these polynomials may be unduly restrictive. More work may be involved and the results less widely applicable. For it should be noted that, insofar as the problems under discussion are concerned, the postulates of Boolean algebra are far more general, and hence, more powerful. In Boolean algebra, for example, the basic operations of union and intersection are both equally distributive; the duality laws permit the interchange of union and intersection in any valid expression.

But, since groups of transformations are involved, the methods of Boolean algebra may ultimately be insufficient anyway. When it appears, the derivation and proof of a completely general minimal representation will probably require broader techniques, such, perhaps, as those of lattice theory. In the meantime, Professor Aiken's formulation, together with his minimizing charts (for they are his own contributions), unquestionably produce results of real engineering significance and great practical usefulness.

The general aspects of the book conform in all respects to the high standards of the Harvard University Press. The typography and workmanship are excellent. The photo-offset printing process which is used insures that the number of typographical errors be reduced to a minimum. This reviewer has not found any and he does not expect to find any.

The material presented is well organized and clearly written. It is felt, however, that an index might be helpful. Further, the bibliographical references seem to be somewhat inadequate. Claude E. Shannon's well-known work is mentioned in the preface, but it does not seem that an explicit reference to his important contribution appears anywhere in the book, (A Symbolic Analysis of Relay and Switching Circuits, *Electrical En-*

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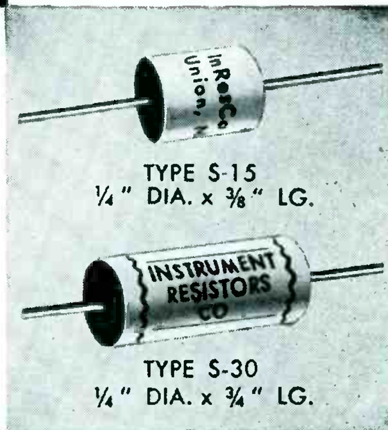

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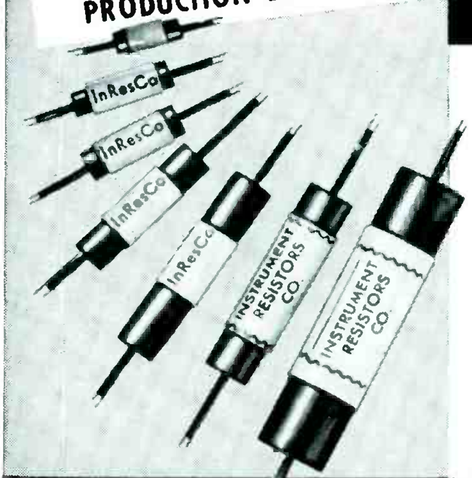

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APPLICATION-DESIGNED RESISTORS FOR ELECTRONICS AND INSTRUMENTATION *gineering,* Transactions Supplement, 1938, p 713).

But these are minor details. The book is highly recommended. Engineers engaged in the development of any digital information-handling equipment, whether strictly for computation purposes or not, should find it most useful. It should be useful also to mathematicians working in abstract algebra—at least to those who are interested in learning what computer engineers expect of them. The authors should be congratulated for this addition to an already long list of solid achievements. — ROBERT SERRELL, *RCA Laboratories Division, Princeton, New Jersey.*

Ferromagnetism

BY RICHARD M. BOZORTH, *Technical Staff Member, Bell Telephone Laboratories. D. Van Nostrand, New York,* 1951, 968 *p,* $17.50.

IN THIS, the most complete work of its kind ever published, Dr. Bozorth has presented to engineers and physicists a most sorely needed central clearing house for information on ferromagnetism and ferromagnetic materials. The book is not a rehash of the principles of electricity and magnetism to be found in any good textbook on the theory of electromagnetism. Indeed, the author touches upon such matters only to the extent that they are necessary to the complete explanation of present-day understanding of the mechanics of ferromagnetism. While it is a reference work rather than a textbook, it will be as valuable to the student and physicist as it is to the practicing engineer since the author presents the theoretical and practical aspects of his subject with equal emphasis.

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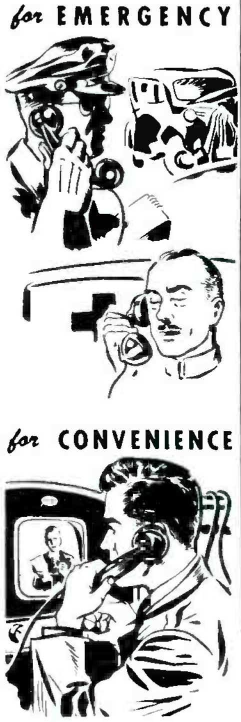

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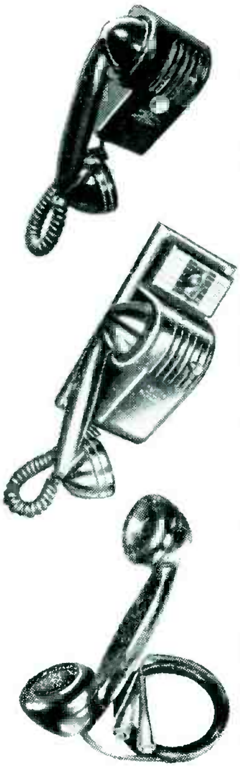

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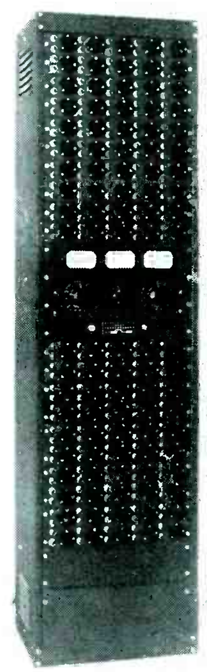

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the iron-nickel system because of the great importance of all these alloys in modern engineering work. However, practically all alloys, of whatever composition, that were ever detected to have exhibited ferromagnetic characteristics have been included and described to the best of existing knowledge. This round-up of far-flung information on flux-carrying materials will be of the greatest value to the design engineer working on transformers or relays or motors or permanent magnet assemblies,—or any of the thousands of other applications involving their use. The serious research worker in such materials will find it mandatory to acquaint himself with the work of others through the complete coverage of such information in this portion of the book.

The second half of the book discusses fully the modern theory of ferromagnetism. The basic causes of the phenomenon are presented in terms of the atomic interactions which produce it. The effect of Ewing's theory, the Weiss theory and quantum theory on modern domain theory is fully explained and the theory itself is used in the discussion and explanation of such age-old mysteries as saturation, residual induction, coercive force, hysteresis, the shape of the magnetization curve, the Barkhausen effect, permeability and anisotropy. The theories of paramagnetism and diamagnetism are presented and a very large chapter is devoted to the increasingly important subject of magnetostriction. The Curie Point of materials and the energy of magnetization are considered as well as such lesser known quantities as the magnetocaloric effect, the magnetoresistance effect, change of magnetization with time and antiferromagnetism. A chapter on permanent magnets embraces a consideration of their design as well as a detailed discussion of the metallurgy and properties of the numerous commercially available alloys. The book is concluded with a presentation of the methods of magnetic measurements.

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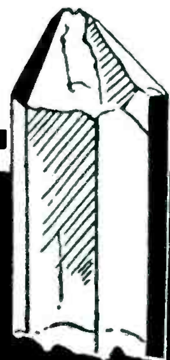

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derstandable form. A means is provided for the more serious student to pursue any particular aspect of the subject through a bibliography of 1,777 references, all completely cross-indexed to the text. This is probably the most complete collection of references to magnetic information ever assembled. A carefully prepared subject and author index makes the location of material easy.

Compiled by one of the country's most outstanding experts on magnetic materials, the book is not only authoritative and comprehensive but its language is interesting and understandable with mathematics maintained to a minimum. It definitely is a must for every engineer and company librarian engaged in the electrical industry.—EARL M. UNDERHILL.

Theory and Design of Television Receivers

BY SID DEUTSCH. *McGraw-Hill Book Co., New York*, 1951, 536 *pages*, $6.50.

THIS book attempts to fill the need for an engineering text on the theory and design of television receivers. On the whole it falls short of achieving this objective. Its most serious fault is the not infrequent distortion of established principles; in many instances inaccurate statements are made which might be accepted as authoritative by relatively inexperienced readers. Because many of the circuits shown are not representative of commercial practice, the utility of the book is impaired.

In choice of subject matter and distribution of emphasis the book leaves much to be desired. It oscillates in technical level between (a) the vocational-school level as exemplified by beating an 8-cycle and 10-cycle wave to illustrate the principles of frequency conversion and (b) a highly mathematical level as exemplified by the use of the Laplace transform. Many items of importance are omitted; and others such as elementary geometrical optics, which might better have been omitted, are treated in excessive detail.

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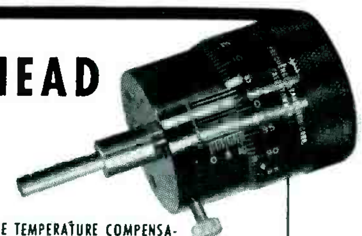

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graduate engineering students as well as professional engineers, is difficult to justify. In this text of over 500 pages there are some 11 references, yet there are many instances where appropriate easily available references would have been invaluable.

This book covers a broad subject in a rapidly changing field and represents a difficult project for any one engineer to handle adequately. It is unfortunate that the several sections of the manuscript were not checked before publication by engineers expert in their individual specialties.—JACK AVINS, *Industry Service Division, Radio Corporation of America*

Industrial High Frequency Electric Power

BY E. MAY. *John Wiley and Sons, New York,* 1950, 355 *pages,* $5.00.

IN THE 350 pages of this book the reader will find a surprising amount of useful information. Although the title does not mention induction or dielectric heating, this is really the subject with which the book deals in a very comprehensive and capable manner. The book has the great advantage that the reader will not have to refer to a lot of other books; it starts with some 50 pages of basic circuit theory, which gives an excellent foundation for what follows. The next 110 pages are devoted to a description of sources of high-frequency power (where by "high" is meant anything higher than the usual power-line frequencies). Treated are arc and spark oscillators, inverters, rotating high-frequency alternators and oscillators using power tubes; the treatment is in sufficient detail to be useful even to the designer of such equipment.

The next 80 pages are devoted to the theory of induction and dielectric heating. The industrial engineer will find this section particularly valuable, because it contains a collection of a great number of formulas and graphs enabling him to decide whether this type of heating will be suitable for a particular application he may have in mind. Data on optimum frequencies for hardening or for through heating,

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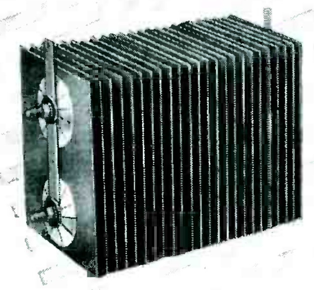

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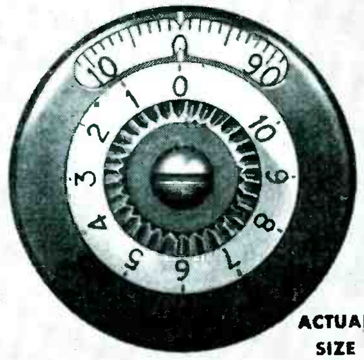

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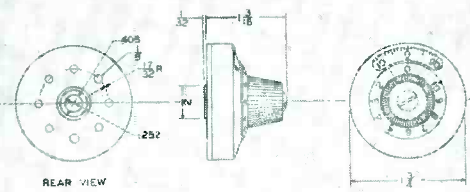

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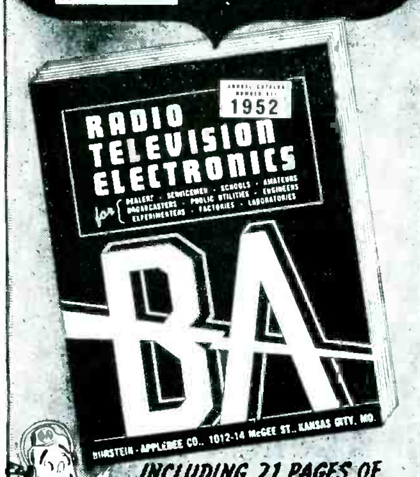

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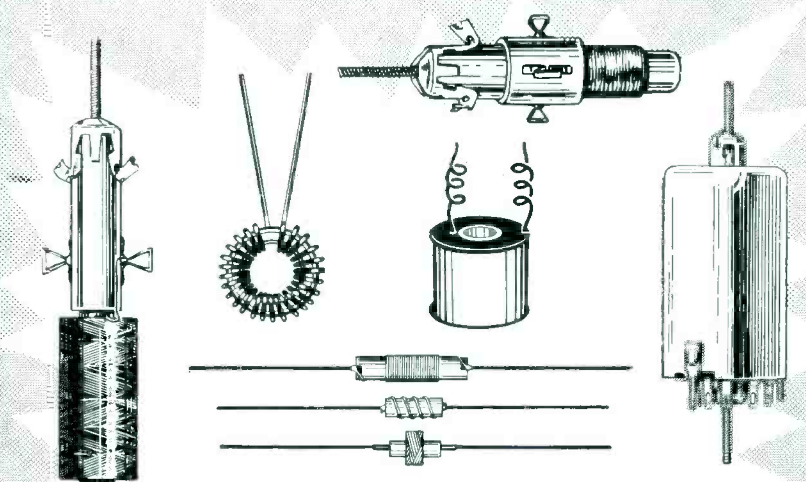

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speed of heating, and power consumption to be expected are given.

The remaining 100 pages are devoted to auxiliary equipment, methods of measurements and the description of commercially available induction and dielectric heating equipment. It should be mentioned, however, that whenever equipment is described, the author confines himself to British apparatus. Some readers may consider this a shortcoming, but in view of the great amount of useful theoretical material, this is a small matter indeed.

An excellent list of references is found at the end of the book.

The title indicates that no information will be found on the application of low-frequency power to induction heating. In recent years 60-cycle power has been used successfuly for the heating of large billets, and the addition of a chapter on this subject might have been welcomed by many readers. This is again of minor importance.

This book should prove a welcome addition to the library of any electrical engineer involved or interested in induction or dielectric heating.—WALTHER RICHTER, *Consulting Electrical Engineer*

The Measurement of Radio Isotopes

BY DENIS TAYLOR. *John Wiley & Sons, New York,* 1951, 118 *pages,* $1.50.

IN ANOTHER of the Methuen monographs on physical subjects, Dr. Taylor, head of the electronics division of the Harwell atomic energy establishment, has written a handy and useful treatise on the application of electronics to detecting and measuring radiation from radioactive isotopes.

Since it is written for the nonexpert, the book makes an excellent first approach to the subject. The mathematics is not too difficult and can be neglected at first reading anyway. After a review of the fundamental facts of how the activity of these isotopes change with time and, therefore, how the instantaneous activity can be measured, the author describes how the several types of radiation are detected. G-M tubes, ionization chambers, electro-

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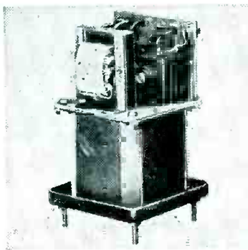

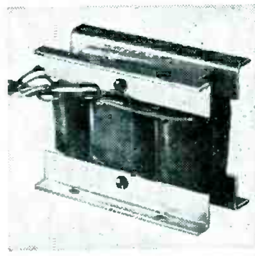

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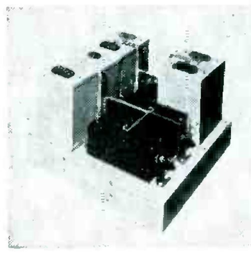

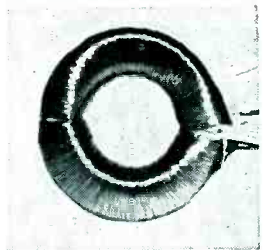

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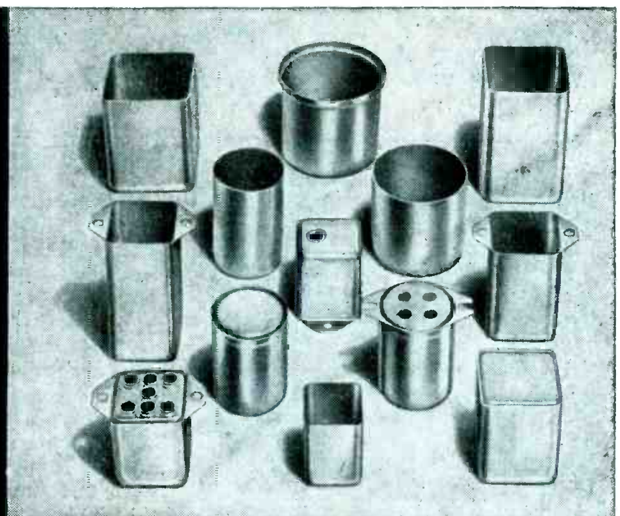

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THUMBNAIL REVIEWS

BROADCAST OPERATOR'S HANDBOOK, Second Edition. By Harold E. Ennes, staff engineer, WIRE. John F. Rider Publisher, Inc., New York, 1951, 440 pages. $5.40. General revision plus new material for the man in the control room or studio, at the master control, outside the studio on remote pickups, or at the transmitter. Problems of emergency shutdowns, descriptions of equipment, measurement techniques etc.

ADVANCED THEORY OF WAVEGUIDES. By L. Lewin. Iliffe & Sons, Ltd., London, 1951, 192 pages, 30 shillings. Selected topics in waveguide theory for the reader already familiar with essentials and practice and with good working knowledge of advanced mathematics. Seven chapters:—electromagnetic theory and its application to waveguides, cylindrical posts, diaphragms, tuned post and tuned window, waveguide steps, T's and tapers, radiation from waveguide and propagation in loaded and corrugated guides.

TABLES OF THE ERROR FUNCTION AND OF ITS FIRST 20 DERIVATIVES. From the computation staff, Harvard University. Harvard University Press, Cambridge, Mass., 1952, 276 pages, $8.00. New 6-place tables of the error function and derivatives on a finer mesh, with more extensive range, with higher derivatives than heretofore published together with areas and ordinates.

BASIC ELECTROTECHNICS. By B. L. Goodlet. Sometime professor of electrical engineering, Universities of Cape Town and Birmingham. Edward Arnold & Co, London, Longman, Green and Co., Inc., 55 Fifth Ave., New York, 1951, 247 pages, $4.00. Elementary electromagnetic theory for beginners and for students who have some knowledge of physics and calculus. Contents:—steady electric currents, electrostatic fields, capacitors and dielectrics, electrodynamics, calculation of magnetic fields, alternating currents, Maxwell's equations.

AN INTRODUCTION TO ACOUSTICS. By Robert H. Randall, associate professor of physics, City College of New York. Addison-Wesley Press, Inc., Cambridge, Mass., 340 pages, 1951, $6.00. For undergraduates in physics or engineering students who may wish later to specialize in acoustics. From fundamental particle vibration theory to speech and hearing, sound measurements, reproduction of sound and applied acoustics.

SYMPOSIUM, LARGE-SCALE DIGITAL CALCULATING MACHINERY. 1951 Harvard University Press, 393 pages, $8.00. Proceedings of the second symposium sponsored by the Navy Department, Bureau of Ordnance and Harvard, held at the Computation Laboratory, 13-16 September 1949, including speeches, discussions and papers on recent developments in computing machinery, numerical methods, computational problems in physics, aeronautics and applied mechanics, economic and social sciences and the future of computing machinery.

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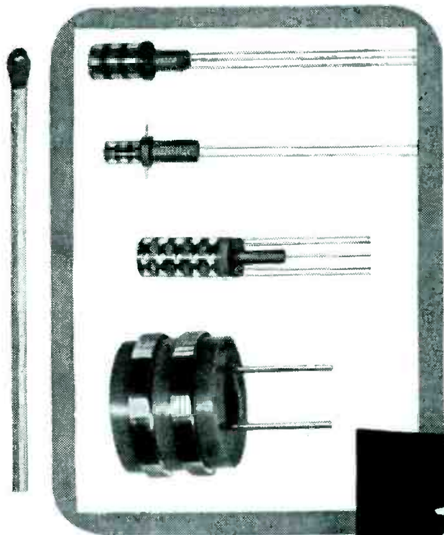

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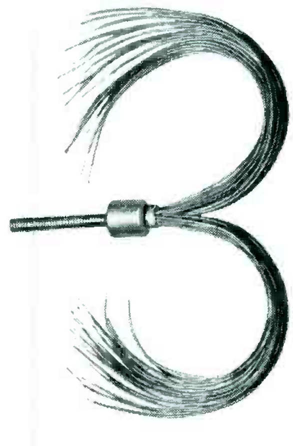

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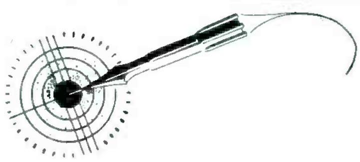

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BACKTALK

How High The Fidelity

DEAR SIRS:

THE ARTICLE by Cooke and Fletcher entitled, "Cathode-Follower Loudspeaker Coupling" (ELECTRONICS, Nov. 1951, p 118) represents another attempt to make music sound more realistic than it actually is. ELECTRONICS has done a great service by publishing this lampoon of the fetishes which are current among groups of audio enthusiasts.

Such superstitions as requirements for audio bandwidth in excess of human hearing, zero electrical phase shift in spite of huge acoustical phase shifts, elimination of the output transformer at any cost, thoughtless applications of rules of thumb, and the cathode-follower myth are carried to absurdity.

The following deathless quotations illustrate our point:

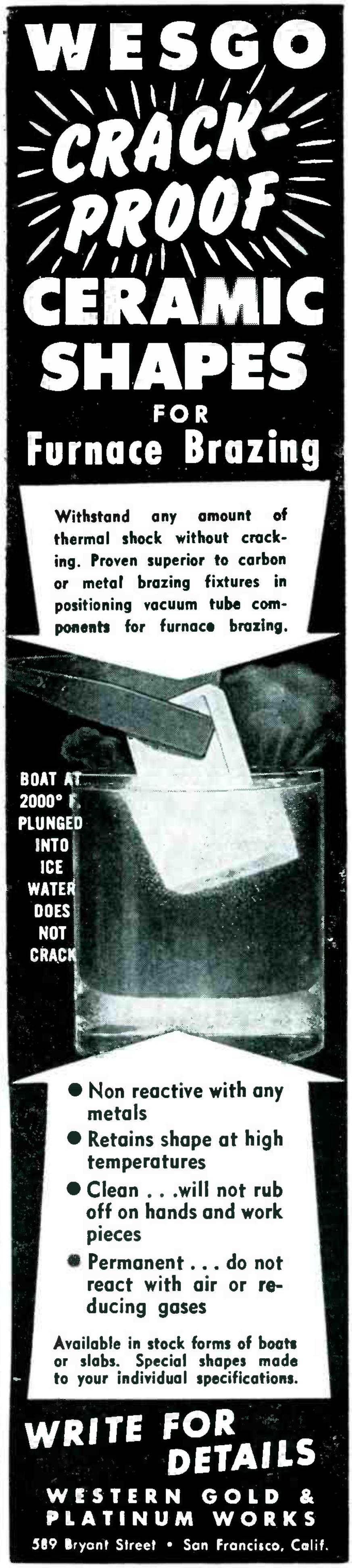
(1) Page 121, third column, last paragraph: ". . . better results at the high frequencies are obtained, especially in the reproduction of percussion instruments. Here step wave fronts require a frequency response possibly as high as 100 or even 200 kc."

We want to know what improvements in humans the authors recommend so that such frequencies may be heard.

(2) Page 119, first column, third paragraph: "A balance should be maintained in extending frequency response at both ends of the audio (?) spectrum; that is, if an extension of upper frequency response is made to 200,000 cps, then an extension of the lower response frequency should be made to 2 cps. One rule of thumb has been to make the product of the upper and lower half-power frequencies equal to 400,000."

(3) Page 119, third column, first paragraph: "This requirement (on the power supply) was easily accomplished by using four rectifiers, type 872/872A. . . ."

(4) Page 120, first column, second paragraph: "It might be pointed out that there is no hum pickup problem here such as that



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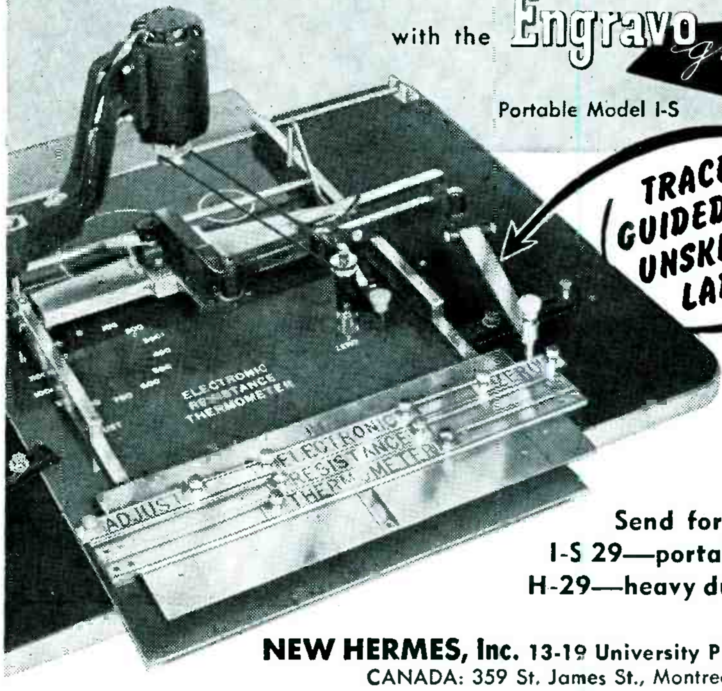

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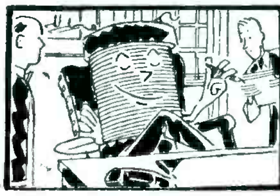

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encountered with output transformers owing to winding linkage or magnetic coupling."

(5) Page 121, third column, second paragraph: "The reaction after several months of listening to this system may be likened to living with a great painting."

Great paintings are often spoken of as having great power. This amplifier beats all by several hundred watts. The authors should have pointed out that this amplifier eliminates the need for a heating plant.

WILLIAM L. HATTON
ROBERT A. RAPUANO
Newton, Massachusetts

Authors' Rebuttal

DEAR SIRS:

ELECTRONICS readers, Mr. Hatton and Mr. Rapuano (see above letter) must be acquainted with the analog of the motor car. Many manufacturers design cars capable of speeds approaching 90 miles an hour. These manufacturers do this in order to improve the operation and performance of these cars at more conservative speeds. An amplifier response of 2 cps to 200,000 cps at the half-power points permits excellent phase and amplitude characteristics from 20 to 20,000 cps.

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We hasten to explain to readers Hutton and Rapuano that the authors are not proposing such a direct coupler as a commercial amplifier, but simply as a power transfer unit which has the ability of reproducing in a pure 16-ohm resistor a voltage exactly like the voltage output of a microphone placed judiciously in Symphony Hall. If this contributes to the house heating to the tune of about a penny an hour, there are several scores of ELECTRONICS readers who have, are, and will accept such by-products graciously in return for superior low-frequency results, as

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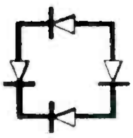

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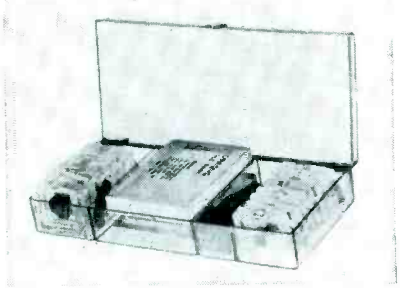

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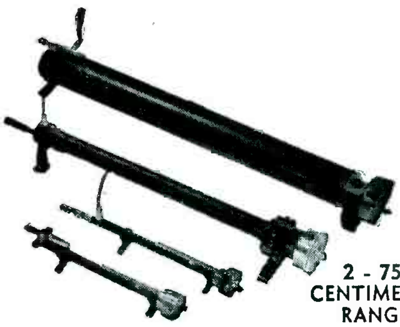

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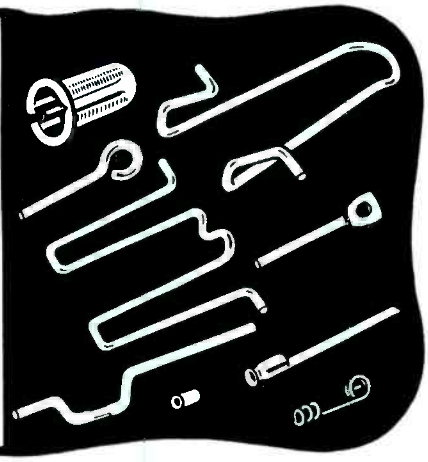

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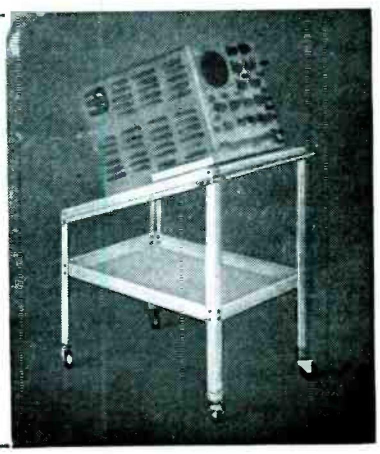

well as high-frequency response as good as the best amplifiers available.

Now the game is to find much better speakers, so that the authors may avocationally brew a pot of witchcraft and superstitions that will correlate laboratory measurements with listening judgments.

EWAN W. FLETCHER
Cruft Laboratory
Harvard University
Cambridge, Massachusetts
AND
STUART P. COOKE
Case Institute of Technology
Cleveland, Ohio

Distributed Amplifiers

DEAR SIRS:

I WISH to submit the following statement for publication in *Backtalk* for answering the letter of July 12, 1951, from G. G. Kelley, Physics Division, Oakridge National Laboratory.

Figure 1 shows the plate characteristic of a pentode in a stage of distributed amplifier. For example,

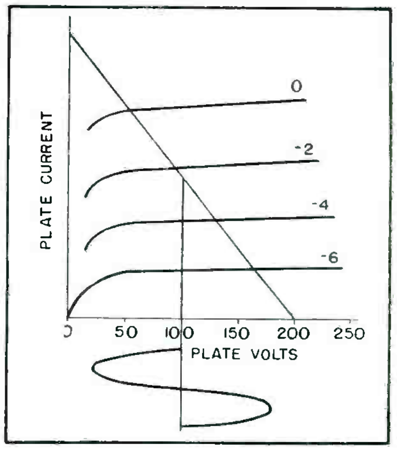

FIG. 1—Plate characteristic of a pentode in a stage of distributed amplifier

the grid reaches zero potential (or slightly negative) and the potential of its plate reaches about 20 volts when a sine wave of about 3 volts peak is applied to the grid line. If the receiving end of the plate line is opened T μsec later, this wave will reflect back to the plate of this particular tube. If the frequency of the applied signal is such that the next positive peak of the grid signal occurs at the same instant when the potential of the plate is reduced to 20 volts by the reflected wave, $f = 1/T$, the maxi-

mum variation in plate potential of the tube, due to this positive peak signal, is therefore less than 20 volts instead of 80 volts for the preceding positive peak. Thus, the gain is very different when the plate of a tube sees a half-wavelength opened line. However, at very low frequency, the electrical length of the plate line is very small compared with the wavelength of the applied signal, and this condition may not occur at all. Thus, the gain is different for different frequencies.

Figure 2 shows the plate characteristic of the same tube when a positive pulse is applied to the grid line. For example, at the instant when the plate potential is reduced to 20 volts by the reflected wave from the opened receiving end, the next applied pulse just reaches the grid of the same tube. Then the maximum variation in plate current of this particular tube is much less than that due to the preceding applied pulse, because the operating load line has been temporarily pushed to the knees of the characteristics. Thus, the amplification of the amplifier depends upon both the repetition frequency and the duration of the applied pulse.

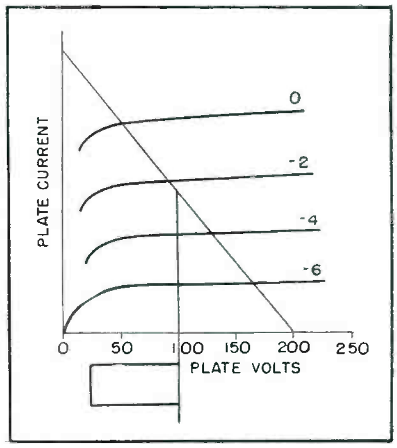

FIG. 2—Plate characteristic of same tube as shown in Fig. 1 with positive pulse applied to grid line

The conditions for constant amplification with the receiving end opened are: (1) the tube characteristics are perfectly linear, and (2) the quiescent plate potential is more than twice of the peak value of the output signal.

Unfortunately, the first condition is very difficult to be found with

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practical tubes and the second condition is very undesirable to establish in the output stage of a distributed amplifier. Precisely, open line can only be used in the output stage of a distributed amplifier, and usually the condition for maximum plate current swing, without exceeding the maximum allowable plate dissipation of a given tube, is the most important factor in the output stage.

Y. P. YU
Development Engineering Section
Instrument Division
Allen B. Du Mont Laboratories, Inc.
Clifton, New Jersey

Horn TV Antennas

DEAR SIRS:

SINCE you published my article entitled, "Horn Antennas for Television" (ELECTRONICS, Oct. 1951, p 84) I have received many queries and comments both personally and by mail. Some of the reports have been excellent and others very poor. The antenna as it stands is unfortunately quite difficult to keep up in the air during any kind of wind.

One slight error should be brought to the attention of your readers, however. It does not effect the final results, but as it stands the math is incorrect. The equation for dimension B_c should read

$$B_c = \frac{W_c}{2 \sin \phi/2} = \frac{0.5 \text{ cutoff}}{2 \sin 30°} = 0.5\lambda_c$$

In this article the 2 under the angle ϕ was omitted.

DEAN O. MORGAN
General Electric Company
Electronics Park
Syracuse, New York

Duality

DEAR SIRS:

AFTER PERUSAL of the article by Gordon Raisbeck entitled, "Transistor Circuit Design" in the December 1951 issue of ELECTRONICS (p 128), as well as the reference paper, "Duality as a Guide to Transistor Circuit Design", I would like to submit the following simple extension of the usual graphical method for the derivation of dual circuits, in support of Mr. Raisbeck's paper.

The method is outlined for stand-

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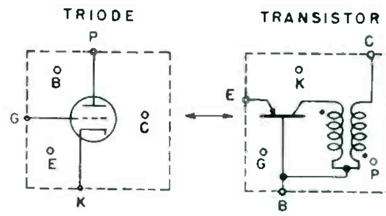
ard circuit elements in the book, "Transients in Linear Systems" by Gardner and Barnes beginning on page 46.

Vacuum tubes such as triodes (or tetrodes and pentodes with their screen grids held at fixed potentials) can be represented by their equivalent circuit using, for example, two independent remote-controlled voltage generators with series resistance and can thus be dealt with by the method. On inspection it will appear that the dual of the triode is the transistor and vice versa as pointed out by Raisbeck. To deal with these circuit elements graphically only the following very simple rules are required:



Proceeding from triode to transistor, the point C in the loop containing cathode and plate becomes the collector node; the point E in the loop containing cathode and grid becomes the emitter node; and the point B in the loop containing plate and grid becomes the base node.

Proceeding from transistor to triode, the point P in the loop containing base and collector becomes the plate node; point G in the loop containing base and emitter becomes the grid node; and point K in the loop containing collector and emitter becomes the cathode node.

In addition there is a 180-degree phase reversal either in the emitter or collector circuit (as shown) when proceeding from triode to transistor. When proceeding from a plain transistor (that is, one not containing a phase reversing transformer) to a triode, a phase reversing transformer should be included in the grid or plate circuit. This will not present any difficulty and can be omitted from some circuits.

Using this simple graphical method it is possible to construct the dual of any planar circuit con-

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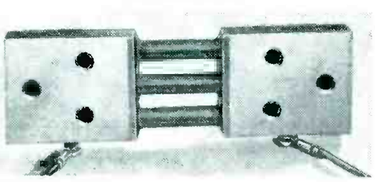

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BACKTALK (continued)

taining vacuum tubes (leading to transistors) or transistors (leading to vacuum tubes), of which many examples are given in the articles mentioned at the beginning of this letter.

HANNS J. WETZSTEIN
Graduate Student
Harvard University
Division of Applied Science
Cambridge, Mass.

Electronics Quiz

IN THIS MONTH'S brain teaser, the reader is asked to account for a seemingly peculiar chain of circumstances that actually happened to Elliott M. Barr of Rochester, New York. The story is as follows:

"During a particularly energetic thunderstorm, a group of students were studying in the dining room of a fraternity house at a midwestern university. A loud crash of thunder and flash of lightning plunged the house into darkness except for the pilot light and tube filaments in the radio in the adjoining living room, which had not been turned on before the crash.

"Playing a hunch, I suggested that as long as we could not study in darkness, we might as well listen to the radio. I turned the volume control knob, and as I did so, the light in the dining room came on. When one of the other students pulled the chain to try the lamp beside the radio, a loud woosh came from the radio along with a cloud of smoke, the house was plunged into total darkness, and the radio went off.

"I then replaced the fuse at the power meter in the basement and came back to find all lights on, but the radio was turned off with a large sign across it, "Out of Order DO NOT TURN ON". I calmly removed the sign, turned on the radio and thus proved it in normal working condition."

Can you account for these somewhat unusual happenings? The explanation will be published next month.

ELECTRONICS offers a payment of five dollars for problems used in this department. Readers are encouraged to submit likely problems (along with correct solutions) for consideration. The address is ELECTRONICS, 330 W. 42nd St., New York 36, N. Y.

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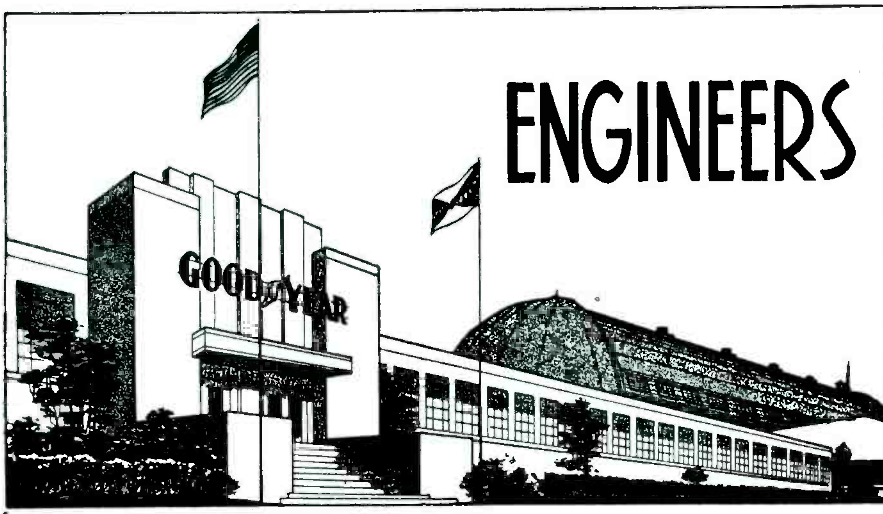

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CORNELL AERONAUTICAL LABORATORY, INC.
P. O. Box 235 Buffalo 21, New York

LOOKING AHEAD?

If you're a top performer in the field of physics, electronic engineering or design, and you're looking for a career as well as a well-paid position, it will pay you to investigate the excellent opportunity we offer.

• • •

BASIC QUALIFICATIONS: Minimum of four year's experience in advanced research or development related to:

- PULSE CIRCUITS
- COMPUTERS
- NUCLEAR INSTRUMENTS
- MINIATURIZATION

• • •

ILLUSTRATED BROCHURE on request. Please write (giving summary of your education and experience, plus salary requirements) to:

THE BERKELEY SCIENTIFIC CORP.
2200 Wright Avenue
RICHMOND, CALIFORNIA

ELECTRONIC ENGINEERS

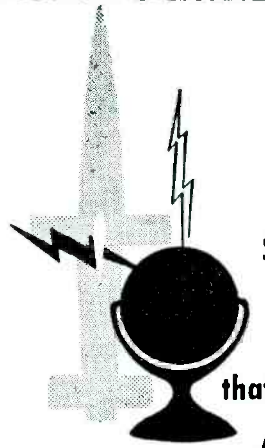
Electronic Engineers qualified by design experience on DC and wide band amplifiers, low power pulse circuitry, computers, telemetering or allied fields, should contact Tracerlab, Inc.

Tracerlab manufactures instruments of all types for the fast growing field of radioactivity and as one of the foremost leaders in this field, has much to offer its employees concerning security and fine opportunities for advancement.

Engineers who have had responsibility for design of electronic instruments in a manufacturing organization with supervision of Junior Engineers and Technicians are invited to write, giving a detailed outline of training and experience. Correspondence will be confidential. Selected applicants will be asked to come to Boston at our expense for interview.

Industrial Relations Department

TRACERLAB, INC.
130 High Street Boston 10, Mass.



ENGINEERS

Special opportunities for YOU in

SAN DIEGO

that sunshiny, smog-free city on the coast of

CALIFORNIA

Convair (Consolidated Vultee Aircraft Corporation) is now accepting applications for these following positions in its modern, progressive Engineering Department.

Microwave Engineers
Servomechanism Engineers
Electronics System Engineers
Electronic Circuit Designers

Unusual opportunities for those experienced in the design and analysis of Radar and Missile Guidance Systems.

WORKING FACTS: You get two holidays a week at Convair — overtime accomplished in 5-day week. Attractive salary ranges. An "engineers" engineering department . . . with stimulating, competent associates . . . and interesting, challenging, essential, long-range projects of a wide variety including — commercial aircraft, military aircraft, missiles, engineering research and electronic development. Excellent patent royalty arrangements. Top-notch retirement plan — better than-average life and health insurance. Complete progress-salary review for each person twice yearly. Opportunity for continuing engineering education.

LIVING FACTS: San Diego, with its wonderful residential areas, offers you and your family incomparable living. Ideal climate — cool, clean, dry. Mountains, desert, Mexico, Hollywood, Los Angeles, Pacific Ocean, beaches and bay — only hours or minutes away. It offers you a new way of Life... pleasant, refreshing, happy.

If you qualify, you will receive generous travel allowances. ***SEND COUPON*** for free booklets and complete information.

THANK YOU
Mr. H. T. Brooks, *Engineering Department* ***900***
Convair, 3302 Pacific Hiway, San Diego, California
Please send me ***FREE*** booklets describing the Convair Opportunity for me and my Convair Application Form.

My name ____________________

Occupation ____________________

Address ____________________

City ____________ State ____________

COLLINS RADIO COMPANY . . .

has excellent opportunities for electrical and mechanical engineers in the following fields:

RADIO COMMUNICATIONS
RADIO NAVIGATION
SERVO MECHANISMS
GYROS
ELECTRONICS
RADAR
COUNTER MEASURES
COMPUTERS
GUIDED MISSILES
AUTO PILOTS
AIRCRAFT INSTRUMENTS
SPECIFICATIONS
QUALITY CONTROL
TECHNICAL WRITING

● See Glenn G. Johnson or W. H. Bigger of the Collins Radio Company at the Waldorf Astoria during the IRE Convention in New York.

An association with Collins brings many advantages—opportunity to the limit of your capacity, salary commensurate with your ability, low cost insurance, hospitalization and surgical service. Selected applicants will be given trips to Cedar Rapids for interview. The requirement is a BS degree in an accredited four-year school.

COLLINS RADIO COMPANY
Cedar Rapids, Iowa
NEW YORK • DALLAS • BURBANK

STAVID ENGINEERING, INC.

has openings for Graduate

ELECTRONIC ENGINEERS
MECHANICAL ENGINEERS

Experience in Design and Development of Radar and Sonar necessary.

Broad knowledge of Search and Fire Control Systems; Servo Mechanisms, Special Weapons, Microwave, Antenna and Antenna Mounts, etc.

Mechanical Engineer should also have experience in packaging of Electronic Equipment to Gov't specifications including design of complex cabinets, shock mount and sway brace structures, Servo Mechanisms.

Positions are available in Field Service and Technical Writing.

Liberal personnel benefits including life, sickness and accident insurance, and a worthwhile pension system. Paid holidays and vacations.

Personnel Office
312 Park Ave.
Plainfield, N. J.
Telephone Dunellen 2-1400

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Long establsihed Precision Electronic Instrument Manufacturer plans permanent program of technical market research and customer contact. Program includes other interesting technical sales assignments.

●

Salary will be commensurate with ability. We are located in a desirable residential area. You will find room to expand your abilities in our organization. Please send resume of education and experience to Sales Manager.

Position requires man with B S in E E or equivalent and 6 to 10 years' experience in one or more of the following: ELECTRONIC INSTRUMENT DESIGN OR DEVELOPMENT, GENERAL ELECTRONIC SYSTEMS OR CIRCUIT ENGINEERING, TECHNICAL SALES ENGINEERING.

BOONTON RADIO CORP.

BOONTON, N. J.

WANTED

ELECTRONIC ENGINEER

Excellent position in expanding corporation for a man who can take charge of the development of electronic instruments for the geophysical field. Practical engineer, preferably geophysical, theoretical background in low-frequency networks and amplifier design, and at least a B.S. in EE required. This is a top opportunity for a man with initiative.

Reply, in full detail, to:

Chief Engineer

Century Geophysical Corporation
1339 North Utica Tulsa, Okla.

OUTSTANDING OPPORTUNITIES FOR PERMANENT POSITION as Mechanical Engineer

In large capacitor manufacturing concern located in the East. Executive ability to direact designers and draftsmen in prepaartion of manufacturing specifications of paper dielectric capacitors, pulse networks and radio noise filters.

P-3201, Electronics
330 W. 42 St., New York 36, N. Y.

Aeronautical

Operators—Technicians—Electronic Engineers

Excellent opportunity with 20-year aeronautical communications firm for FCC licensed fone and telegraph operators and technicians. Also need advanced technicians and practical research personnel (licenses not required) for quality control work in electronics. Domestic and foreign assignments available—liberal foreign allowance. Ham background desirable.

Box 2802—Washington 13, D. C.

ENGINEERS - TRANSFORMER

Opportunity—Capable Men

Well established Chicago Concern has excellent opportunities in both Chicago and Southern California plants for qualified engineers experienced in Transformer design and development, particularly in the hypersil type. Must be familiar with Mil T 27 specifications. Salary commensurate with ability. Our employees know of this ad. Please send resume to Director of Personnel.

P-3304, Electronics
330 W. 42 St., New York 36, N. Y.

OPPORTUNITIES
FOR EXPERIENCED

ELECTRON TUBE ENGINEERS

RAYTHEON MFG. COMPANY
SPECIAL TUBE SECTION

JOIN THIS ESTABLISHED ORGANIZATION AND BECOME A PART OF THEIR LONG RANGE EXPANSION PROGRAM. PLANT LOCATED IN RESIDENTIAL SUBURB OF BOSTON, THE EDUCATIONAL AND INDUSTRIAL HEART OF NEW ENGLAND.

- EXCELLENT OPPORTUNITIES TO IMPROVE FORMAL EDUCATION
- PERIODIC SALARY AND PROMOTION REVIEW
- HOSPITALIZATION & MEDICAL INSURANCE
- RETIREMENT PROGRAM
- EXCELLENT LIVING CONDITIONS
- SALARIES COMMENSURATE WITH ABILITY

MINIMUM REQUIREMENTS:

1. At least two years' experience, or equivalent, in electron tube manufacture, design, research or development.
2. Outstanding record of achievement in this field.

If interested, send complete resume, including salary expected, to:

G. W. Lewis, Personnel Mgr.
RAYTHEON MFG. COMPANY
RECEIVING TUBE DIVISION
55 CHAPEL STREET
NEWTON 58, MASS.

ELECTRONIC COMPONENTS SPECIALIST

Graduate engineer thoroughly experienced in design and production of electronic components, such as capacitors, resistors, transformers, etc., to consult and engage in full-time research in broad field of electrical engineering. Unusual opportunities for professional growth and advancement in large progressive research organization. Prompt, confidential handling of all applications. Please reply directly to

BATTELLE MEMORIAL INSTITUTE
505 King Avenue
Columbus 1, Ohio

ELECTRONIC PROJECT ENGINEER

An opening for a Project Engineer to take over, after an indoctrination period, the direction of a major sonar development, is now available. A first class background in electronic design with at least 2 years experience as a project or assistant project engineer on a military electronic project is required. Sonar experience is desired but is not necessary. Our sonar activity is expanding both in commercial and military applications and offers an excellent opportunity for a qualified man. Please contact P. J. Lynn, Pacific Division,

BENDIX AVIATION CORP.
North Hollywood, Calif.

engineers... physicists... chemists... metallurgists...

GENERAL ELECTRIC
Can Mean A Turning Point in Your Career

In terms of personal satisfaction, assured professional advancement, diversification, and prestige, you can give new impetus to your career through these positions now open with General Electric in: Advanced Development, Design, Field Service, and Technical Writing, in connection with:

MILITARY RADIO & RADAR
MOBILE COMMUNICATION
MULTIPLEX MICROWAVE COMMUNICATIONS
ELECTRONIC COMPONENTS
TELEVISION, TUBES and ANTENNAS

Bachelor's or Advanced Degree in Electrical or Mechanical Engineering, Physics, Metallurgy or Physical Chemistry and/or experience in the Electronics industry necessary.

Please send resume to:

DEPT. 23A, TECHNICAL PERSONNEL
ELECTRONICS PARK
GENERAL ELECTRIC
SYRACUSE, N. Y.

ELEC. ENGRS. AND PHYSICISTS

Need scientific personnel for developmental work pertaining to balloons. Prefer advanced degrees and some research experience involving communications, instrumentation, telemetering, servomechanisms, gas generation, low temperature research, flight operations, or related problems. Salaries commensurate with experience. Liberal employee benefits, including moving expenses both ways. Submit details of background to:

Employment Bureau
Rm. 17, Adm. Bldg.
University of Minnesota
Minneapolis 14, Minn.

METERS

I MA OC 3½" R DeJur Mod 310 (0-4KV scale) .$5.75
3MA DC 2½" R—Simpson black scale 3.35
500 Microamps. OC—2½" round—Sun 4.30
Ima. DC Fan type—4" scale (rem. from equipt) 3.95
500 ma. OC 2½" R.—General Electric 2.95
2 amp. RF 2½" Sq.—Simpson 3.15
5 amp. AC 4½" R.—JBT 4.11
30 V DC 2½" R—General Electric 3.95
3 amp. RF 3½" R.—Weston 6.00

OIL-FILLED 35 KV AND 50 KV ISOLATION TRANSFORMERS

Pri. 460V 60 cy. Sec. 115V 200 VA Insulated for 50KV DC—G. E. Form EIR—36"H x 13" D $125.00
Pri. 115V 60 cy. Sec. 115V 250 VA Insulated for 35 KV DC—G. E. Form EIR—29"H x 12½"D $125.00

VOLTAGE DIVIDER

G.E. Cat. 8248886G-I and 9001934G-I 17,246,400 ohms 35KV 70:1 ratio wire wound shielded oil-filled 40"H x 12"D $77.50

2 ϕ LOW INERTIA SERVO MOTORS

DIEHL Type FPE 25-11 75 Volt 60 cycle 4 watts—new $34.50
KOLLSMAN—45 Volt 60 cycle 4 watts 1500 RPM—new $22.50

OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price
2	400	$.55	3	2000	3.75
5–5	400	1.65	12	2000	8.95
1	600	.55	1	2500	2.75
2	600	.69	1–1	2500	3.85
2	600R'd	.69	32	2500	15.80
2–2	600R'd	1.65	.5	3000	2.40
3	600	.95	2	3000	4.50
4	600	1.65	.03	4000	1.25
4	600R'd	1.65	3 x .2	4000	2.95
5	600	1.75	2	4000	6.95
6	600	1.85	.1	5000	1.60
8	600R'd	1.85	.2	5000	2.50
8–8	600	1.95	1	5000	4.88
4-4-4	600	2.50	.01–.03	6000	1.65
4 x 3	600	2.50	.1	7000R'd	1.79
1	1000	.65	.1	7500	2.85
2	1000	.90	.1–.1	7500	5.95
2	1000R'd	.95	1	7500	12.50
3.5–.5	1000	1.85	.075–.075	8KV	6.50
4	1000	1.95	.1	12KV	8.95
6	1000	2.50	.045	16KV	4.70
8	1000	3.25	.05	16KV	4.95
1	1200	.85	.075	16KV	8.95
1–1–1	1200	1.85	.25	20KV	19.95
.1	1500	.59	1–3	330VAC	1.95
.5	1500	1.25	10	330VAC	3.95
3	1500	2.50	12.75	330VAC	4.10
4	1500	2.95	15	330VAC	4.50
.1–.5	2000	.95	5	440VAC	3.10
.25	2000	1.50	2.9	660VAC	3.50
.3	2000	1.30	7	660VAC	4.2
1	2000	1.95	8	660VAC	4

OILMITES

MFD	VDC	TYPE	Price
.02	600	OM-6002	$ .45
.05	600	OM-6005	.48
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.60
1.0	600	OM-601	.85

HIGH VOLTAGE TRANSFORMERS

G.E.—Pri. 115V 60 cy. Sec. 6250V 80 MA—12.5 KV insulation $18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV insulation $18.50
Raytheon—Pri. 115V 60 cy. Sec. 8500/6450V CT 43 MA Hermetically sealed $22.50

ANTENNAS

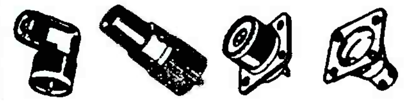
AT-38A/APT (70 to 400MC) $13.70
AT-49/APR-4 (300 to 3300MC) 13.70
AN-74B (125 to 150MC) 3.25
AN-65A (P/O SCR-521) 1.50
AN-66A (P/O SCR-521) 1.75
AIA-3CM conical scan 125.00
ASB Yagi—5 element 450 to 560MC 7.00
ASB Yagi—Double stacked 6 element 12.70
ASA Yagi—Double stacked 370 to 430MC 29.40

RELAYS

Sigma type 4AH—2000Ω 4 ma DC coil—SPDT contacts—hermetically sealed 5 pin plug-in base $3.30
Sigma type 4R—8000Ω I ma DC coil—SPDT contacts—enclosed type 5 pin plug-in base $4.25
Stevens Arnold type 171 Millisec relay—900 ohm coil—SPST NO contacts $5.50
Cutler-Hammer and Square D type B-7A contactor—24 VDC coil—SPST NO 200 Amp contacts...$4.75
Price Bros. type 161-M—220 VAC contactor—SPST NO double bk 30A contacts $3.25
G.E. CR5181-IA6—115 V 60 cy. AC contactor—4PST 30 Amp contacts plus two auxiliary SPDT contacts $14.50
RBM—115 V 60 cy. AC coil—DPDT 3 Amp contacts $3.20
Leach type 1521—115 V 60 cy. AC coil—SPST NO double bk 15 Amp contacts—mycalex insul...$3.25
Cramer type IC2H—110 V 60 cy. Interval timer—two SPST 15 Amp contacts (on 1 hr. off 1 hr.)..$3.95
Sperti IS21 vacuum relay switch (for AN/ART-13) $9.50
G.E. 561 vacuum relay switch SPDT 15 Amp contacts $3.50

Terms 20% cash with order, balance C. O. D. unless rated. All prices net F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS



83-1AC	$ .42	83-1RTY	$ .65	83-22R	$ .68
83-1AP	.30	83-1SP	.50	83-22SP	1.15
83-1F	1.30	83-1SPN	.60	83-22T	1.95
83-1H	.10	83-1T	1.30	83-168	.15
83-1HP	.25	83-2AP	1.95	83-185	.15
83-1J	.80	83-22AP	1.40	83-765	.24
83-1R	.40	83-22F	2.10	83-776	.85
		83-22J	1.50		

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UHF—N—PULSE—BN—BNC

UG-7/AP	$6.30	UG-83/U	$1.85	UG-185/U	$1.60
UG-12/U	.95	UG-85/U	1.75	UG-191/AP	.80
UG-15/U	1.50	UG-86/U	2.50	MX-195/U	.75
UG-18/U	1.25	UG-87/U	1.60	UG-197/U	2.80
UG-19/U	1.80	UG-88/U	1.35	UG-201/U	1.95
UG-21/U	.95	UG-89/U	1.60	UG-203/U	.85
UG-21A/U	1.50	UG-90/U	1.60	UG-206/U	1.80
UG-21B/U	1.35	UG-98/U	1.85	UG-224/U	1.40
UG-22/U	1.35	UG-102/U	1.15	UG-236/U	3.85
UG-22B/U	1.65	UG-103/U	.68	UG-245/U	2.30
UG-23/U	1.20	UG-104/U	1.40	UG-254/U	2.75
UG-23B/U	1.90	UG-106/U	.15	UG-255/U	2.45
UG-24/U	1.30	UG-108/U	2.60	UG-260/U	1.35
UG-25/U	1.35	UG-109/U	2.60	UG-261/U	1.60
UG-27/U	1.30	UG-146/U	2.55	UG-262/U	1.60
UG-27A/U	2.95	CW-159/U	.60	UG-273/U	2.25
UG-29/U	1.55	UG-166/U	32.50	UG-274/U	2.75
UG-30/U	2.30	UG-167/U	5.85	UG-275/U	5.50
UG-34/U	16.50	UG-171/U	2.80	UG-276/U	2.75
UG-36/U	17.50	UG-173/U	.40	UG-290/U	1.35
UG-37/U	17.50	UG-175/U	.15	UG-291/U	1.75
UG-57/U	2.30	UG-176/U	.15	UG-306/U	2.95
UG-58/U	.80	UG-177/U	.24		

QUOTATION UPON REQUEST ON ANY CONNECTORS NOT LISTED HERE

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201
93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$140.00	RG-22/U	$150.00
RG-6/U	180.00	RG-22A/U	285.00
RG-7/U	85.00	RG-24/U	675.00
RG-8/U	135.00	RG-26/U	475.00
RG-9/U	250.00	RG-29/U	50.00
RG-9A/U	275.00	RG-34/U	300.00
RG-10/U	240.00	RG-35/U	900.00
RG-11/U	135.00	RG-54A/U	97.00
RG-12/U	240.00	RG-55/U	110.00
RG-13/U	216.00	RG-57/U	325.00
RG-17/U	650.00	RG-58/U	65.00
RG-18/U	900.00	RG-58A/U	80.00
RG-19/U	1250.00	RG-59/U	70.00
RG-20/U	1450.00	RG-62/U	75.00
RG-21/U	220.00	RG-77/U	100.00

ADD 25% TO PRICES SHOWN FOR QUANTITIES UNDER 500 FT.

CRYSTAL DIODES

1N21	$1.19	1N23	$1.95	1N34	$ .79
1N21A	1.69	1N23A	3.25	1N34A	.95
1N21B	4.00	1N23B	5.25	1N45	.94
1N22	1.09	1N27	1.79	1N52	1.05

TYPE "J" POTENTIOMETERS

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1/8"	10K	3/8"	200K	3/8"
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1 Meg	SS
2500	SS	40K	SS	2.5 Meg	SS
4K	SS	50K	SS	5 Meg	SS
5K	SS	50K	1/4"		

DUAL "JJ" POTENTIOMETERS

50	SS	500	SS	1 Meg	SS
100	SS	1K	SS	2.5 Meg	SS
250	SS	2500	SS	5 Meg	SS
330	SS	10K	SS	1K/25K	3/8"

TRIPLE JJJ POTENTIOMETERS

100K/100K/100K—3/8"   20K/150K/15K—1/8"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A260   W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH
TS-10 Type Handsets .... $8.92 ea.

GENERATORS AND INVERTERS

Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output-AC 115V 10.4A 800 to 1400cy. 1ϕ; DC 30 Volts 60 Amps. Brand new $38.50
Eclipse-Pioneer type 1235-1A. Output-30 Volts DC 15 Amps. Brand New-Original Packing $15.50
PE-218 Inverters-28 VDC to 115 VAC 400 cy 1500 VA. (New) $49.50
G. E. 5D21NJ3A Inverter-24 VDC to 115 VAC 400 cy 485 VA (New) $32.50
Pioneer Type 800-1B Inverter-28VDC to 120V 800 cy 7 amp AC (used) $22.65
G. E. Inverter-28VDC to 120 VAC 800 cy 750 VA 1ϕ $39.50
ATR Inverter 6VDC to 110 VAC 60 cy 75W ... $22.95
PU-7/AP Inverter-28VDC to 115 VAC 400 cy 2500 VA (used) $75.00
Eclipse Pioneer type 12121A Inverter—Voltage and frequency regulated—24VDC 18 Amp input—AC output 115V 3ϕ 400 cy 250VA 0.7 PF—(New) $225.00

TEST EQUIPMENT

- Gen. Radio 475B Frequency Monitor *$200.00
- Gen. Radio 681A Freq. Deviation Meter .. *$87.50
- I-222A Signal Generator *$79.50
- I-72K Signal Generator $48.50
- C-D Quietone Filter Type IF-16 110/220V AC/DC 20 Amps. *$9.00
- TS-127/U Freq. Meter w/spares $69.50
- TS-143/CPN Oscilloscope *$95.00
- Dumont 175A Oscilloscope *$225.00
- Gen. Radio 757-P1 Power Supply *$27.00
- TS-6/AP Frequency Meter *$42.00
- I-130A Signal Generator *$85.00
- A.W. Barber Labs. VM-25 VTVM *$86.00
- TS-10A/APN Delay Line Test Set $45.00
- TS-19/APQ-5 Calibrator $78.00
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars $39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC $11.75
- 3 CM Pickup Horn Antenna AT-48/UP .. $9.95
- I-138A Signal Generator—10 cm *$185.00
- BC-221 Frequency meter *$95.00
- BC-221 Freq. Meter (late models) *$125.00

All items New Except Where noted * (Exc. Used Condition

MISCELLANEOUS EQUIPMENT

I-82F Selsyn Indicator $6.95
SCR-515 compl. w/dynamotor, control box 69.50
Amperex 1B98 Gamma Counter 9.87
Powerstat 1226—115/230V input—0-270V out @ 9 amp 37.00
EIMAC 35T Ionization Gauge 5.95
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
FL-8 1020 cycle filter 2.95
RM-29 remote control unit 8.95
RM-14 remote control unit 8.95
RTA-1B 12/24 V dynamotor 40.00
BC-1206-CM2 Receiver 12.95
CY-230/MPG-1 Radar Console 575.00
ASB-4 Radar equip. Complete 69.75
RCA AVR-15 Beacon Recvr 18.50
Navy SD-3 Radar complete 1200.00
Navy DP-14 Direction Finder complete 385.00

PULSE TRANSFORMERS

UTAH 9262 9278 9280	UTAH 9318 9340 9350
G.E. 68G-627	Westinghouse 232-AW2
G.E. 68G828	Westinghouse 232-BW-2
G.E. 68G929GI	AN/APN-4 Block Osc.
G.E. 80G13	Philco 352-7149
G.E. K-2469A	Philco 352-7150
G.E. K-2744B	Philco 352-7071
AN/APN-9 (901756-501)	Philco 352-7178
AN/APN-9 (901756-502)	Raytheon UX-7350
AN/APN-9 (352-7250)	W.E. D-161310
AN/APN-9 (352-7251)	W.E. D-163247
Westinghouse 132-AW	W.E. D-163325
Westinghouse 139DW2F	W.E. D-164661
Westinghouse 187AW2F	W.E. KS-9563

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A, and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sine-wave modulated signals received by AN-APR-1, AN/APR-2, AN-APR-4, AN/APR-5, BC-348, S-27, SX-28. BRAND NEW $147.50

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P. 7.5 KV, "E" Circuit 1 Microsec. 200 PPS 67 ohms Imped, 3 sections $4.30
7.5 E3-3-200-67P. 7.5 KV. "E" Circuit 3 microsec. 200 PPS, 67 ohms Imped. 3 sections $6.75
7.5 E4-16-60-67P. 7.5 KV. "E" Circuit 4 sections. 16 microsec. 60 PPS. 67 ohms Imped $8.25
15 E4-.91-400-50P. 15KV. "E" circuit .91 microsec. 400 PPS. 50 ohms imped. 4 sections $16.50
15-A-1-400-50P. 15KV. "A" Circuit, 1 microsec. 400 PPS, 50 ohms imped $37.50

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST.   PHILA. 6, PA.
Telephones - MARKET 7-6771-2-3

GUARANTEED BRAND NEW

LECTRONIC RESEARCH

TUBE SPECIALS

STANDARD BRANDS ONLY

Receiving Tubes	
0OA	$1.50
01A	.67
0Z4	.74
0Z4A	.90
1A3	.99
1A5GT	.72
1A6	.99
1A7GT	1.10
1AB5	.96
1B3GT	.99
1B4P	1.17
1C5GT	.99
1C6	.69
1C7G	.69
1D5GP	.69
1D7G	.69
1D8GT	1.17
1E5GP	1.17
1F4	.69
1F5G	.69
1F6	.89
1G4GT	.69
1G5G	.69
1G6GT	.69
1H4G	.89
1H5GT	.74
1H6G	.99
1H6GT	1.10
1J5G	1.19
1J6G	.99
1L4	.74
1LA4	1.10
1LA6	1.10
1LB4	1.10
1LC5	.99
1LC6	1.10
1LD5	1.10
1LE3	1.10
1LH4	1.10
1LN5	.91
1N5GT	.93
1N6G	.97
1P5GT	.99
1Q5GT	.99
1R4	.69
1R5	.89
1S4	.93
1S5	.93
1T4	.93
1T5GT	.99
1U4	.93
1U5	.81
1V	.88
1X2	1.20
2A3	1.28
2A5	.79
2A7	.89
2B7	.79
2E5	.94
2X2	.89
2X2A	1.85
3A4	.65
3A5	1.89
3A8GT	2.25
3B7	.69
3C6	1.15
3D6	.69
3LF4	1.10
3Q4	.93
3Q5GT	1.10
3S4	.93
3V4	.93
5AZ4	.69
5T4	2.20
5U4G	.69
5V4G	1.20
5W4	.82
5X4G	.87
5Y3GT	.59
5Y4G	.75
5Z3	.87
5Z4	1.20
6A4	1.35
6A6	1.17
6A7	1.05
6A8	1.23
6AB4	.99
6AB7	1.39
6AC5GT	1.35
6AC7	1.45
6AC7W	3.25
6AD6G	.98
6AD7G	1.39
6AE6G	.89
6AF6G	1.19
6AG5	1.19

6AG7	1.59
6AH6	1.56
6AJ5	2.50
6AK5	1.85
WE-6AK5	2.85
6AK5W	3.05
6AK6	.99
6AL5	.69
6AL5W	2.90
6AQ5	.89
6AQ6	.79
6AR5	.79
6AS5	.99
6AS6	3.30
6AS7G	4.53
6AT6	.63
6AU5GT	1.32
6AU6	.69
6AV6	.63
6B4G	1.60
6B5	1.20
6B7	1.19
6B8	.99
6B8G	.85
6BA6	.72
6BA7	1.20
6BC5	.88
6BC7	1.10
6BD5GT	1.60
6BD6	.99
6BE6	.72
6BF5	1.10
6BF6	.83
6BG6G	1.92
6BH6	.99
6BJ6	.99
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.65
6C5	.75
6CB6	.89
6C6	.88
6C8G	1.35
6CD6G	2.40
6D6	.88
6D8G	.99
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.99
6F7	1.05
6F8G	1.60
6G6G	1.06
6H6	.83
6H6GT	.83
6J5	.75
6J5G	.64
6J5GT	.64
6J6	1.19
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.69
6K7	.88
6K7G	.88
6K8	1.22
6K8GT	.96
6L5G	1.06
6L6	2.13
6L6G	1.99
6L6GA	1.75
6L7	1.08
6L7G	.95
6N7	1.44
6N7GT	1.20
6P5GT	.96
6Q7	.99
6Q7G	.89
6R7	.99
6S4	.72
6S7	1.06
6S7G	.99
6SA7	.99
6SA7GT	.89
6SB7Y	1.05
6SC7	1.20
6SC7GT	1.05
6SD7GT	1.10
6SF5	.83
6SF5GT	.80
6SF7	.69
6SG7	.91
6SH7	.99
6SH7GT	.99
6SJ7	.89
6SJ7GT	.89

6SK7	.89
6SK7GT	.89
6SL7GT	1.05
6SN7GT	.89
6SN7WGT	2.30
6SQ7	.75
6SQ7GT	.75
6SR7	.81
6SS7	.99
6ST7	1.25
6T7G	1.09
6T8	1.28
6U5	1.19
6U7G	.88
6V6	1.60
6V6G	.89
6V6GT	.79
6W4GT	.72
6W6GT	.99
6X4	.59
6X5GT	.59
6Y6G	1.19
6ZY5G	.89
7A4	.89
7A5	1.08
7A6	.89
7A7	.89
7A8	.89
7AD7	1.44
7AH7	1.08
7B4	.89
7B5	.89
7B6	.89
7B7	.89
7B8	.89
7C4	.69
7C5	.89
7C7	1.08
7E5	1.20
7E6	.79
7E7	1.06
7F7	1.09
7F8	1.59
7G7	1.32
7H7	.99
7J7	1.32
7K7	1.32
7L7	1.32
7N7	1.09
7Q7	.99
7R7	1.08
7S7	1.32
7V7	1.32
7W7	1.32
7Y4	.89
7Z4	.89
10	.45
12A	.79
12A6	.89
12A6GT	.79
12A7	1.16
12A8GT	.89
12AH7GT	1.32
12AL5	.89
12AT6	.59
12AT7	1.15
12AU6	.79
12AU7	.95
12AV6	.63
12AW6	1.20
12AX7	1.08
12BA6	.72
12BA7	.95
12BD6	.99
12BE6	.70
12C8	.89
12F5GT	.79
12H6	.69
12J5GT	.69
12K8	.99
12Q7GT	.89
12SA7	.89
12SA7GT	.89
12SF5	.79
12SF5GT	.79
12SF7	.79
12SG7	.99
12SH7	.89
12SJ7	.89
12SJ7GT	.89
12SK7	.81
12SL7GT	1.03
12SN7GT	.99
12SQ7GT	.79
12SR7	.89
12X3	1.19
12Z3	.89
14A4	1.32

14A7	1.09
14B6	1.09
14B8	1.09
14C5	1.29
14C7	1.15
14E6	1.09
14E7	1.29
14F7	1.09
14H7	1.15
14J7	1.29
14N7	1.29
14R7	1.29
14W7	1.29
14X7	1.29
19	.89
19T8	1.16
22	1.16
24A	.79
25A6	1.16
25L6GT	.89
25Z5	.99
26	.79
27	.69
28D7	1.75
30	.72
30 Spec	.48
31	.62
32	.99
32L7GT	1.29
33	.99
34	.99
35/51	.79
35A5	.89
35B5	.99
35L6GT	.89
35W4	.55
35Y4	.89
35Z4GT	.69
35Z5GT	.59
36	.69
37	.69
38	.69
39/44	.59
41	.99
42	.89
43	.89
45	.89
45Z5GT	.79
46	.99
47	.99
48	1.60
49	1.19
50	1.41
50A5	1.09
50B5	.88
50C5	.88
50L6GT	.79
50Y6GT	.92
53	.95
55	.99
BK55E	.40
L55B	.32
56	.69
57	.89
58	.89
59	1.24
70L7GT	1.52
71A	.79
75	.89
76	.69
77	.69
78	.79
79	.89
80	.65
81	1.41
82	1.19
83	1.59
83V	1.45
84/6Z4	.79
85	.79
89Y	.55
117L7GT	1.89
117P7GT	1.89
117Z3	.74
117Z6GT	.97
FM-1000	1.59
Cathode Ray Tubes	
2AP1	$9.75
2AP5	9.75
3AP1	10.25
3AP4	10.25
3BP1	7.95
3CP1	2.25
3DP1	4.85
3DP1A	6.75
3EP1	4.95

3FP7	4.95
3GP1	4.95
3HP7	4.91
4AP10	4.75
5AP1	5.95
5AP4	4.75
5BP1	5.75
5BP4	5.75
5CP1	4.95
5CP7	9.50
5FP7	4.95
5HP1	5.75
5HP4	5.75
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	19.75
5LP5	19.75
5MP1	10.65
7BP1	8.75
7BP7	7.95
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	12.85
9LP7	9.95
10BP4	18.50
10FP4	24.50
12DP7	16.50
12GP7	16.50
12HP7	16.50
902P1	9.95
905	4.45
Photo Cells	
1P23	$4.10
1P24	1.27
918	1.65
919	1.95
923	1.35
927	1.85
931A	6.95
1645	1.95
Thyratrons & Ignitrons	
OA4G	$1.32
EL-C1A	4.75
2A4G	1.25
2B4	2.10
2C33	4.95
2D21	1.80
3C23	9.95
3C31/EL-C1B	3.95
3C45	17.50
4C35	28.75
EL-C5B	9.95
5C22	53.45
C6J	9.95
FG-17/5557	5.25
FG-33	17.50
FG-41	122.50
FG-67	14.80
FG-81A	4.95
91	7.85
FG-95/5560	25.00
FG-104/5561	24.60
FG-105	19.50
FG-166	95.00
FG-172	39.50
FG-178	14.50
RX-233A	4.95
FG-235A/5552	94.50
FG-271/5551	62.50
393A	8.60
394A	4.77
GL-415/5550	39.50
KU-610	12.50
KU-623	39.50
KU-628	22.25
KU-634	39.50
WL-652/5551	62.50
WL-654/659	82.00
WL-672	22.00
WL-677	39.50
WL-681/5550	39.50
722A	3.75
884	1.85
885	1.90
1665	1.80

1904	13.95
2050	1.80
2051	1.15
5545	32.50
Transmitting & Special Purpose Tubes	
OA2	$1.69
OA3	1.51
OB2	1.88
OB3	1.29
OC3	1.20
OD3	1.15
1B21A	2.85
1B22	3.25
1B23	9.95
1B24 (West)	12.95
1B24 (Sylv)	18.95
1B26	3.73
1B27	19.50
1B29	2.90
1B32	3.95
1B35	12.50
1B36	12.50
1B38	32.50
1B42	9.80
1B54	32.50
1H20	.88
1S21	9.50
1Z2	3.75
2B22	2.20
2C21	.75
2C22	.75
2C26	.49
2C26A	.49
2C34	.49
2C39	22.00
2C40	16.25
2C42	26.50
2C43	22.50
2C44	1.50
2C46	29.50
2C51	5.75
2E22	1.85
2E24	4.10
2J21A	9.95
2J22	9.95
2J26	26.50
2J27	24.50
2J31	39.50
2J32	42.50
2J33	39.50
2J34	39.50
2J36	85.00
2J37	13.70
2J38	17.50
2J39	49.50
2J40	39.50
2J41	175.00
2J48	27.50
2J49	65.00
2J50	39.50
2JB51	2.50
2J55	87.50
2J56	150.00
2J61	45.20
2K23	37.50
2K25	33.50
2K26	107.15
2K28	34.50
2K29	26.00
2K33	295.00
2K45	145.00
2K54	135.00
2K55	135.00
2X2A	1.85
3B22/EL-1C	2.95
3B23	4.75
3B24	5.25
3B24W	7.95
3E25	4.50
3B26	3.75
3B27	3.95
3C24	1.85
3C27	6.95
3D21	1.98
3D21A	2.25
3E29	14.50
3J31	95.00
4-125A	29.50
4A1	1.18
4B22/EL-5B	8.95
4B24	5.75

4B25/EL-6CF	8.95
4E27	17.25
4J36	150.00
4J38	120.00
4J50	375.00
4J52	400.00
5D21	26.50
5J23	24.50
5J29	18.50
C6A	5.75
6-8B	.85
6AN5	5.95
6AR6	3.35
6C21	29.50
6C24	52.50
6J4	7.95
7-7-11	1.19
10T1	.88
10Y	.45
13-4	.80
15E	2.35
15R	.95
REL-21	2.25
24G	1.85
RK-25	3.82
FG-32/5558	6.75
RK-34	.49
35T	4.95
35T Ion gauge	5.95
35TG	4.95
REL-36	.78
RK-47	4.92
EF-50	.79
VT-52	.65
53A	5.60
RK-59	2.44
RK-60	1.95
VT-62(Br)	1.15
RK-63	22.50
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
VR-75/OA3	1.51
75T	5.80
VR-78	.64
VR-90/OB3	1.29
VT-98 (Br)	115.00
C100E	2.30
100R	2.90
100TH	10.25
WE-101D	1.65
WE-101F	3.62
WE-102F	2.85
VR-105/OC3	1.20
WE-113A	1.32
HY-114	.75
WE-117A	.95
F-123A	8.95
WE-124A	3.80
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150/OD3	1.15
FG-190	12.15
HF-200	16.50
203A	7.40
203B	6.33
204A	49.50
CE-206	3.15
211	.95
WE-211D	12.50
WE-211E	12.50
212E	42.50
WE-215A	.24
217C	8.95
221A	1.95
227A/5C27	4.60
WE-231D	2.25
232CH	240.00
WE-244A	5.20
WE-245A	2.35
WE-249B	3.50
WE-249C	3.50
250TH	22.50
250TL	22.50
WE-252A	5.65
WE-254A	5.90

WE-257A	3.77
WE-271A	6.75
WE-275A	6.95
WE-283A	4.25
WE-285A	5.57
WE-286A	7.90
WE-294A	5.75
WE-301A	5.95
304TH	15.00
304TL	15.00
307A	5.50
WE-309A	6.45
WE-310A	7.50
WE-313C	4.15
316A	.89
327A	4.25
WE-331A	9.75
WE-343A	185.00
WE-346A	2.75
350B	4.95
354C	19.50
WE-356B	5.45
361A	4.75
371A	.95
371B	.95
388A	2.95
WE-399A	4.70
417A	16.95
434A	17.50
446	1.95
446A	1.95
446B	2.25
450TH	42.50
450TL	42.50
451	1.39
471A/1B21A	2.75
SS-501	12.50
503AX	1.65
506AX	1.47
507AX	1.47
527	12.25
530	17.20
531	8.25
532A	3.95
WL-533	115.00
559	2.20
561	3.50
HY615	.49
WL670A	8.70
700A	24.50
700B	24.50
700C	24.50
700D	24.50
702A	2.95
702B	4.25
703A	6.95
704A	.95
705A	2.75
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	9.95
707B	22.50
708A	4.85
709A	4.87
710A	1.70
713A	1.45
714AY	6.95
715A	6.75
715B	12.75
715C	26.50
717A	1.47
718AY	45.00
718BY	45.00
WE-719A	26.50
720CY	75.00
720DY	75.00
721A	4.90
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	8.95
726A	8.50
726B	45.00
730A	25.00
731A	2.45
WL-787	9.80
788Y	1.40
800	1.88
801A	.48
803	4.95
804	8.95
805	4.50

806	24.50
807	1.70
808	2.65
809	2.40
810	10.95
811	3.60
813	9.50
814	3.95
815	2.75
816	1.45
826	1.45
828	13.48
829	9.95
829A	14.50
829B	14.50
830B	3.95
832	7.95
832A	9.95
836	3.50
837	1.85
838	3.25
841	.49
843	.59
845	5.75
849	29.50
851	67.00
852	22.60
860	4.95
861	24.50
864	.39
865	1.28
866A	1.48
869B	35.00
872A	3.95
874	1.45
876	1.60
878	1.85
886	3.50
954	.39
955	.49
956	.49
957	.49
958A	.69
959	1.50
991	.45
1003	.90
CK-1005	.79
E-1148	.35
1201	1.20
1203	.69
1291	.69
1294	.69
1299	.69
1602	2.25
1613	1.20
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.30
1624	1.95
1625	.45
1626	.39
1629	.39
1630	.95
1631	1.38
1636	3.10
1638	.70
1641	1.95
1642	.75
1644	1.17
1655	1.90
1960	.70
5611	135.00
5654	5.85
5691	7.75
5692	7.75
5693	6.40
UX-6653	.65
7193	.75
8005	5.95
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8016	1.05
8020	1.39
8025	6.95
9001	1.75
9002	1.50
9003	1.75
9004	.55
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

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AY-120D	5B	5G	7G	X	C-56701	C-78410	C-78670
AY-130D	5CT	5N	A	2J1F1	C-69405-2	C-78411	
1CT	5D	6DG	B	2J1G1	C-69406-1	C-78415	
1F	5DG	6G	M	2J1H1	C-78248	C-79331	

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8 RPM 115V 60 cyc
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GEAR ASSORTMENT

100 small assorted gears. Most are stainless steel or brass. Experimenter's dream!..........Only $6.50

VERNIER DIAL or DRUM (From BC-221)

DIAL—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0-50 in 180°. Black with silver marks ....either 85¢

SOUND POWER HANDSET

BRAND NEW

Includes 6 ft. cord.—No batteries or external power source used. **$17.60 pr.**

AC LINE CORDS—4 ft. long with molded rubber plug **10¢**

Sound Powered Chest Set RCA—With 24 Ft. Cord

Per Pair
USED $17.60
NEW $26.40

400 CYCLE INVERTERS

Leeland Electric Co.

#10800 in: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V. 400 Cyc. 1 phase. 1500 V.A. 90 PF..........$24.95

3AG FUSES

Amp	Per 100	AMP	Per 100	AMP	Per 100
1/8	$4.00	3/4	$4.00	6	$3.00
3/8	4.00	4	3.00	10	3.00
1/2	4.00	5	3.00	15	3.00

DELAY NETWORK—ALL 1400Ω

T 114—Approx. 2.2 micro sec. delay.......... } 95¢
T 115 Similar to T 114 with tap brought out... } each

BEARINGS

Mfg. No.	ID	OD	Thickness	Price
MRC5028-1	5 1/2	6 1/2"	1"	$3.50
MRC7026-1	5 5/64	6 15/64	9/16	3.50
Timken 37625	4 5/16	6 1/4	29/32	4.25
MRC-7021-200	4 1/8	5 9/32	23/64	2.95
Norma A 545	2 1/16	2 5/8	1/4"	1.00
MRC 106 M2	1 17/64	2 7/16	25/64	1.75
MRC 106 M1	1 13/64	2 7/16	25/64	1.60
Federal LS 11	1 1/8	2 1/2	5/8	1.75
Norma S 11 R	1 1/8	2 1/8	3/8	1.25
Fafnir B 541	1 1/16	1 1/2	9/32	.55
Hoover 7203	5/8	1 9/16	7/16	.90
Norma 203S	5/8	1 9/16	7/16	.90
SCHATZ	3/4	1 3/4	9/16	1.00
N5 5202-C13M	1/2	1 3/8	1 3/8	1.00
ND 3200	25/64	1 5/32	11/32	.55
Norma S 3R	3/8	7/8	7/32	.45
MRC 39 R1	11/32	1 1/32	5/16	.45
MRC 38 R3	5/16	55/64	9/32	.45

NEEDLE BEARINGS

TORRINGTON B108 ½" wide ⅝" 13'16" 30¢

Brand New Meters—Guaranteed

0-10 ma. D.C. 3½"... 3.95 | 0-80 Amp. D.C. 2½"..$2.25
0-1 ma. D.C. 3½" Scale Reads 0-4 KV DeJur......$5.75

SELENIUM RECTIFIERS

Full Wave 200 MA 115V..........................$1.79
Half Wave 100 MA 115V..........................91

SPAGHETTI SLEEVING—assortment—99 feet....$1.00

TYPE "J" POTENTIOMETERS

100 3/8	1,000 9/16	10K 5/8	100K S.S.*
100 S.S.*	1,500 1/4S.S.	15K 1/4	200K 5/8
150 S.S.	2,000 1/4	15K S.S.*	200K S.S.*
300 S.S.	2,000 S.S.*	25K S.S.*	250K 5/8
400 3/8	2,500 S.S.	50K S.S.	250K S.S.*
400 S.S.*	3,000 3/8	70K S.S.	500K S.S.*
500 S.S.*	4,000 3/8	80K S.S.	1Meg 3/8
1,000 3/8	5,000 1/4	100K 7/16	1Meg S.S.

* SPLIT LOCKING BUSHING..............$1.50 each

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2–140Y	$0.13	4–141W	$0.30	3–142	$0.21
3–140¾W	.19	5–141	.26	2–150	.39
6–140	.25	5–141¾W	.37	3–150	.54
10–140W	.53	7–141	.36		
10–140¾W	.53	6–141¾W	.49		
3–141¾W	.24	8–141¾W	.58		
3–141W	.24	9–141Y	.64		

TIME DELAY RELAY

Eagle Signal Corp., Moline, Illinois
1 Min. Delay. 115 V., 60 Cycle

2½ second recycling time—spring return • Micro-switch contact, 10A • Holds ON as long as power is applied • Fully Cased •
ONLY $6.50

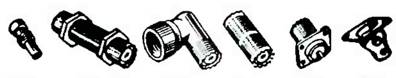
AN CONNECTORS
IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

NEW COAXIAL CABLES

	Price per 1,000 Ft.		Price per 1,000 Ft.
RG 5/U	$140.00	RG 22A/U	$285.00
RG 6	180.00	RG 24	675.00
RG 7*	85.00	RG 26	475.00
RG 8*	135.00	RG 29*	50.00
RG 9*	250.00	RG 34	300.00
RG 9A/U	275.00	RG 35	900.00
RG 10	240.00	RG 41*	295.00
RG 11*	135.00	RG 54A/U	97.00
RG 12	240.00	RG 55*	110.00
RG 13	216.00	RG 57*	325.00
RG 17	650.00	RG 58*	65.00
RG 18	900.00	RG 58A/U	80.00
RG 19	1250.00	RG 59*	70.00
RG 20	1450.00	RG 62*	75.00
RG 21	220.00	RG 77*	100.00
RG 22/U*	150.00		

Add 25% for orders less than 500 feet.
* No minimum order—others 250' minimum.

COAXIAL CABLE CONNECTORS



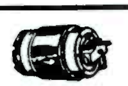
15¢	$1.30	30¢	80¢	40¢	10¢
UG 175/U	83-1F	83-1AP	83-1J	83-1R	HOOD

83-1AC	$ .42	UG13/U	$1.75	UG 87/U	$1.60
83-1AP	.30	UG 21/U	1.20	UG 88/U	1.35
83-1F	1.30	UG 21B/U	1.45	UG 167/U	2.05
83-1H	.10	UG 22/U	1.30	UG 175/U	.15
83-1J	.80	UG 22A/U	1.65	UG 176/U	.15
83-1R	.40	UG 24/U	1.30	UG 206/U	1.60
83-1SP	.60	UG 25/U	1.25	UG 224/U	1.40
83-1SPN	.60	UG27/U	1.30	UG 255/U	2.45
83-1T	1.30	UG 30/U	2.50	UG 260/U	1.35
83-2AP	1.95	UG 57/U	2.30	UG 281/U	.77
83-2J	2.10	UG 58/U	.80	UG 290/U	1.35
83-22AP	1.10	UG 59A/U	2.25	UG 306/U	2.95
83-22SP	1.15	UG 60/U	2.40	UG 499/U	1.25
83-22R	.68	UG 85/U	1.75		

UG 255.......... 2.45 | UG 59A/U.......... 2.25
UG 224/U........ 1.40 | UG 306.......... 2.95

DIFFERENTIAL

115 V., 60 Cyc.
#C78249 **$3.95 ea.**



3⅜" dia. x 5⅝" long
Used between two C78248's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)........$4.50
Mounting Brackets — Bakelite for selsyns, and differentials shown above..............**35¢ pair**

2J1G1 SELSYNS

400 CYCLE—BRAND NEW

POSTAGE STAMP MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd
7	23	47	82	180	500	800	.001625	.0053
7.5	24	51	90	220	510	820	.002	.0056
8	25	56	100	240	560	.001	.0027	.006
8.2	26	60	110	250	580	.0011	.003	.0062
10	30	62	120	350	600	.0012	.0033	.0065
15	33	68	125	370	620	.0013	.0035	.0068
18	39	70	150	390	650	.00136	.0036	.0082
20	40	75	160	400	680	.0015	.004	.01
22	43	80	175	470	750	.0016	.0044	

Price Schedule

8.2 mmf to 910 mmf..............................5¢
.001 mmf to .001625..............................8¢
.002 mfd to .0082 mfd..............................15¢
.01 mfd..............................28¢

SILVER MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
8	47	82	155	275	466	800	.0022	.0033
10	50	100	170	325	470	875	.0023	.0039
18	51	110	180	350	500	.0011	.0024	.005
22	56	115	208	360	510	.0013	.0025	.0051
24	60	120	225	370	525	.0015	.0026	.0056
27	62	125	240	390	560	.0016	.0027	.006
30	66	130	250	400	570	.001625	.00282	.0068
39	68	135	260	410	680	.0018	.002826	.0082
40	75	150	270	430	700	.002	.003	.01

Price Schedule

10 mmf to 875 mfd..............................10¢
.0011 mfd to .0023 mfd..............................20¢
.0026 mfd to .0082 mfd..............................50¢
.01 mfd..............................$1.00

PULSE TANSFORMERS

UTAH—9262 9278 9280 9340
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9365, KS9565, KS9800, KS9862, KS13161
GENERAL ELECTRIC—K2731 80-G-5
JEFFERSON ELECTRIC—C-12A 1318
DINION COIL—TR1048 TR1049
also 352-7250-2A; 352-7251-2A; T-1229621-60

PRECISION RESISTORS—¼ WATT—80¢

2	10.48	12.32	14.98	62.54	147.5	705
2.5	10.84	13.02	15.8	79.81	220.4	2,193
3.5	11.25	13.52	16.37	105.8	301.8	3,500
5	11.74	13.89		123.8	366.6	
6.68				125	414.3	59,148

PRECISION RESISTORS—½ WATT—35¢

.25	13.15	75	400	6,500	16,000	36,000
.334	13.3	87	723.1	7,000	16,700	37,000
.444	15	97.8	855	7,300	17,000	45,000
.502	18.75	125	970	7,500	19,860	47,000
.557	25	178	1,500	8,000	20,150	50,000
.627	45	179.5	2,500	8,500	21,300	56,000
.76	46	180	2,850	8,800	25,000	59,000
1.01	49	200	3,995	10,000	26,667	59,905
1.53	52	210	4,000	12,000	30,000	68,000
2.04	55.1	240	4,285	14,825	32,700	70,000
3.25	60	260	4,300	15,000	32,888	79,012
5.26	61	270	4,451	15,750	33,000	92,000
5.89	65	290	5,714	15,755	33,300	100,000
10.58	66.6	298.3	5,900	15,810	35,888	180,000
11.1	69	335				

PRECISION RESISTORS—1 WATT—45¢

.1	2.55	15	80	1,800	8,000	55,000
.11	2.58	18	125	2,200	8,250	56,000
.2	2.6	28	250	2,215	9,000	65,000
.31	2.66	30	270	2,250	10,000	68,000
.4	3.1	38	312	3,300	12,000	70,000
.861	3.39	45.5	420	5,000	12,420	84,000
1.01	4.29	54.25	425	5,221	12,500	90,000
1.166	5.21	60	1,530	7,000	50,000	95,000

PRECISION RESISTORS—1 WATT—60¢

100,000	166,100	320,000	399,000	590,000
105,000	220,000	340,000	413,000	600,000
120,000	240,000	348,000	520,000	645,000
128,000	260,000	375,000	522,000	650,000
130,000	270,000	376,000	550,000	700,000
132,000	296,000	390,000	560,000	876,457
149,500	310,000			
150,000				

MEGOHM 1 WATT 1%—$1.50—5%—60¢

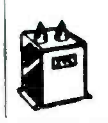
PRECISION RESISTORS—2 WATT—75¢

4,385 5.000 6,000 10,000 19,917 23,000

UNIVERSAL JOINTS ALUMINUM
3/16" hole x ⅜ O.D. 1-⅛" long—**50¢**
¼" hole x ½ O.D. 1-⅛" long—**75¢**

OIL FILLED

MFD	V.D.C.	Price	MFD	V.D.C.	Price
.125	35,000	$35.95	4	1,500	$2.95
.125	27,000	28.95	3	1,000	1.59
.1	25,000	25.95	4	1,000	1.95
.25	20,000	19.95	2	1,000	.90
.15-.15	8,000	2.75	1.02	1,000	.65
.1	7,500	1.95	1	1,000	.65
.03	7,500	1.69	7	800	1.98
.1-.1	7,000	1.98	1	800	.55
.1	7,000	1.85	10	600	2.95
.02-.03	7,000	1.40	8-8	600	1.69
.1	6,000	2.75	8	600	2.05
.3-.03	6,000	1.35	7	600	1.75
2	4,000	4.95	4	600	1.63
.3x.2	4,000	2.50	4 x 3	600	1.95
.1	4,000	2.25	2	600	.69
.06	4,000	1.45	2 x.5	600	.49
.1	3,500	1.95	8	500	1.55
.1	3,000	2.75	4	500	.98
.25	3,000	2.25			
8	2,000	4.95			
3	2,000	3.75			
.5-.1	2,000	1.95			
.5	2,000	1.95			
.3	2,000	1.75			
.1-.1	2,000	1.65			
.02	2,000	.79			
1	1,500	1.50			



2 mfd. 4,000 V.D.C. G.E.
$4.95

OIL FILLED A.C. CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
.2	750	$ .69	30	330	$6.50
8	660	4.95	25	330	5.95
6	660	4.95	20	330	5.50
5	660	4.50	15	330	4.50
4	660	4.25	10	330	3.95
2	660	3.25	6	330	2.95
1	660	2.35	4	330	1.95
15	440	4.95	3	330	1.25
6	440	3.50	10	220	2.95
5-3	440	3.95	20	220	4.95
4.4	375	2.15			

1N34 Crystal Diode..............................79¢

300 Twin Lead..............02½ per ft. $18.95 per M.
Dynamotor DM 33A ....$3.75 ea.

Chokes: 30 Hy. 80MA @....$1.29; 6Hy, 80MA @..79¢

Power Tap Switch—OHMITE # 312—5 Taps non-shorting 25A 150 V. A.C...........................$3.95

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A. C. Fully cased Plugs into octal socket..............................$6.50

BC-224-D Receiver 12 V. D. C. 1.5 mc to 18 mc. Brand new. Includes tubes, dynamotor, shock mts...$125.00

Mike Connector Amphenol 80-81 Interchangeable with Amphenol 80-M cad plated..............................25¢

Minimum Orders $3........All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

Buy TOP Radio-Electronic Values!

AIR TRIMMER CONDENSERS

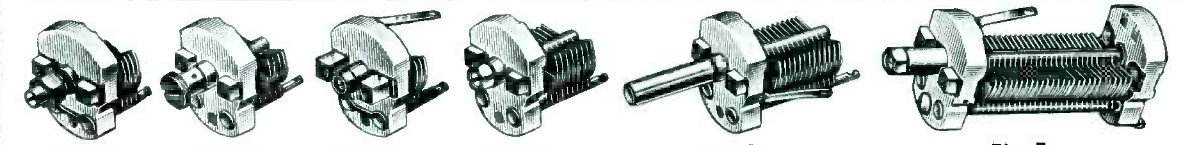


Fig. A Fig. B Fig. C Fig. D Fig. E Fig. F

STOCK NO.	CAPACITY Min. Max.	MANUFACTURER'S NUMBER	FIGURE	SHAFT LENGTH	POST LENGTH	GROUND LUG	PRICE EACH
2937	2.5 – 7	Hamm 250034	D	5/16	3/32	Right	18¢
5716*	3 – 8	ASP 17A224	A	9/16	3/32	Top	25¢
5717	3 – 10	ASP 22G192	A	9/16	3/32	To Post	18¢
4090	2 – 15	ASP 482212	E	1"x1/4" D	3/32	Left	25¢
2939	3 – 15	ASP 217-2	C	5/16	1/4	Top	20¢
5718	3 – 15	Telrad 682070-30	D	5/16	3/32	Right	20¢
5719	3 – 15	Hamm 682070-30	D	5/16	3/32	Right	20¢
231	3 – 25	CAIM 481881	A	9/16	3/32	Left	25¢
5720	3 – 27	Hamm 11725-1	D	5/16	3/32	Right	25¢
5721	2.5 – 28	Comar M420864-6	D	5/16	3/32	Top	25¢
5723	3 – 29	ASP 22G190	A	9/16	3/32	To Post	25¢
2940	2 – 30	ASP A8H-501	D	5/16	5/16	To Post	30¢
5724	4.5 – 30	OB7751E-25	D	5/16	5/16	Right	30¢
5086	5 – 30	Hamm SBL-72265-3	B	1/2	3/32	Bottom	30¢
2941	4.5 – 35	Hamm ESA682070-37	D	5/16	3/32	Left	30¢
232	5 – 54	Hamm ESA682070-35	D	5/16	3/32	Left	40¢
5087	5 – 54	Hamm BL 72265-4	B	1/2	3/32	Right	40¢
5725	4.5 – 55	Sickles M7466880-2	D	5/16	3/16	Right	40¢
5088	6 – 100	Hamm SBL72265-6	B	1/2	3/32	Bottom	50¢
5674	5 – 100	Hamm APCIE100	E	1 1/16"x1/4" D	3/32	Right	75¢
236**	8 – 140	ASP 19A34504	D	5/16	3/32	To Post	55¢
5675	6 – 150	Hamm APCIE150	E	1 1/16"x1/4" D	3/32	Right	75¢
5726	9 – 204	OAK 114M510	F	9/16	3/32	Top	95¢

* Double spaced plates.
** Adjusts both ends, some available w/dust cover.
Fig. A Round Shaft Screwdriver adj. w/locknut.
Fig. B Bakelite Knob Ins. Screwdriver adj.
Fig. C Round shaft Screwdriver adj.
Fig. D Hexnut Screwdriver adj.
Fig. E ¼ Round Shaft.
Fig. F Double End Plate.

INDUSTRIAL SOLDERING IRONS

Jewell 100 and 150 Watt heavy duty type. Underwriters approved. Polished chrome barrel. Nichrome heating element on stainless steel core. ⅜" copper tip. Standard cartons of 36 each.

Stock No.	Item	Price Each	Price Ea. Per Ctn.
5669	100W	$2.95	$2.50
5670	150W	3.25	2.75

TRANSMITTING MICAS

Stock No.	Cap.	Test Volts	Type No.	Price Each
5493A*	.01	1000	1445	.35¢
5494A	.02	1000	144T	.40¢
5495A	.006	1200	A 2	.40¢
5496A	.001	1500	BE 15	.20¢
5493A	.004	2500	4	.30¢
5499A	.001	5000	F	.60¢
5600A	.0036	5000	A2	$1.00
5601A	.15	1000V	XS	1.90
5602A	.00007	2500V	3	.90¢
5603A	.00005	3000V	15L	1.00
5604A	.0001	5000V	F2L	1.00
5605A	.0008	5000V	F21	1.00
5606A	.000025	10,000	PL-34L	1.95
5607A**	.00015	10,000	PL-315	7.95

* Supplied with Meter Bracket
** D.C. Working Voltage
OTHER TYPES AND SIZES AVAILABLE

STRAP ST-19-A

55" long x 2" wide heavy olive drab webbing includes: 2 snap hooks with slide.

Price .... $1.00 ea.

WRITE FOR COMPLETE BULLETIN

OUR FULLY ILLUSTRATED BULLETIN OF ELECTRONIC PARTS IS MAILED AT REGULAR INTERVALS TO MANUFACTURERS AND WHOLESALERS. IN THE CATALOG ARE LISTED AND PICTURED HUNDREDS OF ITEMS OF INTEREST TO PURCHASING AGENTS OF ELECTRONIC PARTS. WE SHALL BE PLEASED TO PLACE YOUR COMPANY'S NAME ON OUR MAILING LIST. PLEASE REQUEST ON YOUR COMPANY LETTERHEAD.

10" PM SPEAKERS

Permoflux 10" PM Speaker with 2.15 oz. Magnet. Packed 18 to a carton.

Stock No. 5335 Price Each **$3.35**

Carton Lot $52.00

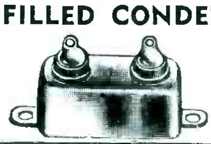
STRIP HEATERS

24 Volt—150 Watt Chromalux Strip Heaters. Manufactured by E. L. Wiegand Co., 1½" x 12" x ⅜" thick.

Stock No. 5492 A Price Each **95¢**

Standard Brand. MFR. Name on Request

OIL FILLED CONDENSERS



Stock No.	Capacity & Voltage	Lug Arrangement	Type No.	Price Each
5166A	.01-600V	Side	306-91	10¢
354A	.05-600V	Top	XDMRTWG	15¢
5167A	.1-600V	Side	306-357	20¢
544A	3 x .1-400V	Side	DYR 6111	25¢
2908A	2 x .02-600V	Top	DYR 600 22	15¢
2911	2 x .1-600V	Top	DYR 6011	25¢
5172*	2 x .1-600V	Top	306-361	25¢

* Can is common ground—Other types and sizes available

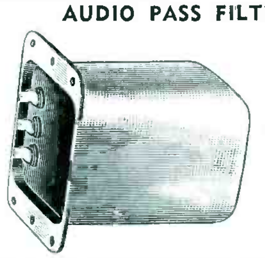
Standard Brand. MFR. Name on Request

ECLIPSE VOLTAGE REGULATOR

5603A Bendix Eclipse V.R. 1365 Model 2 Style A — volts set at 115

Stock No. 5608A $2.95 ea.

THORDARSON AUDIO PASS FILTERS



Band pass 800 to 1200 cycles input 10000 ohms—Output 25000 ohms Level 10DB

Stock No. T48500 Price to: $5.50 ea.

AMPHENOL & CANNON CONNECTORS & FITTINGS

WRITE YOUR REQUIREMENTS

We can Possibly furnish about 75% of complete Amphenol & Cannon list.

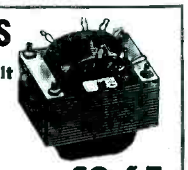
6.3 VOLT FILAMENT TRANSFORMERS

Primary 115 Volt 60 Cycle 1600 Insulation Three 6.3 Volt Secondaries

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Horizontal Half Shell Mounting. 2¼" x 2 13/16" Mounting Centers. 2 13/16" x 3⅜" Core Size. 2½" above Chassis. Solder Lug Terminals—All Terminals Marked.

Stock No. 5254 A



Price Each **$2.65**

Terms: Open Account to rated or acceptable reference accounts. Others Pre-payment or 25% deposit with order, balance C.O.D. Price F.O.B. Chicago and subject to change without notice. Merchandise subject to prior sale.

Radio Surplus Corp.

732 South Sherman Street
Chicago 5, Illinois
Phone: HArrison 7-5923

MOTOR GENERATORS

2.5 KVA Diehl Elec. Co. 120 V.D.C. to 120V A.C. 60 cy. 1Ph., .4PF. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full spec. on request. New........$285.00
2 KVA O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles at 3 Ph. syncs motor on 208V, 50 cy. New. Export crated....................$165.00
1.25 KVA Allis-Chalmers. 230 DC to 120 AC, 60 cy. 1 Ph. Fully enclosed. Splashproof, Ball Bearings, centrifugal starter. New, complete with kit of Spare parts.........................$175.00
M.G. 164, Holtzer-Cabot Motor: 440V, 3Ph, 60 cy., .90A. 1/3 HP, 1750 RPM. Generator: 70V, 3Ph, 146 Cy., .140KVA. Exciter: 115DC, 1A. New...$67.50

INVERTERS

Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy, 1 Ph. Output 115, 480 c. 1 Ph. 1200W and 26V DC at 4 amps. New...............$295.00
G.E. Model 5D-21NJ3A. Input: 24V, DC, Output: 115V, 400 cy., 485 Va. New................$29.50
Leland Elec. Co. Model PE206A. Input: 28V, DC, 38 Amps. Output, 80V., 800 cy, 485 VA. New $22.50
G.E. J8169172. Input: 28V, DC, Output: 115, 400 cycles at 1.5 KVA. New...................$32.50

DYNAMOTORS

Navy-Type CAJO-211444, 105/130V DC to 13V DC at 40A or 26V DC at 20A. Radio Filtered. Complete with Line Switch. New..................$89.50
Elcor. 32V DC to 110V AC, 60 cy. 1 Ph, 2.4 Amps. New...$32.50
Type PE94CM. For use with SCR522 Transmitter-Receiver. Brand new in export cases........$19.50
Carter 6V DC to 400V DC at 375 mils. New $39.50

AMPLIDYNES

G. E. Model 5AM21J17. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V DC. Output: 60V DC, Sig. Corps. U. S. Army MG-27-B. New..$34.50
Edison type 5AM31NJ18A. Input: 27 volts, 44 Amps., 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. New................................$22.50
G.E. Model 5AM45DB20. Input: 115V, 60 cy. 1 Ph, 3450 RPM. Output: 250VDC 0.5 Amps. Price $165.00

SMALL D.C. MOTORS

G.E. Model 5BA50LJ2A. Armature 27V D.C. at 8.3A Field 60V DC at 2.3A. RPM 4000. H.P. 0.5 New...$27.50
Electrolux Corp. of Canada. P/O vent fan assembly for SCR-602-T6. 1/35HP. 28.5V, 2.15 amps., 2200 RPM. Price..............................$16.50
Oster type E-7-5, 27.5V, 1/20HP, 3650 RPM. Shunt wound. Price..........................$15.00
Dumore Co. Type EBLG, 24V DC, 40-1 gear ratio, for use with type B-4 Intervalometer. Price $17.50

400 CY. BLOWERS

Westinghouse 115V. 400 cy. 17 c.f.m. Includes capacitor. Price............................$12.50

SYNCHROS

Ford Inst. Co. Type 5SDG. Brand New....$22.50
Electrolux Torque Motor.....................$16.50

SOUND POWERED PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone. Brand new including 20 ft. of rubber covered cable.......$17.50
Automatic Electric Co. No. GL843AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable.................................$16.00
U. S. Instrument Co. No. A-260. Complete with 20' cable and plug. Brand new..............$17.50
W. E. type TS-10M Handset. New..........$16.50
W.E. Type 316B Laboratory Headsets. Price per set..$8.50

RELAYS

Struthers-Dunn 1BXX129, 110 D.C.............$2.60
Advance type 455C, SPDT, 115 A.C.............$1.95
Leach type 1154A, SPDT, 115 A.C..............$2.35
Leach type 1054, BSN 20-28V D.C..............$2.35
Clare Plug-in base No. 30FMX 115 A.C.........$3.50
G.E. Plug-in base Sensitive K27J853..........$4.50
Allied Control type BJ 452-1128..............$1.95
Western Electric D-163781 Plug-in............$10.00
Guardian Time Delay type B-9-SPDT............$2.95
Haydon Time Delay 17717 110V/60..............$4.75

AN/APA 10 PANORAMIC ADAPTER

SENSITIVITY: "A" channel, 400 microvolts or less per ¼" beam deflection. "B" channel, 400 microvolts or less per ¼" beam deflection. "C" channel, 1 volt or less per ¼" beam deflection.
RESOLUTION: 12 kilocycles at 3 db down from peak, sweep control at maximum, using CW signal.
PRESENTATION: Panoramic ("A" & "B" channels): Oscillographic, "C" channel.
SWEEP WIDTH: Channel A, ± 50 kc (100 kc overall) Channel B, ± 500 kc (1 Mc overall) Channel C, ± 1 Mc (2 Mc overall).
CATHODE RAY SWEEP: Oscillatory or non-oscillatory (Servo) Variable Sawtooth Generator, 35 to 40,000 cycles per second.
AUDIO OUTPUT: 50 milliwatts into 600 or 8000 ohm load.
VERTICAL AMPLIFIER: Single stage, ± 2db from 30 cycles to 100 kc or higher. Amplifier out position permits direct connection to one vertical plate through coupling capacitor.
HORIZONTAL AMPLIFIER: Single stage, ± 2db from 30 cycles to 100 kc. No provision for direct connection to deflection plates.
CATHODE RAY TUBE VOLTAGE: Cathode to accelerating anode; 1200V DC for 115V A.C. input.
SENSITIVITY OF CATHODE RAY OSCILLOSCOPE: Maximum through Amplifier. Horizontal: 10 volts peak to peak per inch. Vertical: 1.5 volts peak to peak per inch.
DIRECT TO VERTICAL PLATE: 150 volts peak to peak per inch.
NOISE: No disturbance in excess of 25,000 microvolts between 200kc to 200Mc generated by equipment.
Overall Dimensions: 19-9/16" x 10¼" x 7⅝".
Weight: 40 lbs.
Power Requirements: 115V. A.C. 60 cycles, 1 phase. With 21 tubes including 3" scope tube, for operation on 115 V. 60 cycle source. **PRICE**..........$245.00
Gov't Cost $1800.00.
AN/APA-10 80 Page Tech Manual..........$2.75

TEST EQUIPMENT

TS-127/U Lavoie Freq. Meter—375 to 725 MC.
TS-47APR Test Osc. 40-500MC.
TS-487/U Peak to Peak VTVM.
AN/APR-1 Receiving sets.
R111A/APR-5A Receiver—1000 to 6000 MC.
AN/APR-4 Tunning Units TN-17 (76-300 MC).
AN/APR-4 Tuning Units TN-18 (300-1000 MC).
AN/APR-4 Tuning Units TN-19 (950-2200 MC).
TU-58 Range "A" Tuning Units (110-370 MC).
BC1203 APN-4 Tests Sets.
AN/APA-10 Panoramic Adaptors 115V/60 cycles.

Repair Parts for BC-348 (H, K, L, R only)

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.

HIGH QUALITY CRYSTAL UNITS

Western Electric—type CR-1A/AR in holders. ½" pin spacing. Ideal for net frequency operation. Available in quantities. 5910-6350-6370-6470-6510-6610-6670-6690-6940-7270-7350-7380-7390-7480-7580-9720. All fundamentals in KC. Good multipliers to higher frequencies....................$1.25 each

RADAR

Antenna-Trans-Rec Unit ASG-1.
Radar Set SQ complete with spares.
Modulator type SO-11.
Pulse Timers CUZ-50AGD (SD-5 Radar)
Radar Crystal Units 98.35kc, Raytheon.
1N21B Sylvania Diodes.
Repeater Adapters CBM-50 AFO.
SO Series Accessory Control Panels.
SO Series Transmitter-Receiver unit.
CARD 23AEK Bearing Control Units for SO Series.
Auxiliary Rectifier.
SG Rectifier Power Units CRP-20ABN.
SG Rectifier Power Unit CRP-20ABM.
SG Modulation Generators CRP-35AAH.
SG Radar Receivers CRP-46ABD-1.
SG Complete trans. RF Coupling Assemblies.
SG Power Control Chassis.
SG Driver Modulator Assemblies.
SG Complete sets equipment spares.
SG Load Divider Modernization kits.

SONAR EQUIPMENT

Hoist Train Mechanisms, Navy type 78219, for Model QBG, Underwater Sound equipment. Purpose: To lower or raise projector. Travel 2'3". Includes 1 partial set of spare parts. 1 wooden box per set; Weight and cube per box: 427 lbs., 42.0 cu.

RECTIFIERS

G.E. No. 6 RC89F16 for 54 cells 10 amps.
G.E. No. 6 RC133F2—In: 110/220/60/1. Out: 15/30V-75-150A
Mallory APS-20—In: 115/230/60/3. Out: 12/24V-65-130A
Turret Trainer Supply. In: 220/60/3. Out: 28V-130A
Complete specs on request

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat. No. 80G184.
KVA .945S-.520P Volts 460/345/200/115. **New $6.95**
FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/.5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.35A. New..................$3.95
PLATE & FIL. Raytheon UX7238. Pri: 115. Sec #1: 830VCT/0.085A. Sec #2: 5V/3A. Sec #3: 640VCT/0.10A. Sec #4: 5V/3A. T.V. 1780 RMS $4.75
PLATE WECO KS9560, 400/800 cy. Pri: 115V, Sec: 1350-0-1350 at .057A (2700 V Total). Elecstat shlded. Wt. 2.3 lbs. New...................$2.95
Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 500 cy. 1 PH. Sec: 5600V. Center tapped. 1.5KV insulation. Brand new............$49.50
PLATE & FIL. WECO KS9555, 400 cy. Pri: 115V. Sec #1: 930-0-930. Sec #2: Three 6.3V windings.......................................$4.95
FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shlded. Wt. 0.5 lbs. New............................$2.95
PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec: #1=1200VDC at 1.5MA. Sec. #2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35VO.8A (ins. 1500V)/5V2A/5V2A..........................$4.95
RETARD. 400 cy. WECO KS9598. 4 Henry 100MA. $2.75

HIGH POT TRANSFORMERS

High Voltage Trans. Westinghouse Pri: 115, 60 cy. Sec: 15,000 C.T., 60 MA. Good for Hi-Pot test set up. C. T. ungrounded.........................$39.50

PULSE TRANSFORMERS

PULSE. WECO KS-9563. Supplies voltage peaks of 3500 from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1.3 =.082H at 100 cps....$7.50
PULSE. WECO KS-161310, 50 KC to 4MC, 1¾" Dia. x 1⅝" high, 120 to 2350 ohms. New....$6.75
High Reactance Trans. G. E. type Y-3502A.—60 cy., Voltage 11200-135. Inductance H.V. Winding 135 Henries. Output: Peak Voltage 22.8KV. Cat. 8318065G1. New..............................$89.50

400 CY. SERVO TRANSFORMERS

G.E. #68G665X Pri: 57.5V. Sec: #1=28.75V. Sec: #2=28.75V..................................$3.75
G.E. #68G666X Pri: 57.5V. Sec: 115V C.T. $3.75
G.E. #68G667 Pri: 220V C.T. Sec: 220 V C.T. $3.75
G.E. #68G668X Pri: 115V. Sec: 275V/275V/275V/275V/230V/230V/6.3V CT/6.3V CT....$6.50

RAYTHEON VOLTAGE REGULATORS

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V., 60 Watts. ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. Special..........$16.75

AMPLIFIERS

GE Servo type 2CV1C1 400 cycle
Constant Output Line BC-730C
Synchro Amplifiers for Radar
Intercommunication type BC-605

ANTENNAS

Coast Guard MR-162 Whips 23½ ft.
Microwave types AT-49, AT-38, AS-125
APT-2 Dipole Antennas
TDY Radar Jammer Horns
Paraboloids, Magnesium Dishes 17½" dia.
SCR-634-A (Part of RC-153-B Antenna).
APT-2 Dipole Antenna

POTENTIOMETERS

W.E. KS-15138 Linear Sawtooth
W.E. KS-8732 for SCR547 Radar
W.E. KS-8801 Motor Driven

MISCELLANEOUS

Cathode Ray Shields for 3" tube.............$3.75
Variac type Motor Controls 600 watt........$13.50
10 CM Waveguide 90° elbow..................$20.00
Adel Clamps assorted types—write for samples
Shock Mounts Lord #20........................$.40
Shock Mounts U. S. Rubber #5150C.............$.30
Commando Pole Jacks (Cook Elec. Co)..........$1.00
Fusetron (Bus FRN 50 Ampere 250V)............$.25
Switchboard Lamp Receptacles & Jewels........$.40
SCR522 Transmitter Receivers Brand New
TCR Transmitters 125 watt Ship to Shore
BC966A Transponders
RT7-AN/APN-1 Receivers
BC-423B Modulators
BC-1366M Jack Boxes—Large quantity
Sweep Generator Capacitors 5/10 mfd.

VIBRATORS

12 Volt Synchronous. Fed. Tel. & Radio Corp. For TA-3/ft Ringers. Quantity available. Brand new. $1.25

HI-VOLT CAPACITORS

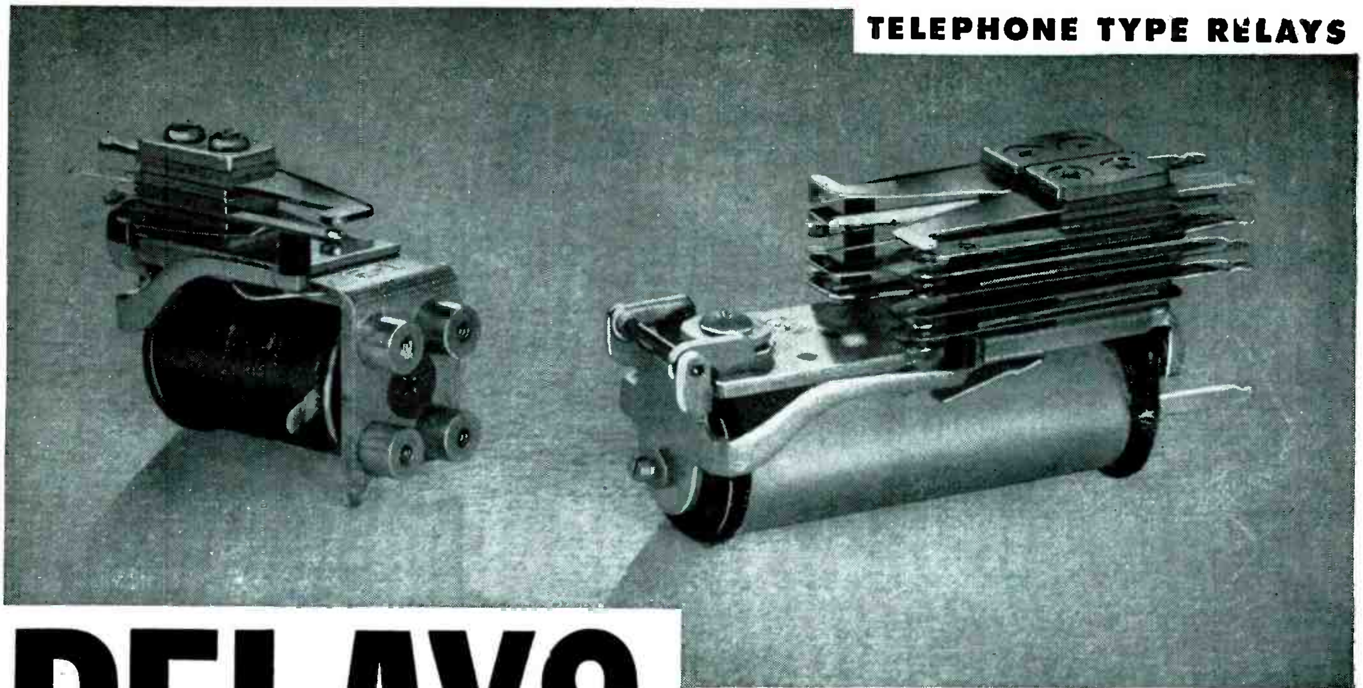
.25 Mfd., 20KV..........$26.50
.25 Mfd., 15KV..........$22.50
1 Mfd., 15KV............$44.50
1 Mfd., 7.5KV...........$12.50
2 Mfd., 6.0KVA..........$14.50

ELECTRONICRAFT
INC.
27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

INDICATORS

ID-24/ARN-9...........$12.50
ID-14/APN-1............$7.95
I-82A..................$9.75
ID-60/APA-10 Panoramic Adapter converted for 60 cycle operation—complete with tubes and 80 page Tech. Manual $245.00

TELEPHONE TYPE RELAYS



RELAYS

This list represents only a small part of more than a million relays in our stock—one of the world's largest. All relays are standard, brand new in original packing, and fully guaranteed by Relay Sales.
Send us your relay requirements. If the items are in stock we can make immediate delivery at substantial savings in cost to you.

SHORT TELEPHONE RELAYS

STK. NO.	VOLTAGE	OHMAGE	CONTACTS	UNIT PRICE
R-635	12 VDC	100	1C&1B	$1.35
R-308	12 VDC	100	2C @ 4 Amps	1.85
R-343	12 VDC	100	1C	2.00
R-826	12 VDC	150	2C, 1B	1.55
R-770	24 VDC	150	1A/10 Amps	1.45
R-368	8/12 VDC	200	1B	1.40
R-771	24 VDC	200	1A/10 Amps	1.45
R-603	18/24 VDC	400	2A	1.55
R-575	24 VDC	500	2C	2.40
R-764	48 VDC	1000	1C&2A	2.00
R-417	5.5 ma	5800	2C	2.50
R-563	60/120 VDC	7500	1A	2/3.10
R-213	5/8 VAC 60 Cy.	....	2A	2.50
R-801	115 VAC	....	NONE	1.45
R-589	12 VDC	125	2A	1.30
R-113	12 VDC	150	4A	1.55
R-689	12/24 VDC	255	1C	1.55
R-799	24 VDC	500	NONE	1.00
R-115	24 VDC	500	1C	1.70
R-110	24/32 VDC	3500	1C	2/3.45
R-121	150 VDC	5000	2A&1C	2.05
R-122	150 VDC	5000	2C/Octal Base	2.50
R-634	150/250 VDC	6000	1A&1B	2.45
R-369	8/12 VDC	150	2A, 2B	1.60
R-908	6 VDC	15	4A @ 4 Amps	1.50
R-800	12 VDC	150	2C&1A	1.55
R-537	12/24 VDC	150	2C&1B	2.00
R-750	24 VDC	400	1A	1.60
R-367	10/16 VDC	195	2C	2.50
R-335	20/30 VDC	700	2A, 1C	2.00
R-366	30/120 VDC	4850	1C	2.50

STANDARD TELEPHONE RELAYS

STK. NO.	VOLTAGE	OHMAGE	CONTACTS	UNIT PRICE
R-806	115 VAC	900	1A	$2.05
R-161	6 VDC	10	2B&1A	1.10
R-873	6 VDC	12	3C-3A MICALEX	3.00
R-305	12 VDC	50	2A Split Cerm.	1.35
R-360	24 VDC	200	1C	1.50
R-484	24 VDC	200	2A, 1C	1.35
R-337	24/48 VDC	1200	1A, 2B Split	2.65
R-101	24 VDC	1300	2A	2.50
R-868	30/162 VDC	3300	1C	1.90
R-365	52/162 VDC	3300	4C	3.95
R-518	85/125 VDC	6500	1C	3.60
R-918	52/228 VDC	6500	1C	3.60
R-852	52/228 VDC	6500	1C, 1A	3.00
R-341	75/228 VDC	6500	4C @ 4 Amps	3.65
R-633	180/350 VDC	10,000	1C @ 5 Amps	2.90
R-344	72/300 VDC	11,300	3A, 1B	2.45
R-332	100/350 VDC	40,000	2A	3.50
R-664	110 VAC	...	2B&1A/OCT.SOCKET	2.45
R-667	6 VDC	.75	1B/10AMP. 1A/3AMP	1.45
R-632	6 VDC	12	5A&1C	3.25
R-154	6/12 VDC	200	1A	1.50
R-517	12 VDC	250	2A	1.50
R-116	85 VDC	3000	1B	3.05
R-631	100/125 VDC	3300	2A	1.90
R-545	110/250 VDC	7000	1C	2.40
R-124	300 VDC	12,000	1A	1.55
R-511	24 VDC	200	W/MICRO N.O.	3.05
R-160	6 VDC	12	3C&3A	3.00
R-851	52/228 VDC	6500	1C, 1A	3.00
R-591	6 VDC	40	1B&1C	1.35
R-155	12 VDC	100	4A&4B	1.45
R-520	200/300 VDC	14,000	2C	3.45
R-159	6 VDC	50	2A	1.35
R-158	6 VDC	50	4A Cerm.	1.85
R-381	6/8 VDC	100	1A Split	2.50
R-382	6/12 VDC	200	1B Split	2.50
R-153	12 VDC	200	1C&1A	1.55
R-304	12 VDC	200	4A Split Cerm.	2.50
R-383	6/12 VDC	500	1A Split	2.50
R-385	6/12 VDC	500	1B Split	2.50
R-384	6/12 VDC	500	3A Split	3.00
R-576	12 VDC	200	2A	2.50
R-316	24 VDC	200	1C	1.50

OTHER RELAY TYPES IN STOCK

- Keying Relays
- Rotary Relays
- Contactors
- Midget Relays
- Voltage Regulators
- Differential Relays
- Sealed Relays
- Special Relays

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Manufacturers and Distributors:
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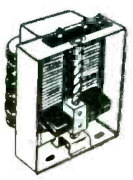
TUBES
AND OTHER RADIO & ELECTRONIC PARTS

110V 60 Cyc TIMING MOTORS

INGRAHAM 8 RPM Fully Enclosed. . $1.95
TELECHRON 3.6 RPM. 2.50
GILBERT With Gear Train for 6 RPDay 1.95
GILBERT 60 RPM (1 RPS). 1.75

VOLTAGE REGULATOR



Amertran Transtat

90 to 130 V, 50-60 cyc, 17.5 Amps, #T282. . **$17.50**
103 to 126 V, 50-60 cyc, 2.17 Amps, #T283. . . **$9.95**
W. E. D122855, 92 to 115 V, 400 cyc, 5.5 Amps, #T28 **$6.75—10 for $60.00**

SHOCKMOUNTS

Series	Mfgr	Lb	Ea
100	Lord	1	.10
100	Lord	2	.10
100	Lord	4	.12
100	Lord	8	.15
100	Lord	9	.18
150	Lord	8	.20
150	Lord	10	.20
150	G'year	25	.25
150PH	Lord	4	.25
150PH	Lord	6	.25
200	Lord	10	.28
200	Lord	20	.30
200	Lord	25	.35
200	Lord	35	.38
200	Lord	45	.45
200PH	Lord	6	.35
200PH	Lord	10	.35
200PH	Lord	12	.38
250PH	Lord	15	.40
250PH	Lord	45	.40

OTHER MOUNTS

VX1021 Harris 2 oz.	.10
2/4" Dia. Lord 2 Lb.	.10
279 Series 250 Lord	1.00
C2030 Barry	1.00

MICROSWITCHES

10 Amp 125 V

Type	Action	Actuator	Each
YZ2R5	SPST n.o.	Pin	.59
BZ2R5	SPDT	Pin	.69
V312	SPST n.o.	Wire	.69
WZ3RTC	SPST n.c.	Pin	.59
APR201	SPST n.o.	Plunger	.79
WZR21	SPST n.c.	Plunger	.79
WZE7RQNT	SPST n.c. Enclosed Type	Plunger	1.50
WZ3RD1	SPST n.c.	Button	.69
WZ7RST1	SPST n.c.	Plunger	.79
YZR31	SPST n.o.	Pin	.69
YZ7RTC	SPST n.o.	Pin	.69
BZR5	SPDT	Pin	.79

ACRO SWITCHES

2MC31A	SPST n.c.	Pin	.59
2MD21A	SPDT 6A	Pin	.69
2MD31A	SPDT	Pin	.79
XC721	SPST n.c.	Leaf	.79
11RC7-1A2T	SPST n.c.	Pin	.69

OTHER SENSITIVE SWITCHES

C-H 8911K524 DPST n.o. Plunger. 79
MuSwitch DGBP32 SPST n.o. Plunger. 95

TOGGLE & PUSH SWITCHES

Contacts	Mfgr. & No.	Description	Amps	Each
SPST	Carling	Small Toggle	3A, 110 V	.15
SPST	A, H&H	Toggle	3A, 250V	.29
SPST	C-H B5A	Aircraft	35A, 24V	.29
SPDT	C-H B9A	Aircraft	35A, 24V	.29
SPDT	A, H&H	Toggle	3A, 125V	.29
DPST	A, H&H	Toggle	3A, 125V	.39
1 B*	A, H&H	Momentary	5A, 125V	.23
1 B*	T&M Co.	Push	3A, 125V	.29
1 A*	Square D	Push	15A, 24V	.49
SPST	Circle F	Molded Toggle	6A, 125V	.35
SPST	A, H&H	Molded Toggle	6A, 125V	.35
DPDT	A, H&H	Molded Toggle	6A, 115V	.69
2Bs	C-H	C6B Aircraft	20A, 125V	.89
DPST	C-H	AN3023-2B	20A, 125V	.89
3DPT	C-H	8744K7	10A, 250V	1.95
3PST	C-H	8740-K4	10A, 250V	129
3PDT Center Off	C-H	8742K6	10A, 250V	2.00
4PDT Center Off	C-H	8905K628	10A, 250V	2.50

*1A=SPST n.o. 1B=SPST n.c.

20% off in lots of 100 or more

KOVAR GLASS TO METAL SEALS HIGH-VOLTAGE FEED THRU

Many types and sizes. Send us your blueprint or sample for our quote. Our prices are a fraction of original factory cost.

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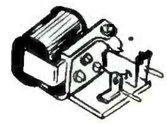
OVER 1000 DIFFERENT TYPES

HERMETICALLY SEALED RELAYS

Clare 5001; 24vdc; DPDT; 300 ohm; Octal Plug Base; #R678. . . . . $5.95
Struthers-Dunn 181CXC100; 12vdc; 3As, 3Bs; #R679. . . . . 5.95
Sigma 73351; 16vdc; SPDT; 2000 ohm; 8 ma; #R682. . . . . 6.95
Sigma 7791; 3v; SPDT; 750 ohm; 4 ma; Octal Plug Base; #R683. . . . . . 6.95

D.C. SENSITIVE RELAYS



RBM 23025 6 ma., SPDT, 8000 ohm, #R428 . . . . 1.50
W.E. (Whelock) KS9665 9 ma., 1A, 1B, 1C, 2000 ohm, #R426. . . . . 4.95
Kurman Midget 12 ma., SPDT, 1500 ohm, #R427 98
Clare Type J (K102) 6 ma., SPDT, 3500 ohm, #R30 . . . . 3.50
Dumont 5 ma., 1A, 5000 ohm #R230. . .98
Automatic 5035A7 8 ma., 1A, 1300 ohm, #103 . . . . 1.25
Cooke Type C 4 ma., 1A, 6500 ohm, #R596 . . . . 3.50
Claire B11613 (K101) 2 ma., SPDT, 6500 ohm, #R588 . . . . 4.95
Clare A8053 8 ma., 3A, 6500 ohm, #R408 . . . . 3.95
Potter-Brumfield; 9 ma; 2500 ohm, SPDT; 5 Amp Contacts; #R364. . 1.25
Potter-Brumfield; 5 ma; 5000 ohm; SPDT; 5 Amp Contacts; #684. . . . 1.50
RBM 452-1041; 4 ma; 12,000 ohm; DPDT; Telephone Type; #R685. . . 4.95

TS2A VARIABLE CERAMICONS

1.5 to 7; 1.5 to 7.5; 3.5 to 30; 5 to 40; 5 to 50; 7 to 45; 30 to 65 mmf (Types NPO & N-500)
35ea; 32.50/C; 300.00/M.
Also 12-62; 20-125 mmf. . **.40 ea; 35.00/C.**

TD2A DUAL CERAMICONS

2X4-30; 2X7-45 mmf. . . . **.60 pr; 54.00/C**

CERAMIC & FEEDTHRU CAPACITORS

Type	No.	MMF Tol.	Ea.	per C
Button	FA	175±10%	.18	15.00
Button	FA	240±10%	.18	15.00
Button	FA	345±10%	.18	15.00
Button	FA	470±10%	.18	15.00
Disc		2000±10%	.40	30.00
Standoff	324	1000±10%	.12	10.00
Feedthru		55±10%	.10	9.00

324 CANAL ST. N. Y. C., 13, N. Y. • WAlker 5-9642

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15 HY @ 800 MA Choke	6.95
2 mfd 3000 V Condenser	4.25

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1N21 Xtal	1.25
1N21A "	2.25
1N21B "	4.25
1N22 "	1.35
1N23 "	2.25
1N23A "	3.25
1N23B "	6.95
1N26 "	5.95
1N27 "	1.69
1N34A "	1.40
1P23	3.95
1P24	1.79
1P36	2.95
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2C34/RK34	.69
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2C44	1.49
2C46	7.50
2C51	6.95
2D21	1.79
2E22	1.95
2E24	4.89
2E26	3.69
2E30	2.29
2J21A	9.95
2J22	8.45
2J26	29.50
2J27	29.50
2J30	99.50
2J31	39.50
2J32	39.50
2J33	39.50
2J34	39.50
2J36	97.50
2J37	12.75
2J38	12.75
2J39	39.50
2J40	39.50
2J46	39.50
2J48	29.50
2J49	39.50
2J50	22.50
2J54B	39.50
2J55	97.50
2J61	49.50
2J62	49.50
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2K28	36.25
2K29	24.50
2K33	310.00
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3B24W	7.95
3B25	4.65
3B26	3.95
3B27	3.95
3B28	8.95
3BP1	8.95
3C22	64.50
3C23	9.95

3C24	$2.25
3C27	4.95
3C31/C1B	3.49
3C45	19.95
3CP1	2.25
2CP1S1	2.95
3DP1	4.95
3DP1A	6.95
3DP1-S2A	8.95
3D21A	1.98
3E29	14.95
3FP7	3.95
3GP1	4.75
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4B25/6CF	8.95
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4B32	9.95
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4C35	34.50
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5AP1	3.69
5AP4	3.69
5BP1	5.95
5BP4	5.95
5CP1	4.95
5CP7	12.95
5C22	55.00
5D21	24.50
5FP7	3.25
5GP1	4.95
5JP1	24.45
5JP2	24.45
5JP4	24.45
5J23	12.95
5J29	12.95
5J30	49.50
5J32	99.50
5LP1	15.95
5NP1	5.95
6AS6	3.69
6C21	24.50
6F4	5.95
6J4	6.95
7BP7	8.95
7DP4	17.95
9GP7	14.95
9JP1	14.95
9LP1	19.95
9LP7	14.95
10BP4	22.50
10	.49
12DP7	16.95
12GP7	16.95
12HP7	16.95
12LP4	22.50
15E	1.19
15R	.89
16AP4	42.50
16CP4	42.50
19T8	2.90
23D4	.45
30 Special	.59
35TG	4.95
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53A	5.95
75TL	6.95
100R	.89
100TH	9.95
121A	2.98
203A	8.95
204A	69.50
211	.69
212E	49.50
215A	.19

217C	$8.95
227/5C27	5.95
24AC	3.95
250R	12.95
250TH	22.50
250TL	21.50
274A	5.50
274B	2.65
276A	9.95
293A	2.98
294A	5.75
300B	9.95
304TH	14.95
304TL	14.95
305A	34.95
307A/RK75	5.95
310A	8.95
316A	.65
323A/B	24.50
327A/5C37	4.95
328A	8.95
331A	12.95
350A	8.95
350B	4.95
368AS	7.95
371A	1.49
371B	.98
388A	2.75
393A	6.95
394A	4.95
417A	12.95
434A	4.95
446A	4.95
446B	4.95
450TH	47.50
450TL	47.50
527	12.75
559	1.39
562	97.50
575A	13.95
701A	5.95
702A	3.95
703A	7.95
704A	1.05
705A	2.95
706BY	39.50
706CY	39.50
706FY	42.50
706GY	42.50
707B	17.95
708A	4.95
709A	3.95
710A/8011	1.75
713	1.45
714AY	6.95
715A	7.95
715B	9.75
715C	29.95
717A	1.69
721A	2.59
722A	2.95
723A	14.95
723A/B	22.50
724B	3.89
725A	7.95
726A	6.95
726B	29.50
730A	30.50
750TL	79.50
800	1.95
801A	.49
802	4.49
803	4.49
804	9.95
805	4.49
806	29.95
807	1.98
808	7.25
809	2.45
810	9.95
811	3.25
812	2.95

812H	$6.90
813	8.95
814	3.95
815	2.95
816	1.30
826	.98
828	12.75
829	12.95
829B	14.95
830B	3.95
832	12.95
832A	12.95
833A	41.50
836A	3.95
837	1.69
838	2.95
841	.45
843	.39
845	4.95
849	39.50
851	69.50
852	29.95
860	6.95
861	29.50
864	.39
865	1.45
866A	1.39
866JR	1.29
869B	49.50
872A	2.95
874	1.49
876	.59
878	2.25
884	1.85
885	1.49
905	3.59
902A	10.95
905	3.59
908	12.95
918	1.69
919	2.79
922	.98
923	1.05
927	1.59
930	1.20
931A	4.95
954	.39
955	.45
956	.45
957	.45
958	.45
959	.69
991/NE16	.39
1603	5.25
1613	1.25
1614	2.25
1616	.98
1619	.35
1622	3.25
1624	1.98
1625	.45
1626	.45
1629	.35
1630	.98
1631	1.29
1632	.79
1633	.75
1634	.75
1636	3.25
1638	.65
1641	2.25
1644	.98
1654	2.39
1655	1.50
1665	1.45
1851	1.89
1960	.79
1961	4.99
2050	1.90
2051	1.45
5670	8.95
8005	5.95

8008	$7.95
8011	1.75
8012	3.95
8013	2.95
8014	29.95
8020	1.29
8025	5.95
9001	2.25
9002	2.25
9003	2.25
9004	.75
9005	2.95
9006	.49
C1JA	9.95
C5B	9.95
C6A	7.95
C6J	6.95
C100D	1.49
CK502AX	2.95
CK503AX	2.95
CK505AX	2.25
CK506AX	2.25
CK507AX	2.25
CK512AX	2.25
CK517AX	8.45
CK1005	.89
CK1006	3.25
E1148	.35
EF50	.69
F123A	8.75
F127A	22.50
F128A	89.50
F606	37.60
F660	79.50
FG17	3.95
FG27A	8.75
FG32	7.95
FG57	14.95
FG81A	3.95
FG105	22.95
FG172	34.50
FG146	8.95
FG434A	4.95
FG451	.89
FG502A	1.85
FG562	97.50
FG592	14.95
GL502	1.85
HF125	14.95
HF300	19.95
HY114B	.79
HY115	.79
HY615	.29
KC4	37.50
KU610	6.95
ML101	69.50
REL21	3.95
RK20	9.95
RK25	4.49
RK33	.69
RK34	.89
RK48A	4.49
RK59	1.49
RK60/1641	2.25
RK65	24.50
RK72	.59
RK73	.59
RX21A	2.95
RX120	8.95
V70D	6.95
VR78	.69
VR91	1.49
VR92	.98
VT127A	3.95
VT158	14.95
VU129	2.95
VU111	1.49
WL468	12.95
WL530	12.75
WL531	12.75
WL532	2.95
WL578	81.29

WL616	$37.50
WL619	18.95
WL677	34.50
WL681	22.50
OA2	1.55
OA4G	1.20
OB2	1.65
OZ4	.75
01A	.73
1A3	.73
1A4P	1.30
1A5GT	.78
1A6	.85
1A7GT	.95
1AB5	.80
1B3/8016	1.25
1B4	1.15
1B5/25S	.95
1B7GT	1.25
1C5GT	.85
1C6	.73
1C7G	.73
1D5GP	.73
1D7G	.73
1D8GT	.73
1E5GT	.73
1E7G	1.19
1F4	.73
1F5G	.73
1G4	.73
1G6GT	.73
1H4G	.89
1H5GT	.75
1H6GT	1.05
1J6	.98
1L4	.73
1LA4	.89
1LA6	1.15
1LB4	1.06
1LC5	.89
1LC6	.98
1LD5	.98
1LE3	.85
1LG5	.85
1LH4	.89
1LN5	.95
1N5GT	.89
1P5GT	.79
1Q5GT	.73
1R4	.73
1R5	.95
1S4	.73
1S5	.85
1T4	.85
1T5GT	.73
1U4	.89
1V	.72
1X2	1.18
2A3	.95
2A4G	1.25
2A5	.73
2A6	.73
2A7	.75
2B7	.75
2V3G	.79
2X2	.65
2X2A	1.60
3A4	.65
3A5	.90
3B7/1291	.59
3D6/1299	.59
3LF4	.95
3Q4	.79
3Q5GT	.85
3S4	.85
3V4	.90
5R4GV	3.75
5T4	1.95
5U4G	.73
5V4G	1.12
5W4	.81
5X4G	.89
5Y3GT	.63

5Y4G	$0.73
5Z3	.89
5Z4	.89
6A3	1.25
6A4LA	1.35
6A6	.92
6A7	.99
6A8	1.05
6AB7	1.05
6AC5GT	1.20
6AC7	1.15
6AD7GT	1.35
6AE6G	.89
6AF6G	.95
6AG5	.89
6AG7	1.55
6AH6	1.40
6AJ5	1.15
6AK5	1.50
6AK6	1.25
6AL5	.82
6AQ5	.92
6AQ6	.87
6AR5	.79
6AT6	.73
6AU5	1.25
6AU6	.93
6AV6	.72
6B6G	.99
6B7	.85
6B8G	.85
6BA6	.85
6BC5	.98
6BE6	.85
6BF6	.79
6BG6G	1.18
6BH6	.97
6BJ6	.97
6BQ6	1.35
6C4	.85
6C5	.79
6C6	.79
6C8G	.98
6CB6	.98
6D6	.85
6D8	.95
6F5	.79
6F6	.79
6F7	.89
6F8G	.95
6G6G	1.15
6H6	.75
6H6GT	.79
6J5	.75
6J5GT	.73
6J6	1.20
6J7	.82
6K5GT	.89
6K6GT	.79
6K7	.79
6K8	.73
6L5G	.87
6L6	3.00
6L6G	1.75
6L6GA	1.75
0L7	.98
6L7G	.95
6N7	.89
6Q7	.85
6R7	.85
6S7G	.98
6S8GT	1.05
6SA7	.85
6SC7	1.30
6SD7GT	.98
6SF5	.89
6SF5GT	.89
6SF7	.98
6SG7	.98
6SH7	.98
6SJ7	.89
6SK7	.89

6SL7GT	$0.98
6SN7GT	.98
6SQ7	.75
6SR7GT	.85
6SS7	.95
6ST7	1.10
6SU7GTY	2.15
6SV7	1.25
6T7G	1.20
6T8	1.18
6U5G	.95
6U6GT	.98
6U7G	.59
6V6	1.55
6V6GT	.89
6W4	.85
6W7G	1.05
6X4	.73
6X5GT	.75
6Y6G	.98
6Y7G	1.25
6ZY5G	.89
7A4/XXL	.79
7A5	.89
7A6	.85
7A7	.85
7A8	.89
7AG7	1.05
7B4	.85
7B5	.85
7B6	.85
7B7	.85
7C4	.79
7C5	.85
7C6	.79
7C7	.85
7E5	.75
7E6	.59
7E7	.89
7F7	.85
7H7	.85
7K7	1.20
7L7	.98
7N7	.98
7Q7	.83
7R7	.95
7S7	.98
7V7	.95
7W7	1.05
7X7	1.10
7Y4	.75
7Z4	.85
12A	.65
12A6	.73
12A7	1.05
12A8GT	.79
12AH7GT	1.27
12AL5	.93
12AT6	.73
12AT7	1.25
12AU6	.95
12AU7	1.15
12AV6	.73
12BA6	.85
12BE6	.87
12C8	.79
12F5GT	.79
12H6	.82
12J5GT	.55
12J7GT	.82
12K7GT	.79
12K8	.89
12Q7	.69
12SA7GT	.93
12SC7	.99
12SF5	.89
12SF7	.89
12SG7	.79
12SH7	.73
12SJ7	.79
12SK7	.98

12SL7	$1.05
12SN7	.98
12SQ7	.85
12SR7	.85
12Z3	.85
14A4	.98
14A7	.95
14B6	.95
14E7	.95
14F7	.95
14F8	.95
14H7	.95
14J7	.95
14N7	.95
14Q7	.95
14R7	.95
19	.69
24A	.75
25L6GT	.85
25Z5	.79
25Z6GT	1.05
26	.50
27	.49
28D7	2.25
30	.49
31	.85
32	.95
32L7GT	.89
33	.93
34	.89
35/51	.83
35A5	.89
35B5	.89
35C5	.98
35L6GT	.85
35W4	.75
35Y4	.75
35Z3	.85
35Z4	.73
35Z5	.69
36	.79
37	.79
38	.60
39/44	.40
41	.75
42	.75
43	.75
45	.89
45Z3	.89
45Z5	.80
46	.82
47	.89
48	.98
49	.95
50A5	.95
50B5	.95
50C5	.95
50L6GT	.85
50Y6	.85
53	.98
56	.65
57	.80
58	.85
59	.95
70L7	.95
71A	.75
75	1.25
76	.55
77	.60
78	.79
80	.73
82	.89
83	1.15
83V	1.15
84/6Z4	.85
85	.89
89Y	.45
117L7/M7	1.35
117N7	1.35
117P7	1.35
117Z3	.89
117Z6	.90

RADAR—COMMUNICATIONS—TEST EQUIPMENT

AN/APA10 Panoramic Adapter	$175.00
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BC221AK Freq. Mtr. with Modulation	149.50
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BC-1016 Tape Code Recorder	459.50
BC-1206 Beacon Receiver	4.95
MN26Y Compass Receiver	24.95
PE-75 2½KW Gasoline Generators	450.00
RA-34 Power Supply	250.00
SCR269G Automatic Radio Compass	129.95
SCR504 Portable D.F. 100 KC-65MC	
SCR522 Airborne VHF Transceiver.	
SCR536 Handi-Talkie.	
SCR694 Lightweight Field Radio.	
SK-1M Radar Receiver Indicator	89.50
SQ Portable Radar 10 CM	850.00
T-50 Portable Radiotelegraph Xmitter	275.00
TCS Marine 2 Way Radio.	
TRC-1 Complete Antenna System.	
RA-62 Power Supply for SCR-522	
MD-5/APS-3 Modulators with Tubes	65.00

AN/ARR-2X RECEIVER

Secret Transmission Receiver for reception of double modulated carrier. Will receive 235-258 mcs signals that have been modulated by a 600-750 KC signal. When carrier is heard on a standard receiver no modulation is heard on the carrier when actually speech is being transmitted. 12V DC input. Excellent condition.

ARA 500-1500KC Receiver, good	$24.95
R28/ARC-5 Receiver	29.95
BC455B 6-9 mcs. Receiver	19.95
BC433 200-1750KC Compass Rec.	29.95
ARR-2 234-258 mcs. Receiver	19.95
BC-454 3-6 mcs. Rec. w/tubes. New	16.95
T23/ARC-5 Xmitter	49.95
BC696-A 3-4 mcs Xmitter	29.95
TYPE O 5.3-7 mcs Xmitter	9.95
AVT-23 300-13,000KC Complete. New	79.50
BC-950A 100-156 mcs. Xmitter. New	59.95
BC-456 Modulator, good	2.25
BC-450 Control Box (3 Rec.) used	1.25
BC-442 Relay Unit (Ant) used	1.95
BC-451 Control Box (Xmitter) used	.98

FLEXIBLE SHAFTING AVAILABLE.

HRU-28 28V 2000W Gasoline Generator	
RG-8U Coaxial Cable. Per Thousand Feet	$85.00
SCR-518 Altimeter. Complete installation	29.95
SCR-522 Trans/Rec. Complete installation 28V Input. 12V input avail.	129.50
RCA Sound Powered Chest & Headsets, Pair	29.95
LARGE QUANTITY PE-104 VIBRAPACK FOR SCR-284 NEW EXPORT PACKED	
HS-30 Headsets	3.95
FT-154 (BC-348 Shock Mount)	2.98
HS-33 Headsets	4.95
BC-608 Automatic Keyer for SCR522	5.95
BC1284 Lighthouse Tube Preamplifier	69.95
APA-17 D.F. Antenna. 300-1000 MC	59.00
BC-996 Interphone Amplifier	9.95
ART-13 Loading Condenser	4.95
CU-25 Loading Box for Art-13	49.95
AS-27/ARN5 Antenna	4.95
SA-1/ARN-1	2.95
ID-80/APA-17 Indicator	129.95
RM-29 Remote Control	18.95
RA-300 FM Exciter	32.50
A-55 Dummy Antenna	2.25
BC-1365 Control Box	3.95
FL-8 Filter	3.95
FL-5 Filter less Cables	2.65
3C-16D GSAP Gun Camera Computer, complete	19.95
AT-2/APN-2 Antenna	4.95
CG-(172/173)CPN-8 10CM Patch Cable	4.95

TS3/AP S-Band Freq & Power Meter.	
TS10/APN Altimeter Test Set, Ex.	$ 35.00
TS11/AP	
TS12/AP V.S.W.R. Test Set for X-Band.	
TS13/AP XA Band Sig Gen Pwr & Freq Mtr.	
TS14/AP SA Band Sig Gen.	
TS15/AP Flux Meter.	
TS16AP/ Altimeter Test Set	$ 29.95
TS19/APQ5 Range Calibrator.	
TS23/APN Test Set for SCR718 Altimeter.	
TS32/TRC-1 70-100 mcs Sig Gen used to check ANTRAC Equipment.	
TS33/AP X-Band Freq. Meter.	
TS34/AP Synchroscope.	
TS35/AP X-Band Sig Gen Pwr Mtr Freq Mtr.	
TS36/AP X-Band Power Meter.	
TS45/AP X-Band Sig Gen.	
TS47/APR Sig Gen 40-500 Mcs.	
TS59/APN Altimeter Test Set.	
TS61/AP S-Band Echo Box	$140.00
TS62/AP X-Band Echo Box.	
TS67/AP I.L.S. Test Set.	
TS69/AP Freq. Mtr. 300-1000 mcs	$ 72.50
TS89/AP Voltage Divider.	
TS102/AP Range Calibrator.	
TS110/AP Echo Box.	
TS111/AP S-Band Freq. Meter.	
TS125/AP S-Band Power Meter.	
TS126/AP Synchroscope.	
TS155/UP S-Band Sig Gen Pwr Mtr Freq. Mtr.	
TS164/AR A.C. Version of BC221.	
TS170/ARN I.L.S. Test Set.	
TS174/AP Freq. Mtr. 40-400 Mcs	$385.00
TS175/AP Freq. Mtr. 300-1000 mcs.	
TS184/AP	
TS189/AP	
TS226/AP 300-1000 mcs Pwr Mtr	
TS268 Xtal Diode Test Set.	
TS278/AP AN/APS13 Test Set	
BC-221 Frequency Meter.	
1E-19 Test Set for SCR522.	
1E-36 Test Set for SCR522.	

SO-13 S-BAND MARINE RADAR

Compact Sea Search Radar for small vessels. P.P.I. indication is provided. Complete in original cases with complete sets of spares. Excellent condition.

AN/ARC-1 TRANS/REC.

Provides Radio-Telephone Communication between Aircraft or Aircraft & Ground. Complete with Shock Mount & Control Box. Input: 28V DC. Excellent condition. Available in either 10 or 20 Crystal Controlled Channels 100-156 MCS. checked out.

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MOTOR SPECIALS
BODINE NSHG-12 MOTOR
Constant Speed

27 v. D-C Governor controlled 3000 rpm. 1/30th hp. Stock #SA-39. **Price $17.50 each.**

DELCO CONSTANT SPEED MOTOR A-7155

1/30 hp. 27.5 v d-c 3600 rpm. Cont. duty. 2½" diam. x 5½" lg. ⅞" shaft extension. 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $12.50 each**

JA1 MOTOR (D-C)

Electric Specialty. ¼ hp. 24 v. D-C. (Wing flap motor.) Stock #SA-325. **Price $19.50 ea.**

¾ HP DC MOTOR
Electric Specialty Co. HOA315T.

24 volts DC. 3800 rpm. Stock #SA-321. **Special Price $24.50 each**

DC Motor Special

1¾ hp. 28 v. DC. motor. Magnetic brake. Electric Specialty Co. type HCA32B. **Large Qty. Available.**

Dumore DC Motor

Type E1Y2PB. 24 v. DC @ 5.0 Amps. Model 1023-263. Gear Head. 200 rpm. 10 min. 0.05 hp. Stock #SA-316. **Price $12.75 each.**

PERMANENT MAGNET GEARHEAD MOTORS

Delco type 5069600—27.5 v. DC. 250 rpm output shaft speed. 12 in/oz.
Delco type 5071895—27.5 VDC. 250 rpm.
Delco type 5069230—27.5 VDC. 145 rpm.

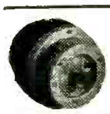
AC-SERVO MOTORS
PIONEER CK-17

400 cycles, 2 phases, 26 v. fixed phase. 45 v. max. variable phase. Built in gear reduction. Output shaft speed approx. 4 rpm. Stock #SA-287. **Price $16.50 each.**

FORD SERVO MOTOR

115 volt 60 cycle two phase low inertia motor. 15 watts output. BuOrd. 207927. Stock #SA-291. **Price $49.50 each.**

Pioneer Servo Motor



Type 10047-2A. 2 φ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. **Stock #SA-90. Price $12.50 each.**

C1B THYRATRON

Special offer — Large quantity C1B thyratrons available. New, original packing. Write for quantity quotation.

1 H.P. VARIABLE SPEED DRIVE
Louis Allis Adjusto-Spede

Squirrel Cage A-C motor and an electromagnetic clutch and pilot governor. Speed range 0-1050 rpm. Three phase. 208 v. operation. 60 cycles. DC excitation 0-10 volts. Small quantity available.

— SERVO SPECIAL —
Low Inertia Servo Motor
400 Watts Output

115 volt 2 ph. 2 pole. 60 cy. Mfd. by Pioneer-Bendix.

Uses built in Fan Motor.

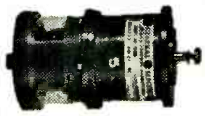
Navy Type CM-211518A W.E. KS-151182L1
Small Qty. only

MAGNETIC AMPLIFIER
Pioneer Type 12077

115 V. 400 cy. One Tube Servo Amplifier using saturable reactor type output transformer.

Limited Quantity

SELSYN SPECIAL



General Electric 2J1F3

115 v. 400 cycle Selsyn Generator. Large quantity.
Prices on request

OSTER MOTOR

John Oster Type B-9-1 motor with dual output shaft gear reduction. Cam operated linear motion translation. Motor 27.5 v. DC at 0.7 Amps. 5600 rpm. Stock #SA-335. **Price $9.75 each.**

REVERE CAMERA MOTOR

27 v. D-C Split field series. Approx. 2½" sq. x 2½" lg. Stock #SA-315.
Price $6.75 each.

Indicator Attitude Gyro

Sperry No. 659644. Gov't. No. R-86-1-1310 Three phase 115 v. 400 cycle. Navy overhauled May 1950. **Prices on request.**

SYNCHROS-SELSYNS

1SF, 5G, 5F, 5CT, 5HCT, 5SDG, 5DG, 5SG, 5SF, 5HSF, 6G, 6DG, 7G, 2J1F1, 2J1G1, 2J1H1, 2J5FB1, 2J5R1, 2J1" F3, XX1, X, XV, VII, II, 5V, etc.

MAGNESYNS

Pioneer Type CL-3, 6 power.
Pioneer 1006-1E-B1 Indicator. AN-5730-2.

BLOWER ASSEMBLY
WESTINGHOUSE FL Blower

115 v. 400 cy. 17 c.f.m. Includes capacitor. Stock #SA-144. **Price $14.50 ea.**

Radio Compass Indicator

I-82F. Compass Indicator. 0-360°-5 in. dial. 26 v. 400 cy. 8-12 v. 60 cy. Ideal position indicator. Stock #SA-284.
Price $6.50 each

PRECISION AUTOSYN

Pioneer Type AY-150 Control Autosyn. Precision type. 26 v. 400 cycle. Stock #SA-297. **Special low price $14.50 each.**

CONSTANT VOLTAGE TRANSFORMER
One only.

Sola No. 30710. Dual voltage primary 95-125/190-250 volts. Secondary 115 volts 60 cycles at 17.4 Amps. 2000 VA. **Special Price $145.00.**

INVERTERS

WinchargerPU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 φ at 2500 VA. Voltage and frequency, regulated. Cont. duty. Stock #SA-164. **Price $89.50 each.**

G.E. 5AS131NJ3 (PE-118) Input 26 VDC at 100 amps. Output 115 v. 400 cy. 1 φ at 1500 VA. PF 0.8 W.E. Spec. KS-5601L1. Stock #SA-286. **Price $29.50 ea.**

PE-218EInverters Russell Electric and Leland. Input 28 VDC at 92 amp. Output 115 v. 400 cycles at 1500 VA. PF 0.9. Stock #SA-112A. **Price $49.50 each.**

Pioneer 12130-4-B Input 28 VDC at 14 amps. Output 120 v. 400 cy. single phase at 1.15 amps. (140 VA.) Voltage and frequency regulated. Made 1949. Stock #SA-304. **Price $89.50 each.**

Leland SD-93—(10285)—Input 28 volts DC at 60 amps. Output 115 volts three phase 400 cycles at 750 va. 0.90 P.F. Second output voltage of 26 volts 400 cycles at 50 V.A. Voltage and frequency regulated. Designed for use with various autopilots. Stock #SA-209. **Price $99.50 each**

D-C ALNICO FIELD MOTORS

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Prices F.O.B. Paterson
Phone ARmory 4-3366

Servo-Tek products co.
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A C MOTORS

TELECHRON SYNCHRONOUS MOTOR, Type B3, 110 V., 60 Cy., 4 W., 2 RPM. PRICE $5.00 EA.

TELECHRON SYNCHRONOUS MOTOR Type BC, 110 V., 60 Cy., 6 W., 60 RPM. PRICE $4.00 EA.

EASTERN AIR DEVICES, Type J33, Synchronous, 115 V., 400 Cy., 3φ, 8000 RPM. PRICE $15.00 EA.

HAYDON TIMING MOTORS 110 V., 60 CY.

Type 1600, 2.2 W., 4/5 RPM. PRICE $3.00 EA.

TPE 1600, 2.2 W., 1/240 RPM. PRICE $3.00 EA.

TYPE 1600, 2.3 W., 1 RPM. PRICE $3.00 EA.

TYPE 1600, 2.2 W., 1-1/5 RPM. PRICE $3.00 EA.

TYPE 1600, 3.5 W., 1 RPM., With shift unit automatic engaging and disengaging shaft. PRICE $3.75 EA.

TYPE 1600, 2.2 W., 1/60 RPM. PRICE $3.00 EA.

SERVO MOTORS

CK1, PIONEER, 2 φ 400 Cy. PRICE $10.00 EA.

CK2, PIONEER, 2 φ, 400 Cy. PRICE $14.00 EA.

CK2, PIONEER, 2 φ, 400 Cy., with 40:1 reduction gear. PRICE $15.50 EA.

10047-2-A, PIONEER, 2 φ, 400 Cy., with 40:1 reduction gear PRICE $10.00 EA.

MINNEAPOLIS HONEYWELL Type B, Part No. G303AY, 115 V., 400 Cy., 2 φ, built-in reduction gear, 50 lbs. in torque. PRICE $10.00 EA.

MINNEAPOLIS HONEYWELL Amplifier Type G403, 115 V., 400 Cy., Used with above motor. PRICE $10.00 EA. WITH TUBES

REMOTE INDICATING COMPASSES 26 V., 400 CY.

PIONEER TYPE AN5730-2 Indicator and AN5730-3 Transmitter. PRICE $40.00 PER SET

KOLLSMAN TPE 680K-03 Indicator and 679-01 Transmitter. PRICE $15.00 PER SET

D C MOTORS

DELCO MOTOR, TYPE 5068750, 27 V., D.C., 160 R.P.M., with Brake. Price $22.50 EA.

JAEGER WATCH CO. TYPE 44K-2 Contactor Motor, 3 to 4.5 V. Makes one contact per second. PRICE $3.50 EA.

GENERAL ELECTRIC TYPE 5BA10AJ37, 27 V., 0.5 amps., 8 oz. in torque, 250 RPM. PRICE $10.00 EA.

BARBER-COLMAN CONTROL MOTOR, Type AYLC 5091, 27 V., 0.7 Amps., 1 RPM. Contains 2 adj. limit switches. 500 in. lbs. torque. PRICE $9.50 EA.

WHITE RODGERS ELECTRIC CO., Type 6905 No. 3, 12 V., 1.3 Amps., 1½ RPM, torque 75 in. lbs. PRICE $10.50 EA.

ENGINE HOUR METER

John W. Hobbs Model MI-277. Records running time up 1000 hours. 20 to 30 volts D.C. PRICE $15.50 EA.

INVERTERS

WINCHARGER CORP. PU-16/AP, MG750. Input 24 V. D.C., 60 Amps. Output 115 V., 400 Cy., 1 φ, 6.5 Amps. PRICE $100.00 EA.

HOLTZER CABOT TYPE 149F, Input 24 V. D.C. at 36 Amps., Output 26 V. at 250 V.A., 400 Cy., and 115 V., 400 Cy., at 500 V.A., 1 φ, PRICE $75.00 EA.

PIONEER TYPE 12117. Input 12 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE $30.00 EA.

PIONEER TYPE 12117. Input 24 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE $30.00 EA.

PIONEER TYPE 12116-2-A. Input 24 V. D.C., at 5 Amps. Output 115 V., 400 Cy., 1 φ at 45 watts. PRICE $100.00 EA.

GENERAL ELECTRIC TYPE 5D21NJ3A. Input 24 V. D.C. at 35 Amps. Output 115V., 400 Cy., 485 V.A., 1 φ. PRICE $35.00 EA.

LELAND PE 218. Input 24 V. D.C. at 90 Amps. Output 115 V., 400 Cy., 1 φ at 1.5 K.V.A. PRICE $47.50 EA.

PIONEER AUTOSYNS

TYPE AY1, 26 V., 400 Cy. PRICE $8.50 EA.

TYPE AY5, 26 V., 400 Cy. PRICE $8.50 EA.

TYPE AY14G, 26 V., 400 Cy. PRICE $15.00 EA.

TYPE AY 14D, 26 V., 400 Cy. PRICE $15.00 EA.

TYPE AY54D, 26 V., 400 Cy. PRICE $10.00 EA.

TYPE AY131D Precision Autosyn. PRICE $35.00 EA.

PIONEER AUTOSYN POSITION INDICATORS & TRANSMITTERS

TYPE 5907-17. Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE $30.00 EA.

TYPE 6007-39. Dual Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE $50.00 EA.

TYPE 4550-2-A Transmitter, 26 V., 400 Cy., 2:1 gear ratio. PRICE $20.00 EA.

VOLTAGE REGULATORS

LELAND ELECTRIC CO. TYPE B, Carbon Pile type. Input 21 to 30 V. D.C. Regulated output 18.25 at 5 Amps. PRICE $6.50 EA.

WESTERN ELECTRIC TRANSTAT VOLTAGE REGULATOR Spec. No. V-122855, Load K.V.A. 0.5. Input 115 V., 400 Cy. Output adjustable from 92 to 115 V PRICE $10.50 EA.

RATE OR TACHOMETER GENERATORS

EASTERN AIR DEVICES J36A, .02 V. D.C. per RPM. Max. speed 5000 RPM. PRICE $17.50 EA.

ELECTRIC INDICATOR CO. TYPE B68 Rotation Indicator, 110 V., 60 Cy., 1 φ. PRICE $14.00 EA.

GENERAL ELECTRIC TACHOMETER GENERATOR TYPE AN5531-1. Variable frequency, 3 φ output. PRICE $25.00 EA.

GENERAL ELECTRIC TACHOMETER GENERATOR TYPE AN5531-2. Variable frequency, 3 φ output. PRICE $30.00 EA.

ALL PRICES F. O. B. GREAT NECK N. Y.

SYNCHROS

1F SPECIAL REPEATER, 115 V., 400 Cy. PRICE $20.00 EA.

2J1F3 GENERATOR, 115 V., 400 Cy. PRICE $10.00 EA.

2J1G1 CONTROL TRANSFORMER, 57.5/57.5 V., 400 Cy PRICE $10.00 EA.

2J1F1 GENERATOR, 115 V., 400 Cy. PRICE $10.00 EA.

2J1H1 DIFFERENTIAL GENERATOR 57.5/57.5 V., 400 Cy. PRICE $10.00 EA.

5SDG DIFFERENTIAL GENERATOR, 90/90 V., 400 Cy. PRICE $20.00 EA.

5G GENERATOR, 115 V., 60 Cy. PRICE $50.00 EA.

W. E. KS-5950-L2 Size 5G, 115 V, 400 Cy. PRICE $10.00 EA.

D C ALNICO FIELD MOTORS

DIEHL TYPE S.S. FD6-23, 27 V., 10,000 RPM. PRICE $10.00 EA.

DELCO TYPE 5069466, 27 V., 10,000 RPM. PRICE $15.00 EA.

DELCO TYPE 5069370, 27 V., 10,000 RPM. PRICE $15.00 EA.

DELCO TYPE 5072400, 27 V., 10,000 RPM. PRICE $15.00 EA.

BLOWER ASSEMBLIES

JOHN OSTER TYPE MX215/APG, 28 V. D.C., 7,000 RPM, 1/100 H.P. PRICE $10.00

WESTINGHOUSE TYPE FL, 115 V., 400 Cy., 6,700 RPM, Airflow 17 C.F.M. PRICE $10.00 EA.

DELCO TYPE 5068571 Motor and Blower Assembly, P.M. Motor, 27 V., 10,000 RPM. PRICE $15.00 EA.

GENERAL ELECTRIC D C SELSYNS

8TJ9-PAB, TRANSMITTER, 24 V. PRICE $4.50 EA.

8DJ11-PCY, INDICATOR, 24 V. Dial marked −10° to +65°. PRICE $6.00 EA.

8DJ11-PCY, INDICATOR, 24 V. Dial marked 0 to 360°. PRICE $7.50 EA.

RECTIFIER POWER SUPPLY

Hammett Electric Mfg. Co., Model SPS-130, Input Voltage AC 208 or 230, 60 cycle, 3 phase, 21 amps. Output 28 Volts, 130 amps, continuous duty. 37" high, 22½" wide, 21" deep. Contains DC Volt meter, DC amp meter and 8 point tap switch for variable output voltage. Brand new. Price $350.00.

MISCELLANEOUS

SPERRY A5 CONTROL UNIT, Part No. 644836. PRICE $7.50 EA.

SPERRY A5 AZIMUTH FOLLOW-UP AMPLIFIER, Part No. 656030, with tubes. PRICE $5.50 EA.

SPERRY A5 DIRECTIONAL GYRO, Part No. 656029, 115 V., 400 Cy., 3 φ. PRICE $25.00 EA.

PIONEER TYPE 12800-1 GYRO SERVO UNIT. 115 V., 400 Cy., 3 φ. PRICE $20.00 EA.

ALLEN CALCULATOR TYPE C1 TURN & BANK INDICATOR, Part No. 21500, 28 V. D.C. PRICE $15.00 EA.

TYPE C1 AUTO-PILOT FORMATION STICK, Part No. G1080A3. PRICE $15.00 EA.

PIONEER GYRO FLUX GATE AMPLIFIER Type 12076-1-A, 115 V., 400 Cy. PRICE $40.00 EA.

INSTRUMENT ASSOCIATES

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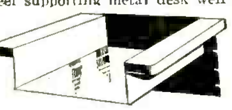
TYPEWRITER WELL

Heavy Duty Standard Panel, 19" x 10½"W x ⅛", tough steel supporting metal desk well 20" x 15" wide x 4½" deep. Ideal for that new, compact rig. Space saving panel may be used to support extra equipment. Attractive gray finish. New. Only a few left $4.95



OIL CONDENSERS Mfd.	Volt.	Price
5	50	$0.45
650	80	1.95
15	220AC	2.20
0.5	750AC	1.59
0.5	1000	.69
2x0.5	1000	.70
1	1000	.75
1.5	1000	.85
2	1000	.90
4	1000	1.75
3x.01	1200	1.35
1	1500	1.30
1.5	1500	1.40
2	1500	1.45
0.15	4000	1.20
2x0.1	4800	1.20
0.1	6000	2.39
1.5	6000	17.50
2x0.1	7000	2.95
.015	16000	3.95
.0016	15000	5.95
.25	20000	
1	25000	
.5	25000	
1	7500	

MANY OTHERS

MOTOR START. COND. Cap	Vac.	Price
13-15	220-	$1.20
20-24	110-	1.00
26-30	220-	1.35
43-65	110-	1.25
43-48	110-	1.25
50-75	110-	1.25
53-60	220-	1.50
61-69	320-	1.60
64-72	110-	1.25
72-87	110-	1.25
75-84	110-	1.25
88-106	110-	1.50
107-129	110-	1.65
130-157	110-	1.75
130-150	70-	1.50
130-180	110-	1.85
158-191	110-	1.85
161-180	110-	1.75
189-210	110-	1.95
200-220	110-	1.95
270-300	110-	2.10
324-360	110-	2.40
378-420	175-	3.00
432-480	110-	2.75
485-540	110-	2.85

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps.	Radio Set
PE86	28	1.25	250	.060	RC36
DM416	14	6.2	330	.170	RU 19
DM33A	28	7	540	.250	BC 456
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1,75	285	.075	APN-1
ZA0515	12/24	4/2	500	.050	
B-19 pack	12	9.4	275	.110	MARK II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	.5	

INVERTERS

PE-218-E: Input: 25 28 vdc. 92 amp. Output: 115 v. 350-500 cy 1500 volt-amperes. Dim. 17"x6½"x10". New $34.50

PE-218-H: Same as above except size: 16½"x6"x10". New $34.50

PE-206: Input: 28 vdc, 38 amps. Output: 80 v 800-cy. 500 volt-amps. Dim: 13"x5½"x10½". New.... $22.50

MG 149F. Input: 24 vdc, 36A. Output: 26 v @ 250 va. 400 cy, and 115 v @ 400 cy—500 va 1 phase.... $75.00

AUDIO TRANSFORMERS

AT501 Hi-Fi Special: PRI: 3000 ohms P-P/Sec: 4/16/12/50/200 ohms 60-10,000 CY.—1 db 50W $3.49

AT152 Hi-Fi Driver Pri: 10,000 ohms Sec: 40,000 ohms PP Grids 50-15 KC/1 db........ $1.49

AT063 Output to H.S. or line PRI: 14,200 ohms SEC: 8000/600 ohms 1.19

AT449 Hi-Fi Driver (5000 ohms) to P.P. output grids (4,000 ohms) 100-10,000 CY. 10 W. 6V6 to PP 805's $2.39

AT666 Intercon Input: Spkr (-4-8 ohms) to grid (250,000 ohms) $0.69

AT415 Plate (18.000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY........ $1.95

AT858 Plate (10,000 ohms C.T.) to line V.C. (500/125130 ohms) HI-FI—50 W........ $6.95

AT070 Mike-or-Line (250 ohms) to grid (250.000 ohms C.T.) $1.29

AT765 Mike-or-Line (600 ohms) to grid (50,000 ohms C.T.) $0.89

AT-871 Universal Output—10W Hi-Fi
PRI: 20,000 Ohms P-P/16,000 Ohms P-P also 5000/4000 ohms. Single End.
SEC. 500/15/7.5/3.75/1.25 ohms. Response Flat P.M. 1 d.b. 30-20,000 Cycles........ $4.75

AT-694 Hi-Fi Output: 3 Watts. 8500 Ohms P-P to V.C. (15 Ohms) 15-15KC PM 1 db........ $1.49

AT4-AI: Mike (35 ohm Carbon) to Line 600 ohm/200 ohm $1.19

AT 649: Line (500 ohms) to Grid (75K ohms).... .89¢

AT 448: Line (600 ohms) to V.C. (6 ohms) 17 d.b. Level $1.19

AT 631: Mike-or-Line (200 ohms) To Single or P-P Grids (50K Ohms)........ .59¢

AT 718 Line (300 ohms) to Line (600/30 Ohm) Response 50-20KC P.M. 1 db........ .49¢

TUBES! VACUUM TUBES TUBES!

Tube	Price	Tube	Price	Tube	Price
01A	.66	12HP7	14.65	723A	9.75
2C21	.66	12SK7	.79	723A/B	17.95
2C22	.54	12SR7	.79	724B	3.15
2J21A	14.95	15E	.98	725A	7.95
2J22	14.95	15R	.75	726A	6.75
2J26	24.50	23D4	.42	730A	37.50
2J27	21.50	35/51	.74	800	1.45
2J31	29.75	38	.54	801-A	.44
2J32	38.75	39/44	.52	809	2.35
2J38		45S	.32	837	1.65
2J39	47.50	227A	4.39	838	3.25
2J49	59.50	5C27	4.39	860	
2J61	54.50	355A	14.00	861	23.50
2J62	48.50	417A	8.75	876	1.45
3B24W	5.25	532	3.49	932	.75
3BP1	4.95	559	.98	1619	.28
3CP1	2.25	615	.44	1625	.39
3C23	9.95	700-A	23.50	1626	.39
3C30		700-B	23.50	1629	.35
3DP1	3.95	700-C	23.50	1961	4.75
3EP1	3.95	703-A	6.75	8013A	4.85
3FP7	2.19	704-A	.89	9004	.49
3J31	85.00	705-A	2.45	9006	.27
4C27	9.75	706-AY	42.50	GL697	
4J38	87.50	706BY	37.50	NR74	.27
5FP7	2.95	706CY	37.50	QK60	85.00
5GP1	4.75	706EY	44.50	QK61	85.00
5J23	12.75	715B	15.95	QK62	85.00
5J30	24.50	717A	1.25	VR91	1.45
6U5/6U5G	.89	718DY	44.50	WL530	9.95
10Y	.47	719A	24.50		

IE-12
SCR 522 TEST SET-UP

CONTAINS SIG. GEN. 1-96, F.S. METER 1-95, RCVR.-XMTR. SCR 522, ALSO, CONTROL BOXES, CABLES, ALL CRYSTALS, DYNAMOTOR, TOOL SET, INSTRUCTION MANUAL, ETC. BRAND NEW, COMPLETE........ $1295.

SPECIALS

BC 306 ANTENNA TUNING UNIT, NEW...... $6.95
R9/APN-4, New, With Tubes........ $75.00
ID6/APN-4, New, With Tubes and Crystal...... $75.00
A-62 Phantom Antennae........ $8.50
2 Meter Choke, 1000 MA, 20-144........ 8/$1.00
Supersonic Crystal Head, M-1, 22-27KC HI-2... $27.45
Underwater Microphone, Model JR, Z=50ω...... $24.50
Dynamic Mike & Headset Combo. B-19. New.... $3.75
HS-30 Inserts, M-300........ $3.50 per M
Motors, 3 RPM—115V, 60 Cy........ $1.85
AN/ARC-4 VHF Trans-Rcvr........ $75.00
IE 36 Test Set, New........ $37.50
SCR 274 Test Set, I-104........ $42.25
Time Delay Relay—45 Sec. 115VAC-DC 10A...... $2.29
Carbon Pile Reg., 18V-.5V #25X025........
ART-13 Driver Trans. 6V6 to P-P 811's........ $1.29
DM 34 Dynamotor, 14V In. 220V, 80 MA out....
Sens. Relay: 3.5MA, 13K ohms, 2PST, 2A........ $1.29
Klixon Breaker: Thermal, 35A........ .69
T-30 Carbon Mikes. New........ .89
Screen Mod. Trans. for 807's........ $1.19
3-4 MC Coils for ARC-5 #6029, #7247........ Set $2.79
400 Cy Volt Reg. RH Transtat. In: 115V. 400 Cy. Out: 75-120V, 6A $12.75
BC 1203 Pulse Test Set for SCR 535........ $175.00

SELENIUM RECTIFIERS

UP TO 18 VAC IN—UP TO 14 VDC OUT	
2A	$2.50
4A	4.00
6A	6.00
10A	7.50
12A	9.00
24A	18.00
UP TO 36 VAC IN—UP TO 28VDC OUT	
1A	$3.00
2A	4.00
4A	8.00
10A	14.50
12A	18.00
24A	36.00
UP TO 54 VAC IN—UP TO 42 VDC OUT	
2A	$6.50
4A	8.50
UP TO 120 VAC IN—UP TO 100 VDC OUT	
2A	$11.00
10A	48.00
12A	60.00

Special Rectifiers On Request

Hi-Current Chokes

1 HY—12 Amp—46 Ohms...... $14.95
.01 HY—2.5 Amp—Cased...... $2.25

LO-VOLT. XFMRS

Primaries 115v, 60 Cycle

36V-40V at 3.5 amps	$3.75
24v-1.5A	1.95
8v-1.5A	.98
16v-5A	3.75
12v-5A	3.75

HI CAP. FILTER CONDENSERS

Cap.	WVDC	Price
800	15	$1.35
2000	6	1.85
500	200	2.00
250	150	1.45

PRECISION RESISTORS

OHMS	OHMS	OHMS
5	150	7,500
5.05	250	10,000
10	430	12,000
18	468	17,000
82	800	20,000
120	920	30,000
125	1100	35,000
128	4300	84,000

30c EACH....10 FOR $2.50
100K 120K 150K 220K
40c EACH....10 FOR $3.50
1 MEGOHM.....EACH 75c

MAGNETRONS

Tube	
2J27	2J62
2J31	3J31
2J21-A	5J30
2J22	718DY
2J26	720BY
2J32	725-A
2J38 Pkg.	730-A
2J39 Pkg.	QK 62
2J49	QK 59
2J61	QK 61
	QK 60

700 A, B, C, D
706 AY, BY, DY, EY, FY, GY

UNIVERSAL POWER TRANSFORMER

Pri: Vibrator Input @ 6/12/24/110 VDC, AC Input: 110/220 V. @ 60 CY.
Sec: 230-0-230 V—40 MA. 6.3V—1.8A.
Ea. $1.49

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps input.

CT-341	1050V/10 MA. —625V @ 5 MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A			$22.50
CT-77B	5500V/.002A, 2.5V/2A 12KV TEST 6.3VCT/.6A—1600V TEST			12.95
CR-825	360VCT	.340	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-626	1500V	.160	2.5/12, 30/100	9.95
CT-15A	350VCT	.070	6.3/.6, 6.3/1.8, 3 lbs	2.95
CT-071	110V	.200	33/.200, 5V/10, 2.5/10	4.95
CT-378	2300V	4 MA	2.5/2	6.95
CT-367	580VCT	.050	5VCT/3A	2.25
CT-721	550VCT	.100	6.3/1, 2.5VCT/2	2.95
CT-99A	2x110VCT	.010	6.3/1A 2.5VCT/7A.	3.25
CT-403	350VCT	.026 MA	5V/3A	2.75
CT-931	585VCT	.036	5V/3A, 6.3V/6A	4.25
CT-610	1250	.002 MA	2.5V/2 1A, 2.5V/1.75A	4.95
CT-137	350VCT	.026 MA	5V/3A	2.75
CT-866	330V	.065	6.3V/1.2, 6.3V/600 MA	1.75
CT-456	390VCT	30 MA	6.3V/1.3A, 5V/3A	3.45
CT-160	800 VCT	100 MA	6.3V/1.2A, 5V/3A	4.95
CT-319	660VCT	.085A	5V/2A, 6.3/7.5A, /6.3/3A	3.25
CT931	585VCT	86 MA	5V/3A, 6.3V/6A	4.95
CT-442	525VCT	75 MA	5V/2A, 10VCT/2A, 50V/200 MA	3.85

Filament Transformers—115V/50-60 cps input.

Item	Rating	Each
FTG-31	2.5V/2.5, 7V/7A (Tap @ 2.5V/2.5A), 16KV TEST	$9.95
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25V/21A, 2x7.75V/6.5A	17.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A	12.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-38A	6.3/2.5A, 2x2.5V/7A	4.19
FT-A27	2.5V/2.5A, 7V/7A TAP 2.5V/2.5A 16KV TEST	18.95
FT 340	2x2.5V/3A, 7V/7A—23KV TEST	24.95
FT-038	6.3V/500A WELD	29.45
FT-364	6.3V/2A, 6.3V/4.5A	2.29

Plate Transformers—115V/50-60 cps input.

Item	Rating	Each
PT-919	1200-0-1200 200 MA	$8.95
PT-976	Auto: 120VCT/10 MA	.69
PT-31A	2x300V/5 MA	.79
PT-46A	4080VCT N.L. 3% to 18" Hx6" Wx7" L 20 lbs	29.95
PT-033	4150V/400 MA	49.95
PT-403	Auto: 70V/1A	2.29
PT-160	1120VCT/770 MA, 590VCT/82 MA, 25 lbs.	24.95
PT-170	Auto: 156/146/137/128—.71A	3.29
PT-31A	2x300V/5 MA	.79
PT-976	120VCT/10 MA	.79
PT-12A	260VCT/1.2A	2.95
PT-614	4730VCT/500 MA 12 KV INS	29.25

KLYSTRON TRANSFORMER

PRI: 115V, 60 CY.
SEC: 1050V/10MA, MINUS 625V/5MA, 26.3V/4.5, 2x2.5V/3A, 6.3V, 3A.
Stock No. CT-341. Only a few left at.... $22.45

115 V—400 CY XFMRS

Stock #	Ratings	Price
901699-501	2.77V @ 4.25A	$3.45
901698-501	900V/75MA, 100V/.04A	4.29
UX8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65 MA, 5VCT/3A	3.69
T-48852	700VCT/80 MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6 MA, 300VCT, 135 MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A	4.25
KS 8984	27V/4.3A, 6.3V/2.9A, 1.25V/.02A	2.95
52C080	526VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT, .00006 KVA	1.75
302433-A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4V/7.5A, 6.4V/3.8A, 6.4V/2.5A ALL CT	4.79
70G30G1	600 VCT/36 MA	2.65
M-7474318	2100V/.027A	4.95
95-G-45	2000V/.002A, 2000V/NL, 465V/.6A, 44V/10A, 6.3V/23.5A, 6.3V/1.8A, 5V/9A, 2X2.5V/1.75A	17.95
TRANSTAT;	IN: 115V, 400 CY. OUT: 75-120V	12.95

FILTER CHOKES

Stock	Description	Price
CH-250	SWING. 2.5-24H/.4-.05A 10KV Test	$7.95
CH-8-19	SWING. .006H/5A-.035H/.5A .032 ohms DCR, 1KV TEST	3.95
CH-776	1.28 H/130 MA/75 ohms	2.25
CH-344	1.5 H/145 MA/1200V Test	2.35
CH-854	1 HY/80 MA	1.29
CH-43A	10 HY/15 MA—850 ohms DCR	1.75
CH-999	15 HY/15 MA—400 ohms DCR	1.95
CH-511	6 H/80 MA—310 ohms DCR	2.45
CH3-501	2x.5H/400 MA	2.79
CH-188M	5 HY 200 MA	1.79
CH-488	10 HY .030A	1.19
CH-791	Dual 1.75-.125 HY 100 MA	1.27
CH-86C	Dual .01-3.5 HY 950-75 MA	1.10
CH-981	15 HY .110A	1.59
CH-22-1	1 HY .100A	1.17
CH-779	.6 HY .490A	1.25
CH-25A	SW .09/.018 HY 3/.3A	8.95
CH-922	10000 HY O MA	2.75
CH-043	2.2 HY 80 MA	.98

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All merchandise subject to prior sale and prices subject to change without notice.

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E-3 Chas. Rosen Phone: Digby 9-4124

EQUIPMENT CO. — SONAR

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5. 1.0, 2.0 microsec. Input voltage: 115 v 400 to 2400 cps. Uses: 1-715B, 4-829-B, 3-72's, 1-73. New........$110.00
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. Pwr. out 35 KW Energy 0.018 Joules........$49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS, 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes........$49.50
APS-1C MODULATOR DECK. Complete, less tubes........$75.00

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec 400 PPS, 50 ohms imp........$22.50
G.E. #6E3-5-2000-50P2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS 50 ohms impedance........$6.50
G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 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
7.5E3-3-200-67-P. 7.5 KV, "E" Circuit, 3 microsec, 200 PPS, 67 ohms imp. 3 sections........$12.50

MULTI SECTION PULSE NETWORK: ALL RATINGS 8KV Z=50 OHMS, "E" CKT.

Pulse Length μ Sec.	PRR	Sections
.25	1600	2
.50	800	2
2.6	400	4
5.20	200	4 + 4

Physical Size; 2" x 10 3/8" x 5 3/8"........$47.50

PULSE TRANSFORMERS

G.E.K.-2745........$39.50
G.E.K.-2744-A. 11.5 KV High voltage. 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or 1/microsec. @ 600 PPS........$39.50
W.E.-KS 9800 Input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core........$6.00
W.E. #D169271 Hi Volt input pulse Transformer........$27.50
G.E. K2450A. Will receive 13KV. 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100KW G.E........$34.50
G.E. K2748A. Pulse Input line to magnetron........$36.00
Ray UX 7896—Pulse Output Pri. 5v, sec. 41v........$7.50
Ray UX 8442—Pulse Inversion—40v + 40v........$7.50
Ray UX 7361........$5.00
PHILCO #352-7250, 352-7251.
UTAH #9262, 9332, 9278.

MICROWAVE TEST EQUIPMENT

X BAND POWER METER

Consists of thermistor mount and bridge. microammeter, rough attenuator. X-Band Waveguide thruout. For power measurements anywhere in the 9000 MC band.

BROADBAND TEST OSCILLATOR

Freq. coverage 50-3000 MC. By direct calibration and interpolation anti-backlash gear drive: compact. portable. Operates from any 115V source or battery source. New, with all tubes........$425.00

TS 56A/AP	I-158	TS 47/APR	TS 250/APN
CW60-ABM	I-222	TS 36/AP	TS 89
LU-1	I-185	TS 12 UNIT 2	I-203-A
LU-3		Q. METER	
TS 159	TS 268/U	TS 69/AP	TS 11/AP
CS60-ABW	TS 102/AP	TS 226	BC 438

SEND FOR FURTHER INFORMATION AND PRICES

MICROWAVE ANTENNA EQUIPMENT

AS-31/APN-7: 10 cm. Polyrod in Lucite Ball. Type N Fitting, Coax Feed....$27.50
3 CM ANTENNA WITH DISH 14". Cutler Feed horizontal and vertical scan with 28 V DC drive motor and drive mechanisms. Complete. New........$125.00
Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½' x 3'. New........$75.00
Dipole for above........$12.00
TDY "JAM" Radar rotating antenna. 10 cm. 30 deg. beam, 115 V AC drive. New........$150.00
10 CM Horn, Rectangular-to square-to circular RF assembly ending in horn, radiating circularly polarized beam. Waveguide input. Complete with flange....$50.00
Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal, 33 deg. in vertical planes........$35.00
Cone Antenna. AS 125 APR, 1000-3200 mc. Stub supported, with type "N" connector........$4.50

140-600mc Directional Antenna

140-310mc cone and 300-600 mc cone, each consisting of 2 end fed half wave conical sections with enclosed matching stub for reactance changes with changing frequency. New: complete with mast, guys, cables, carrying chest....$49.50

AN MPG-1 Antenna. Rotary feed type high speed scanner antenna assembly, including horn parabolic reflector. Less internal mechanisms. 10 deg. sector scan. Approx. 12'L x 4'W x 3'H. Unused........$250.00
Gov't Cost—$4500.00

RADAR SETS

APS-2, Airborne, 10 CM, Major Units, New.
APS-4, Airborne, 3 CM, Compl.
APS-15, Airborne, 3 CM, Major Units. New.
SD-4, Submarine, 200 MC, Compl., New.
SE, Shipboard, 10 CM, Compl., New.
SF-1, Shipboard, 10 CM, Compl., New.
SJ-1, Submarine, 10 CM, Compl., Used.
SL-1, Shipboard, 10 CM, Compl., Used.
SN, Portable, 10 CM, Compl., Used.
SQ, Portable, 10 CM, Compl., Used.
SO-1, Shipboard, 10 CM, Compl., Used.
SO-7, Portable, 10 CM, Assault.
SO-8, Shipboard, 10 CM, Compl., Used.

10 CM RESEARCH EQUIPMENT

COAXIAL WAVEMETER, W.E. Transmission type, using type "N" fittings. Calibrated between 3400-4500 MC........$99.50
LHTR. LIGHTHOUSE ASSEMBLY, Part of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated........$49.50
BEACON LIGHTHOUSE cavity 10 cm. Mfg. Bernard Rice........each $47.50
MAGNETRON TO WAVEGUIDE Coupler with 721A Duplexer Cavity, gold plated........$45.00
SIGNAL GENERATOR, using 417A klystron, 2700-3300 mc. Output approx. 50 mw. 115 vac power supply. With tubes, new........$425.00
REGULATED POWER SUPPLY for GL 446 type lighthouse tubes (2C40, etc.) 115 vac. 60 cycles. Panel Mounting. Less tubes........$32.50
RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr.-TR cavity, compl. recvr. & 30 MC IF strip using 6AK5 (2C40, 2C43, 1B27 lineup) w/Tubes.
721A TR BOX complete with tubes and tuning plungers........$12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28. Three types available..$4.00
TS 268 CRYSTAL CHECKER........$35.00
F 29/SPR-2 FILTERS, type "N" input and output........$12.50
WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" ADAPTER CHOKE FLANGE SILVER PLATED BROAD BAND........$32.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized, 45 degrees........per set, $75.00
POWER SPLITTER: 726 Klystron input dual "N" output........$5.00
MAGNETRON COUPLING FOR TYPE 720 MAG. to 1½" x 3" Waveguide..$35.00
S BAND SIGNAL GENERATOR, complete with calibrated attenuator, W. E. coax. wavemeter, McNally Klystron Cavity. Regulated power supply operates from 115 V.A.C., 50-1200 Cycles. Manufactured by W. E........$650.00
CAJ ECHO BOX, 10 CM, TUNABLE........$22.50

⅞" RIGID COAX—⅜" I. C.

RIGHT ANGLE BEND, with flexible coax output pickup loop........$8.00
SHORT RIGHT ANGLE BEND, with pressurizing nipple........$3.00
RIGID COAX to flex connector........$3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length........$5.00
RT. ANGLES for above........$2.50
RT. ANGLE BEND 15" L. OA........$3.50
FLEXIBLE SECTION, 15" L. Male to female........$4.25
FLEX COAX SECT. Approx. 30 ft........$16.50
⅞" RIGID COAX. BULKHEAD FEED-THRU........$14.00

1.25 CM RESEARCH EQUIPMENT

Low Power Load........$20.00
Waveguide Lengths, 2" to 6" long, gold plated with circular flanges and coupling nuts........per inch, $2.25
APS-34 Rotating Joint........$49.50
Right Angle Bend E or H Plane, specify combination of couplings desired..$12.00
45° Bend E or H Plane, choke to cover........$12.00
Mitered Elbow, cover to cover........$4.00
TR-ATR-Section. Choke to cover........$4.00
Flexible Section 1" choke to choke........$5.00
"S" Curve Choke to cover........$4.50
Adapter, round to square cover........$5.00
Feedback to Parabola Horn with pressurized window........$27.50
90° Twist........$10.00

3 CM RESEARCH EQUIPMENT
1" x ½" Waveguide

1" x ½" waveguide in 5' lengths, UG 39 flange to UG40 cover....per length, $7.50
Rotating Joints supplied either with or without deck mounting. With UG40 flanges........each, $17.50
2J42 Magnetron Pulse Modulator. 14kw max. rating 7kw min. Plate voltage pulsed 5.5kv 6.5 Amp. .001 duty cycle. 2.5 μ sec pulse length max. filament 6.3V .5 Amp. Includes magnetron mtg. and blower. Requires 3C45 and 2-3B24. New....$75.00
Bulkhead Feed-Thru Assembly........$15.00
Pressure Gauge Section 15 lb. gauge and press nipple........$10.00
Pressure Gauge, 15 lbs........$2.50
Dual Oscillator-Beacon Mount. P/O APS 10 Radar for mounting two 723A/B klystron with crystal mts. matching slugs, shields........$42.50
Dual Oscillator, Mount. (Back to back) with crystal mount, tunable termination attenuating slugs........$18.50
Directional Coupler, UG 40/U Take off 20 DB........$17.50
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount. Iris coupling and choke coupling to TR........$22.50
TR-ATR Duplexer section for above........$8.50
CU 105/APS 31 Direction Coupler 25 DB........$25.00
723AB Mixer—Beacon dual Osc. Mnt. w/xtal holder........$12.00
Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius. 90 deg. bend........$4.50
Twist 90 deg. 5" choke to cover w/press nipple........$6.50
Waveguide Sections 2½ ft. long silver plated with choke flange........$5.75
Rotary joint choke to choke with deck mounting........$17.50
3 cm. mitred elbow "E" plane unplated........$12.00
UG 39 Flanges........$ .85
UG 40 Chokes........$1.00
90 degree elbows. "E" or "H" plane 2½" radius........$12.50
90 degree twist 6" long........$8.00
45 degree twist........$8.00
40KW X BAND Radar, complete as described and illustrated in July 1951 PROC IRE.
APS-4 Under Belly Assembly, less tubes........$375.00

1¼" x ⅝" WAVEGUIDE

Mtred Elbow H Plane UG51-UG52........$12.00
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X Band Wave GD. 1¼" x ⅝" O.D. 1/16" wall aluminum........per ft., 75c
Slug. Tuner Attenuator W.E. guide. Gold plated........$6.50
Bi-Directional Coupler, Type "N". Takeoff 24 d.b. coupling........$27.95
Bi-Directional Coupler, UG-52, Takeoff 25 d.b. coupling........$24.95
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C1B	6.95	2J36	105.00	5JP1	27.50	328A	9.95	726B	56.00	885	1.75
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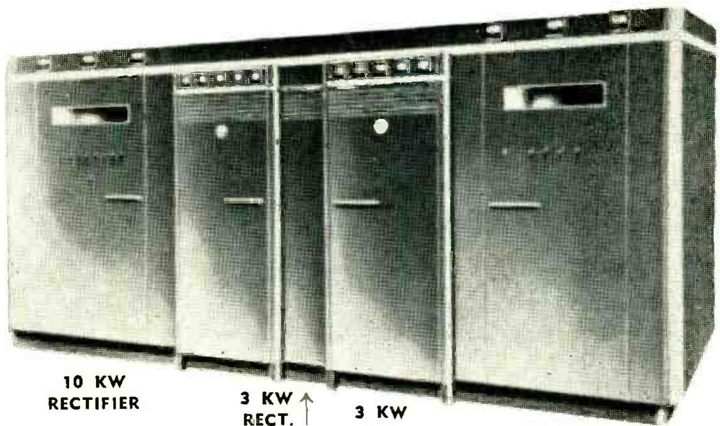

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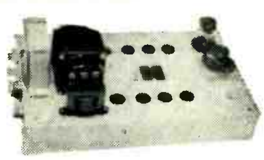

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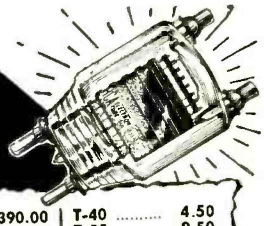

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OB3/VR90	1.65
3D24	7.50
6AN6	3.50
6D4	2.85
6SJ7WGT	2.45
6SL7WGT	3.00
7AK7	6.50
807W	12.85
1280	1.56
5642	1.29
5933	12.85

HYTRON

2E25A	5.50
2E30	2.45
3D21A	10.70
5514	4.95
5516	7.95
5812	3.10
HY75A	4.70
HY615	2.25

WESTINGHOUSE

KU-618	15.75
SR-53	10.50

TAYLOR

211-C	12.50
T-20	4.00

T-40	4.50
T-55	9.50
T-100	12.50
T-200	25.00
TT-17	7.00
TUF-20	5.50
TZ-20	4.00
TZ-40	4.50

RAYTHEON

IAE5	12.65
2C34/RK34	3.50
2E26	3.85
CK501AX	3.15
CK506AX	1.88
CK512AX	1.88
CK522AX	1.88
CK523AX	1.88
CK524AX	3.15
CK525AX	1.88
CK528AX	1.88
CK529AX	2.41
CK553AXA	1.85
CK556AX	3.65
CK569AX	2.50
CK570AX	6.75
CK605AX	7.50
CK608AX	2.41
CK619AX	6.80
CK1007	1.20
CK5517	3.40
CK5676/CK556AX	3.65
CK5678/CK569AX	2.50
CK5697/CK570AX	6.75
CK5702/CK605AX	7.50
CK5703/CK608AX	2.41
CK5744/CK619AX	6.80
CK5784	7.50
CK5995	7.50
RK-3B24W	11.75
RK-6D22	55.00
RK-72	11.75
2051	1.90

EIMAC

2C39A	36.50
4-65A	20.00
4-125A	30.25
4-400A	60.50
4X100A	48.00
4X150A	48.00
4E27A/5-125B	35.75
25T	9.00
35T	10.50
35TG	11.00
100TH	18.25
100TL	18.25
250TH	33.00
250TL	33.00
450TH	77.00
1000T	137.50
KY21A	13.25

878	12.75
884	1.85
885	2.00
886	4.60
889R-A	295.00
902-A	12.50
905-A	65.25
908A	16.50
912	155.00
914-A	93.50
917	3.50
918	3.10
919	3.50
920	4.15
921	2.05
922	1.95
923	2.05
924	3.30
925	2.40
926	2.90
927	2.50
928	2.85
929	1.50
930	1.65
931-A	9.75
934	3.40
935	7.80
954	5.65
956	7.00
957	3.75
991	.75
1608	7.90
1610	2.50

5551	80.50
5552	121.00
5553	265.00
5554	190.00
5558	14.00
5563	47.00
5581	2.25
5582	2.65
5583	3.05
5584	3.95
5618	3.60
5652	6.55
5763	1.75
5819	55.00
5820	1200.00
5822	143.00
5826	1300.00
5879	1.75
5893	19.40
5915	1.20
5963	1.40
5964	1.50
6026	2.95
6146	4.90
8000	14.50
8003	14.00
8005	8.40
8008	8.20
8012-A	15.50
8013-A	10.30
8020	8.40
8025-A	11.30
9001	3.40

5950	6.50
6119	6.50
6143	6.50
VX-10	5.00
VXR-130	5.00

AMPEREX

4B32	12.00
203-A	13.75
203-H	25.00
207	242.00
211-C	19.00
211-D	17.50
211-H	19.00
212-E	102.00
212-F	102.00
220-C	365.00
221-A	20.00
222-A	300.00
228-A	325.00

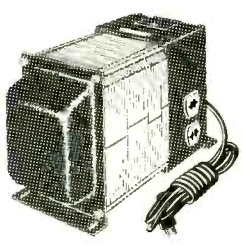
810	14.50
813	16.00
833-A	49.50
834	14.50
849-A	135.00
849-H	135.00
851	253.00
858	500.00
859	500.00
866-AX	2.50
869-B	132.00
880	510.00
889-A	210.50
891	223.00
891-R	362.00
892	223.00
892-R	362.00
893-A	630.00
893-AR	1150.00
5604	540.00

SPECIAL! OIL-FILLED CAPACITORS

These condensers are new and perfect, manufactured by radio industry's most famous names!

Capacity	D.C.W. Volts	Net Price
4 mfd.	10,000	49.50
10 mfd.	6,000	39.75
2 mfd.	5,000	9.95
4 mfd.	4,000	13.95
2 mfd.	4,000	8.95
4 mfd.	3,000	8.95
12 mfd.	1,000	6.95

SPECIAL! 2KW STEP-DOWN TRANSFORMERS



Westinghouse #2F127 2,000 watts EXPORT ADAPTER AUTOTRANSFORMERS. Reduce 230 volts to 115 volts, 50/60 cycles AC. Famous Westinghouse 2F127 autotransformers rated 230V to 115V 50 cycles 2,000 VA. Ideal for air conditioners, electric machinery, commercial refrigerators, transmitters, etc. Fully shielded. 9-foot heavy duty rubber cord and plug, two 115 volt outlet receptacles. Individually export-boxed. Net: 52 lbs., Shipping weight: 63 lbs. Quantity limited. *Special,* **29.95**

Transformers for all radio applications in stock! We carry complete lines of U.T.C., KENYON, STANCOR, THORDARSON

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RECEIVING

00A	$1.60
0A2	1.54
0A3/VR75	1.25
0A4G	1.19
0B2	1.64
0B3/VR90	1.25
0Y4	2.40
0Z4G	.74
01A	.72
1A3	.72
1A4P	1.29
1A5GT	.77
1A6	.84
1A7GT	.94
1AB5	.79
1AC5	1.10
1AD5	1.10
1B3GT	1.24
1B4P	1.14
1B5/25S	.94
1B7GT	1.24
1C5GT	.84
1C6	.72
1C7G	.72
1C8	.75
1D5GP	.72
1D7G	.72
1D8GT	.72
1E5GT	.72
1E7GT	1.18
1F4	.72
1F5G	.72
1F6	.75
1F7G	.75
1G4GT	.72
1G5G	.75
1G6GT	.72
1H4G	.88
1H5GT	.74
1H6GT	1.04
1J5G	.75
1J6GT	.97
1L4	.72
1L6	1.33
1LA4	.88
1LB4	1.05
1LC5	.88
1LC6	.97
1LD5	.97
1LE3	.84
1LG5	.84
1LH4	.88
1LN5	.94
1N5GT	.88
1P5GT	.78
1Q5GT	.72
1Q6	1.10
1R4	.72
1R5	.94
1S4	.72
1S5	.84
1S6	1.10
1T4	.84
1T5GT	.72
1T6	1.20
1U4	.88
1U5	.88
1V	.71
1V2	.75
1V5	1.10
1W4	1.33
1W5	1.10
1X2	1.17
1X2A	1.33
2A3	.75
2A4G	.85
2A5	.45
2A6	.45
2A7	.45
2B7	.40
2E5	.45
2X2	.64
2X2A	1.59
2Z2	1.95
3A5	.89
3A8GT	2.40
3B7	.45
3C6/XXB	1.60
3D6	.45
3E6	1.33
3LF4	.94
3Q4	.78
3Q5GT	.84
3S4	.84
3V4	.89
5AZ4	.73
5R4GY	2.25
5R4GYW	3.50
5T4	1.94
5U4G	.72
5V4G	1.11

5W4GT	$.80
5X4G	.88
5Y3GT	.62
5Y4GT	.72
5Z3	.88
5Z4	.88
6A3	1.24
6A4/LA	1.34
6A5G	1.95
6A6	.91
6A7	.98
6A8GT	1.04
6AB4	1.00
6AB5/6N5	1.33
6AB7/1853	1.04
6AC5GT	1.19
6AC7/1852	1.14
6AD7G	1.34
6AE6G	.88
6AF6G	.94
6AG5	.88
6AG7	1.54
6AH6	1.39
6AJ5	1.14
6AK5	1.49
6AK6	1.11
6AL5	.81
6AL7GT	1.33
6AQ5	.91
6AQ6	.86
6AQ7GT	1.29
6AR5	.78
6AS5	.99
6AT6	.72
6AU5GT	1.24
6AU6	.92
6AV5GT	1.33
6AV6	.72
6AW6	1.33
6AX5GT	.83
6B4G	1.60
6B5	1.60
6B6G	.98
6B7	.97
6B8G	.84
6BA6	.84
6BA7	1.14
6BC5	.97
6BC7	1.33
6BD5	1.60
6BD6	.99
6BE6	.84
6BF6	.78
6BG6G	1.18
6BH6	.96
6BJ6	.96
6BK6	.75
6BL7	1.45
6BN6	1.52
6BQ6GT	1.34
6BT6	.75
6BU6	.83
6BY5	1.33
6C4	.78
6C5GT	.78
6C6	.78
6C8G	.97
6CB6	.97
6CD6	2.94
6D6	.84
6D8	.88
6E5	1.10
6E6	1.33
6E7	1.95
6F5GT	.78
6F6	.94
6F6GT	.83
6F7	.88
6F8	.94
6G6	1.11
6H4GT	1.33
6H6GT	.78
6J5GT	.68
6J6	1.19
6J7GT	.81
6J8	1.60
6K5GT	.88
6K6GT	.78
6K7GT	.72
6K8GT	.72
6L5	.86
6L6G	1.74
6L6GA	1.74
6L7	.97
6N5	1.33
6N6	1.95
6N7GT	.88
6P5GT	1.20
6P7G	1.60
6Q6G	1.60
6Q7GT	1.00

6R7GT	$.84
6R8	1.60
6S4	.88
6S7	.97
6S8GT	1.04
6SA7GT	.84
6SB7Y	1.20
6SC7	1.00
6SD7GT	.97
6SF5GT	.88
6SF7	.97
6SG7	.97
6SH7GT	.72
6SJ7GT	.88
6SK7GT	.88
6SL7GT	.97
6SN7GT	.97
6SQ7GT	.74
6SR7GT	.84
6SS7GT	.94
6ST7	1.09
6SV7	1.24
6SZ7	1.10
6T7G	1.19
6T8	1.17
6U4	1.20
6U5	.94
6U6GT	.97
6U7G	.45
6V5GT	1.95
6V6	1.54
6V6GT	.88
6V7G	.90
6W4GT	.84
6W5G	1.33
6W6GT	1.00
6W7G	1.04
6X4	.72
6X5	1.33
6X5GT	.74
6Y3G	1.95
6Y6G	.97
6Y7G	1.24
6Z4	.90
6Z7G	1.95
6ZY5G	.88
7A4	.78
7A5	.88
7A6	.84
7A7	.84
7A8	.88
7AD7	1.60
7AF7	.90
7AG7	1.04
7AH7	1.10
7AJ7	.90
7AU7	1.10
7B4	.84
7B5	.84
7B6	.84
7B7	.84
7B8	.90
7C4	.78
7C5	.84
7C6	.84
7C7	.84
7C8	1.33
7E5	.74
7E6	.58
7E7	.88
7F7	.84
7F8	1.33
7G7	1.33
7H7	.84
7J7	1.33
7K7	1.19
7L7	.97
7N7	.97
7Q7	.82
7R7	.94
7S7	.97
7V7	.94
7W7	1.04
7X6	1.10
7X7	1.09
7Y4	.74
7Z4	.84
10	1.05
10Y	.88
12A	.72
12A5	1.60
12A6	.72
12A6GT	1.45
12A7	1.04
12A8GT	.78
12AH7GT	1.26
12AL5	.92
12AT6	.72
12AT7	1.24
12AU6	.94
12AU7	1.14
12AV6	.72
12AV7	1.45
12AW6	1.33

12AX7	$1.20
12AY7	3.00
12B7	1.10
12BA6	.84
12BA7	1.19
12BD6	1.00
12BE6	.86
12BF6	.83
12BH7	1.20
12BJ6	.75
12BK6	.75
12BN6	1.45
12BT6	.75
12BU6	.75
12C8	.78
12F5GT	.78
12H6	.90
12J5GT	.54
12J7GT	.81
12H7G	1.00
12K7GT	.78
12K8GT	.88
12Q7GT	.68
12S8GT	1.33
12SA7GT	.92
12SC7	.98
12SF5GT	.88
12SF7GT	.88
12SG7	.62
12SH7GT	.72
12SJ7GT	.78
12SK7GT	.94
12SL7GT	1.04
12SN7GT	.97
12SQ7GT	.83
12SR7GT	.84
12Z3	.84
14A4	.97
14A5	1.95
14A7	.94
14AF7	1.20
14B6	.94
14B8	1.10
14C5	1.33
14C7	1.20
14E6	1.10
14E7	1.33
14F7	.94
14F8	.94
14H7	.94
14J7	.94
14N7	.94
14Q7	.94
14R7	.94
14S7	1.33
14W7	1.33
14X7	1.33
14Y4	1.20
15	.35
18	.35
19	.35
19BG6G	2.34
19C8	1.60
19J6	1.60
19T8	1.45
20	.35
22	.35
24A	.74
25A6GT	1.60
25A7GT	3.70
25AC5GT	1.43
25B5	1.95
25B6G	1.33
25BQ6GT	1.60
25C6G	1.60
25L6	1.60
25L6GT	.84
25N6G	1.95
25S	1.60
25W4GT	1.00
25Y5	1.45
25Z5	.78
25Z6	1.10
25Z6GT	.75
26	.49
26BK6	.83
27	.30
30	.25
31	.84
32	.94
32L7GT	.88
33	.92
34	.88
35/51	.82
35A5	.88
35B5	.88
35C5	.97
35L6GT	.84
35W4	.68
35Y4	.90
35Z3	.84
35Z4GT	.72
35Z5GT	.68
35Z6G	1.33

36	$.78
37	.78
38	.59
39/44	.25
40	1.10
41	.74
42	.74
43	.74
45	.68
45Z3	.54
45Z5GT	.79
46	.61
47	.88
48	2.40
49	.94
50	2.48
50A5	.94
50B5	.94
50C5	.94
50C6G	1.45
50L6GT	.84
50X6	1.10
50Y6GT	.84
50Y7GT	1.00
50Z7G	.90
52	1.95
53	.97
55	1.10
56	.64
57	.79
58	.84
59	.94
70A7GT	.94
70L7GT	1.95
71A	.58
75	1.00
76	.45
77	.59
78	.78
79	1.33
80	.68
81	2.34
82	.88
83	1.14
83V	1.14
84	.84
85	.88
89	.25
99	1.60
99V	1.60
99X	1.60
117L7GT	1.34
117N7GT	1.34
117P7GT	1.34
117Z3	.74
117Z4GT	1.45
117Z6GT	.89
FM-1000	1.60
XXD	1.20
XXFM	1.33

TRANSMITTING

1B22	$2.50
1B23	9.95
1B24	9.95
1B25A	4.95
1B26	4.95
1B27	19.50
1B29	2.50
1B32	3.95
1B38	30.00
1B42	4.95
1B60	24.50
1N21	.89
2AP1	11.95
2B22	1.29
2C4	1.12
2C21	.49
2C26A	.39
2C34	.79
2C40	8.75
2C43	12.95
2C44	4.95
2C51	4.95
2E22	1.19
2E24	4.95
2E25A	4.95
2E26	3.85
2E30	2.45
2J21A	9.75
2J22	9.95
2J26	28.50
2J27	28.50
2J30	90.00
2J31	29.50
2J32	29.50
2J33	29.50
2J34	29.50
2J37	12.50
2J38	12.50
2J48	27.50
2J49	37.50
2J50	22.00

2J54B	$37.50
2J55	87.50
2K23	45.00
2K25	39.50
2K28	35.00
2K29	22.50
2K33	3.75
3AP1	12.50
3B22	2.75
3B23	4.75
3B24	5.75
3B26	3.75
3B27	3.75
3B28	8.50
3BP1	8.50
3C24/24G	2.00
3C27B	8.50
3C31	3.25
3C45	17.50
3D21A	1.75
3DP1	4.75
3E29	14.50
3EP1	5.75
3FP7	3.75
3GP1	4.50
3HP7	3.75
4AP10	4.75
4B32	9.75
4C27	25.00
4J26	99.50
4-65A	20.00
4-65A	*14.21
4-250A	41.25
4-250A	*29.50
5AP1	3.50
5BP1	4.95
5AP4	3.50
5BP4	4.95
5CP1	4.95
5CP1A	9.95
5FP7	6.95
5FP14	9.95
5GP1	4.95
5HP1	4.95
5HP4	4.95
5J23	12.50
5J29	12.50
5JP1	24.50
5JP2	24.50
5JP5A	24.50
5LP1	19.50
5LP5	9.95
5NP1	5.50
6CF	8.50
6C21	22.50
7BP1	4.95
7BP7	7.50
7C23	72.00
7C25	90.00
7DP4	14.50
9C23	200.00
9GP7	14.00
9JP1	14.00
9LP7	14.00
10BP4	17.50
10CP4	19.50
12DP7	14.95
12FP7	14.95
12GP7	14.95
12HP7	14.95
12KP4	49.50
12TP4	37.50
12LP4	25.73
15E	1.15
15R	.75
35TG	11.00
35TG	*4.50
75TL	13.25
75TL	*6.50
100TH	18.25
100TH	*8.95
100TS	18.25
100TS	*1.95
114B	.75
121A	2.50
203A	8.50
211	.49
215A	.15
218	69.50
221A	1.50
227A	4.95
231A	1.15
247A	8.50
249B	3.50
249C	3.75
250R	22.00
250R	*9.95
250TH	33.00
250TH	*22.50
250TL	33.00
250TL	*19.50
252A	4.95
254	14.95
271A	4.95

274B	$1.95
276A	9.95
282A/B	8.25
283A	9.95
284D	7.50
286A	9.95
287A	2.75
290A	4.95
291A	4.95
293A	2.75
294A	4.95
301A	5.95
304TH	60.50
304TH	*19.50
304TL	60.50
304TL	*19.50
307A	5.90
310A	7.50
311A	6.75
327A	.75
328A	13.75
331A	12.50
350A	8.50
350B	4.75
354C/D	19.95
357A	39.50
367A	3.25
371A	1.25
371B	.75
374A	2.50
393A	5.95
398A	6.95
399A	2.50
400A	3.25
401A	1.95
417A	8.95
464A	12.95
527	12.50
531	4.95
532A	8.75
575A	13.50
700D	17.95
703A	6.95
704A	.99
705A	2.50
706BY	37.50
706CY	37.50
707B	14.95
708A	4.95
709A	3.75
710A	1.70
713A	1.40
714AY	6.75
715B	9.50
715C	29.50
717A	1.50
719A	28.00
721A	4.95
722A	2.75
723A/B	14.75
724A/B	3.75
725A	7.75
726A	6.75
726B	27.50
730A	12.50
800	1.75
801A	.28
803	4.25
805	4.25
807	1.75
808	4.95
809	1.95
810	9.95
811	2.95
811A	3.25
812	2.75
813	8.75
814	2.75
815	2.75
816	1.25
826	.75
828	12.00
829	12.75
829B	13.75
830	3.50
830B	3.75
832	9.95
832A	12.50
834	5.50
836	3.75
837	1.50
838	2.50
843	.29
845	4.50
849A/H	27.50
851	49.50
852	27.50
860	6.50
861	25.00
864	.29
865	1.25
866A	1.25
872A	2.40
874	1.25
876	.29
878	1.65
884	1.75
902P1	11.50
905	3.75
918	1.50
923	.99

927	$1.25
931A	4.75
954	.35
955	.40
956	.40
957	.40
958A	.40
967	4.95
975A	12.95
991	.35
1603	5.00
1612	1.95
1613	.99
1616	1.50
1619	.35
1620	4.75
1621	1.20
1623	2.00
1624	1.50
1625	.39
1626	.45
1629	.39
1630	.98
1631	.99
1632	.75
1634	.70
1636	3.00
1638	.50
1642	.65
1644	.90
1645	1.98
1649	1.25
1654	2.00
1665	1.25
1851	1.75
1960	.70
2050	1.25
2051	1.35
5610	1.00
5654	4.50
5670	5.50
7193	.45
8005	5.95
8011	1.75
8013A	2.75
8014A	29.50
8020	1.20
9001	1.25
9002	1.25
9003	1.75
9004	.59
9005	1.95
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TS-8A/U	TS-61/AP	TS-173/UR	I-56	BC-949/A	LU2
TS-10A/APN-1	TS-62/AP	TS-174/U	I-95/A	BC-1060/A	LU3
TS-11/AP	TS-69/AP	TS-175/U	I-106/A	BC-1066/A	OAA-2
TS-12	TS-76/APM-3	TS-184/AP	I-122	BC-1201/A	P4E
TS-13	TS-87/AP	TS-197/CPM-4	I-126	BC-1203	TAA-16EA
TS-14	TS-89/AP	TS-203/AP	I-130A	BC-1236/A	TSS4SE
TS-15B/AP	TS-96/TPS-1	TS-204/AP	I-145	BC-1255/A	TSX3SE
TS-16/APN	TS-98/AP	TS-205/AP	I-177	BC-1287/A	TSX4SE
TS-19	TS-100/AP	TS-220/TSM	I-178	BC-1277	TTS-4BR
TS-23/AP	TS-101/AP	TS-226A	I-208/A	BE-67	TTX-10RH
TS-24/APN-3	TS-102/AP	TS-233/TPN-2	I-212	LAD	TUN-9HU
TS-27/TS	TS-108/AP	TS-251	I-222/A	LAF	
TS-32/TRC-1	TS-110/AP	TS-263	I-225		
TS-33/AP	TS-111/GP	TS-286	I-233		
TS-34/AP	TS-117/GP	TS-270/UP	IE-21/A		
TS-34A/AP	TS-118/AP	TS-281/TRC-7	IE-36		
TS-35/AP	TS-125/AP	TS-301/U	IF-12/C		
TS-36/AP	TS-127/U	TS-314/FSM-1	IS-185		
TS-46/AP	TS-131/AP	TS-323	AN-PNS-1		
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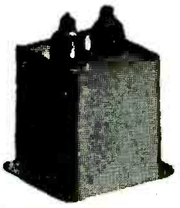

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BATHTUB CONDENSERS CP53BIFF504K .5MFD—600V. . .$.64

Round 1 MFD. 1000 VDC screw Type 1 Lug 2¾" High....................50¢ ea. electrolytick condensers round

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MICA HIGH POWER Type G3 .0001 Mfd 25KV ....$48.00 ea. Type G2-50. .0001 mfd, .0002 mfd, .0005 mfd. 10KV......................$19.00

ATTENUATOR DAVEN TYPE T-994-2 7500/3900-2DBStep ....$4.25 Type TA-1000-2 7500/3900 Ohm..$5.25 ea.

Rheostat Type J 150 Ohm 50 Watt #5381 .... $2.15 each

RHEOSTAT Type K 100 Watt 25 Ohm $3.78

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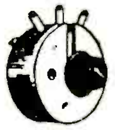

Standard Brands: 5 Ohms; 100 Watt; 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.

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G. E. MOTOR AMPLIDYNE

Mod. 5AM45DB15. Input: 115 volts, single phase, 60 cycle, 4.5 amp. Output: 250 volts DC, .6 amps, 3450 RPMS........**$79.00 ea.**

PIONEER TORQUE UNITS

TYPE 12604-3-A: Contains CK5 Motor coupled to output shaft through 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15:1 **$70.00 ea.**

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ALNICO FIELD MOTORS

(Approx. size overall . . . 3¾" x 1¼" diameter)
Delco-Type 5069230: 27.5 volts, DC; 145RPM **$19.95 ea.**
Delco-Type 5068820: 27.5 Volts; DC; 250 RPM ....**$19.95 ea.**

PIONEER AUTOSYNS

AY-1......26 Volt—400 Cycle........**$4.95**
AY-5......26 Volt—400 Cycle........**$5.95**
AY27D **$25.50**
AY6—26 Volt—400 cyc...........**$4.95 ea.**
AY30D—26 Volt—400 cyc.......**$25.00 ea.**
AY38D—26 Volt—400 cyc., shaft extends both ends ....**$19.95 ea.**
AY20—26 Volt—400 cyc..........**$12.50 ea.**

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SINGLE

Sensitive Type, Kollsman Mark V; Range 0-3500 RPM in 3½ revolutions of the indicating pointer. **$9.95 ea.**

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Pioneer Instrument Mark V, screw mount Used with Kollsman Mark V Indicator **$25.50 ea.**

Tachometer Indicator and Generator (above) ....Both **$33.50**

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(Approx. size...4" long x 1¼" dia.)

General Electric-Type 5BA10AJ37: 27 volts, DC; .5 amps, 8 oz. inches torque; 250 RPM; shunt wound; 4 leads; reversible **$12.50 ea.**

G. E. Type 5BA10FJ215, 24 volts DC, .77 amp. 30 lbs. in. torque, 4 RPM...**$15.00 ea.**

General Electric-Type 5BA10AJ52C: 27 Volts, DC; .65 amp; 14 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible **$12.50 ea.**

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PIONEER GYRO FLUX GATE AMPLIFIER
Type 12076-1-A, complete with tubes **$27.50 ea.**

PIONEER TORQUE UNIT AMPLIFIER
Type 12077-1-A. A single tube amplifier designed for autosyn take off signal. Contains magnetic amplifier assembly. With tube ....**$24.50 ea.**

SERVO MOTOR 10047-2-A: 2 Phase; 400 Cycle; with 40-1 Reduction Gear $10.00 ea.

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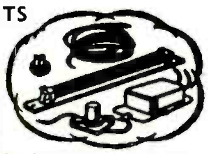
Ultra-Violet Fluorescence



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4-Watt Kit—(5½" tube)...........**$3.00**
8-Watt Kit—(12" tube)............**$4.00**

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AIRESEARCH: 115V; 400 CPS; Single phase; 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03.....................**$10.00 ea.**

EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles; 6000 RPM ....**$12.50 ea.**

EASTERN AIR DEVICES, TYPE J31B: 115 V, 400-1200 Cycle, Single Phase. **$12.50 ea.**

PIONEER, CK-2, 400 cycle 2-phase, 115 volt ....**$20.00 ea.**

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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.**

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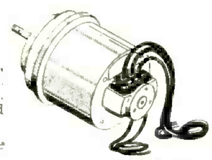
Input: 24 V. DC, 52 amps; Output, 115 volts—400 cycles, 3-phase, 750 VA, and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated ....**$95.00 ea.**

12116-2-A PIONEER
Output: 115 VAC; 400 cyc; single phase; 45 amp. **Input:** 24 VDC; 5 amp. **$90.00 ea.**

10563 LELAND ELECTRIC
Output: 115 VAC; 400 cycle; 3-Phase; 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp. ....**$80.00 ea.**

16186 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.**

SYNCHRONOUS SELSYNS



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5DG Differential Generator 90/90 volts 60 cycle ....**$50.00 ea.**

TRANSMITTER, BENDIX C-78248: 115 Volt, 60 Cycle...................**$25.00 ea.**

REPEATER, BENDIX C-78410: 115 Volt, 60 Cycle ....**$37.50 ea.**

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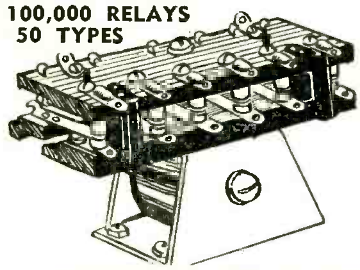

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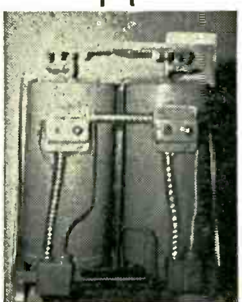

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OC3	$1.60	2J36	100.00	4E27	17.50	371B	2.50	724B	6.50	954	1.00
OD3	1.50	2J38	17.50	4J33	190.00	388A	2.75	725A	——	955	1.00
C1A	6.00	2J39	17.50	4J52	350.00	446A	2.00	730A	——	956	1.00
C1B	7.00	2J42	150.00	5J23	——	446B	4.00	803	7.00	1616	2.75
C6A	——	2J50	75.00	5J26	350.00	450TH	45.00	807	1.65	1619	.75
C6F	12.50	2J61	75.00	6C21	29.50	450TL	45.00	813	9.00	1624	2.00
C6J	——	2J62	75.00	10Y	1.25	464A	9.50	829A	12.00	1625	.65
1B22	3.95	2K22	——	100TH	9.00	705A	3.50	832A	10.00	1626	.75
1B23	10.00	2K25	35.00	204A	60.00	706A-GY	45.00	836	4.75	1629	.65
1B24	——	2K26	150.00	211	1.00	707B	25.00	837	2.75	1636	3.00
2B22	4.95	2K29	35.00	250TH	20.00	714AY	17.50	843	——	1642	3.50
2B26	3.75	2K41	150.00	250TL	20.00	715B	17.50	849	50.00	2050	2.00
2C40	18.00	2K45	140.00	304TH	15.00	720	——	851	80.00	8012	4.25
2C43	25.00	2K54	150.00	304TL	15.00	721A	3.75	860	5.00	8020	3.50
2D21	1.70	2K55	150.00					861	40.00	8025	7.00
2E22	3.75	3B24	6.50					865	1.40	9001	1.65
2J21	17.50	3B27	10.00					872A	3.85	9002	1.50
2J22	17.50	3B28	10.00					874	1.50	9003	1.75
2J26	27.50	3C31	5.75					889R	195.00	9004	1.75
2J27	27.50	3E29	15.00					891R	250.00	9005	1.90
2J31	27.50	4C27	25.00					892R	250.00	9006	.50
2J32	65.00										

Special C.R. Tube Offering:
12DP7A (in date)—39.50

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RELAY 115v 60cy adjustable 6 sec to 2 minutes Cramer TD2-120S. Also TD60S 6 to 60 sec...**$12.95**
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BLOWER MOTOR 400-1800cy 115v **EAD** J31C.**$9.95**
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250 WATT OUTPUT XFRMR PP-8ohm KS-9496 .**$14.95**
FIL XFRMR 6.3 @ 1.3A (other sizes avail) ...**$.99**
CHOKE 4H 70ma...**69c**, 2H 70ma 100 ohm...**$.49**
SILV TRMR TS2A 1.5-7, 7-45 @ **39c; MICA** 3-30 **8c**
AN3106-10S-2S, PL-68, PL-259A, 83-1H, SST, JK33&34
CONDENSERS: BATHTUB, MICA, AIR, OIL, HV, CER.
SPARES for: AN/TRC-1, MK11 Radar, AN/TPN-2
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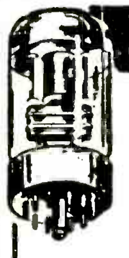

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RADIO TUBES

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
OZ4A	$0 70	6B8G	$0 93	6SK7GT	$0.96
1G6GT	0 72	6BE6	1 20	6SN7GT	1 20
1LN5	0 80	6C4	0 86	6SS7	0.95
1R5	0.90	6C5GT	0.51	12A6	0 48
1S4	0 86	6C6	0.75	12SH7	0 96
1T4	0.86	6H6	0.94	12SK7	0 98
5U4G	0 80	6J5	0 60	12SQ7GT	0.90
6AB7	0.90	6J5GT	0 51	12SR7	0 90
6AC7	1 20	6K6GT	0 91	35Z4GT	0 85
6AL5	1 00	6K7GT	0 70	35Z5GT	0.75
6AQ5	1 40	6SG7	0.90	50L6GT	0.90
6B8	0 93	6SK7	0 96	49	0 76

★★★★★★★★★★★★

TYPE	PRICE
2E22	$2 50
6C21	30.00
307A	3.75
357A	22.50
805	2.90
808	1.70
830B	3.00
9005	1.30

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This offer subject to change and prior sale.

SPECIAL SALE TYPE 805 — **OUR PRICE: $2.90**
List Price: $13.50

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4665 Melrose Avenue Los Angeles 29, California
Telephone DUnkirk 8-2211

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3FP7	$1.95	5CP1	$4.95
4AP10	.95	5FP7	1.95
5BP4	3.95	16JP4	19.95
16DP4	19.95	304 TH	8.95
9001	1.39	304 TL	8.95
9002	.98	830 B	2.95
9003	1.49		

RA 52—RECTIFIER
A transtat controlled rectifier to produce high voltage DC from 110 VAC 60 cycle source. Up to 11,500 volts DC at 50 watts. Metered high voltage (0-15KV) and current (0-20 MA). New **$74.50**
Some available with small repair or minor part replacement, less tube .... only $49.50

SCR 625 Famous Army Mine Detectors for prospectors—miners—oil companies—plumbers—etc. $59.50 WHILE THEY LAST
This unit is being offered now at a considerable reduction in price. Recently advertised at $79.50 it is now available in the same brand new wrappings in suitcase style carrying case (less batteries)
USED, LIKE NEW $39.50

APT1	MD4/APS2	R18/APS3
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APT3	MD22/UPN2	AS18/APS15
APT4	MD38/APQ13	RC213
T85/APT-5	TS16APN	RT34/APS13
PP-104	TS27/TSM	RT28/APG4X
BC638	TS61	RT19/ARC4
BC1287	TS89	RT48/TPX
BC1277	TS92	RT73/UPN
1-83G	TS131	RT10/APS3
1-86A	TS159	AN/APT4
1-114	TS170	APS4
1-183	TS184	TS51
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Regulated Tube Rectifiers—Western Electric #J86207 Input 105 to 125 volt 50-60 cycles. Output 50 volt 3 amp. D.C. ... $85.00

35 mm. Slide Cabinets will hold 2,218 slides, also contains a 28x20 Da-Lite screen, overall size 32¼"x21"x6" finished in black simulated leather $25.00

Eastern Air Device J50E Dual Centrifugal Blower, 115 volt 60 cycles 0.1 amp. 1 PH 20 C.F.M. Continuous duty 1.0 M.F.D. Capacitor start. Without capacitor ... $18.25

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Ammeter 150/300 dual range Triplett 341A 3½" rectangular flush bakelite 5 amp. Movement @ $4.95 with external current transformer for 150 amp $7.50

Drierite—The Versatile indicating Desiccant-size #8 mesh in 6 oz. bottles, 24 bottles to a case. In case lots $4.80 per case, minimum order 6 bottles for $1.50

Selenium Rectifier—Full wave bridge, G.E. model 6R5FB3, up to 54 V. AC, 150 mill. Cont. Duty, 12-1" plates 1500 ea. available.

Vibrator Tubes. 6 volt 4 Prong OAK V6506 89¢
12 volt 4 Prong KS5566 List 04 .... 89¢
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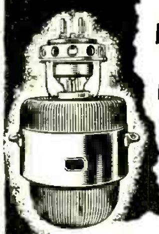

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26 CONDUCTOR CABLE made up by Western Electric in 50 foot lengths with S324CCT connectors on each end. Each conductor is #22 standard and rubber covered. Although the O.D. is only 9/16 inches there is a heavy live rubber jacket.
Per length, only $9.95

VITAMIN Q TUBULAR CONDENSERS

Cat. No.	Mfd.	Volt	Qu.	Price
774-606A*	.0033	600	231	$.95
G191P10391	.01	100	60	1.50
G91P10392	.01	200	250	1.60
G88P10394	.01	400	180	1.65
G191P22391	.022	100	20	1.65
G191P68352	.068	200	454	1.65
G91P82394	.082	400	48	1.65
G91P15491T	.15	100	199	1.65
G191P22491	.22	100	49	1.65
G191P27491	.27	100	23	1.65
G191P4791	.47	100	140	1.75
G91P56492	.56	200	28	1.75
G91P68492	.68	200	30	2.19
G91P10592	1	200	78	2.20
XFC1889*	1	600	20	2.20

*not Vitamin Q but similar

THESE ULTRA HIGH QUALITY CONDENSERS ARE MADE BY LEADING MANUFACTURERS.
Feature
- 20,000 Megohm or More
- Subminiature
- Glass Seal Terminals
- Up to $7.50 regular

25 WATT POTENTIOMETERS

Ohm	Bush	Shaft	Cat #	Price
2	5/8s	1/8sd	O-H	$1.04
3-3	1/2	1/2	I	1.04
15	3/8	1"	C	1.04
15	3/8	1-1/8	D-245	1.04
15	1/2	1-1/4	I	1.04
20	1/2	1/2F	D-245	1.04
25	3/8	1	D-245	1.04
30	3/8	1	C	1.04
50	3/8	1-1/8	D-245	1.04
50	5/8	1/8sd	O-H	1.04
75	1/2	7/16	O-H	1.04
100	3/8	1	D-245	1.04
350	3/8	1-1/8	O-H	1.04
500	3/8	11/16	D-245	1.04
4K	1/2	1/2	O-H	1.17
3K	3/8	1-3/16	D-245	1.20
5K	1/2	1/8sd	I	1.24
5K	3/8	7/8f	D-245	1.24
20K	1/2	1/8sd	D-245	1.40

These excellent wirewound controls are manufactured by the leading companies and are in the original cartons. Priced ridiculously low, only 20% of list. SATISFACTION GUAR.

50 & 100 WATT POTENTIOMETERS

Ohm	Watt	Cat. #	Price
75	100	O-K	$2.19
500	50	O-J	1.41
500	50	D	1.41
500	100	O-K	2.19
800	50	O-J	1.48
1.5K	100	O-K	2.34
2.5K	50	O-J	1.48
5K	50	O-J	1.56

WIREWOUND POTENTIOMETERS

Leading Makes — Clean New

Ohm	Bush	Shaft	Cat #	Watt
10	3/8	1-5/8	I	2
10	3/8	2	C	2
20	1/2s	1/8sd	CTS	2
20	3/8	3/8	M	4
20	3/8	1-1/4	CTS	4
50	3/8	3/8sd	M	4
100	5/8	3/8f	I	2
100	3/8	5/16	CTS	4
200	3/8	7/8	CTS	2
200	5/8s	1/8 sd	CTS	4
200	3/8	2-1/16	CTS	4
255	1/2s	1/8sd	CTS	2
350	3/8	1-1/8	I	2
350	3/8	1/2	CTS	2
400	3/8	1-1/4sd	CTS	4
750	3/8	1/8sd	CTS	4
1K	3/8	3/8	I	2
1K	3/8	3/8	CTS	2
1K	3/8	3/8sd	CTS	4
2K	1/4	1/8	CTS	2
2K	1/2s	5/16sd	CTS	2
2K	3/8	1-1/16	CTS	4
2K	1/2	1-1/2	TRF	4
3K	3/8	1/2	CTS	4
3K	3/8	1-1/2f	C	4
5K	3/8	7/16sd	CTS	2
5K	1/2	1/2sd	TRF	4
5K	1/2	1-7/8	TRF	4
5K	7/16	1-7/16	C	4
7.5K	1/2	3/8	CTS	4
10K	3/8	1/2sd	CTS	2
10K	3/8	3/8f	I	2
15K	3/8	1/2sd	CTS	4
20K	5/8	3-3/16	CTS	4
20K	5/8	5/8	CTS	4

ONLY 45¢ ea

REVERSIBLE REMOTE CONTROL DRIVE

A.C. motor driven unit designed for 'lazy man' control of 1951 Zenith TV. Operates from 115 volts 60 cycles; but, self incorporated transformer permits low voltage control leads. Includes attractive plastic hand grip switch with black & white control buttons, one for each direction. Motor drives worm gear which is moved against a nylon gear by solenoid. Made this way so that TV set could be tuned manually. Output to ¼ inch shaft is approximately 4½ RPM. Intermittent duty. Includes 17 feet three wire control cable with plug. Brand New. ACT NOW! Our limited supply going fast at $10.95

COAXIAL CONNECTORS

Type	Price
UG18B/U	$1.95
UG19B/U	1.95
UG21/U	.90
UG22/U	1.25
UG23/U	1.10
UG24/U	1.10
UG25/U	1.10
UG27/U	1.10
UG58/U	.80
UG60A/U	2.25
UG61A/U	2.55
UG85/U	1.75
UG87/U	1.50
UG88/U	1.35
UG89/U	1.50
UG97/U	4.00
UG97A/U	4.20
UG98/U	2.25
UG102/U	1.15
UG103/U	.85
UG104/U	1.40
UG105/U	1.25
UG106/U	.10
UG131/U	4.50
UG167/U	2.00
UG171/U	1.80
UG173/U	.40
UG175/U	.15
UG176/U	.15
UG201/U	2.25
J201	4.50
UG224/U	1.40
SO239	.40
SO239Y	.60
UG245/U	2.25
UG255/U	2.45
PL258	.80
PL259	.60
PL259A	.55
UG260/U	1.35
UG261/U	1.75
UG262/U	1.60
UG274/U	3.75
PL274	1.30
UG275/U	4.50
UG290/U	1.30
UG291/U	1.75
UG296/U	3.75
UG306/U	2.95
UG335/U	3.75
UG342/U	2.95
M358	1.62
M359	.30
UG422/U	3.25
UG625/U	1.50

PULSE FORMING

DELAY LINE 15-E4-.91-400-50P. Sprague #S92-5245. H623, 4x5x7 inch oil filled with 3½ inch insulators. 0.91 Microsecond, 15KV $9.90

AN CONNECTORS

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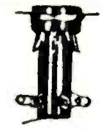

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BETTER CIRCUIT

Socket	Height	Stock	Price
Octal	2 1/2"	10-0-9T	$5.59
Octal	2	8-0-9T	.57
Octal	1 1/2	6-0-9T	.54
Min.	3"	12-MB-12	.73
Min.	2"	8-M-9T	.63
Min.	1 1/2	6-M-6T	.60
Min.	1"	4-M-6T	.59
Noval	3"	12-NB-12	.78
Noval	2"	8-N-9T	.66
Noval	1 1/2	6-N-6T	.65
Noval	1	4-N-6T	.63

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94-29 MERRICK BOULEVARD JAMACIA, N.Y.- REpublic 9-4651

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Tube	Price
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1P23	3.50
2C22	.30
2C26	.25
2C26A	.40
2E22	1.10
2E25	4.75
3B27	2.50
3B28	7.50
3C31	3.00
3D6	.50
3D23	4.50
4A1	1.50
4B24	6.50
4B25	7.50
4E27	13.00
4-125A	27.50
4X500A	75.00
5J29	11.50
6-4	.35
6 Amp Tungar	3.75
10Y	.35
12A6	.65
24G-3C24	1.75
35T ion	3.50
101L	1.00
203Z	4.50
211	.50
227A	3.75
249B	3.25
252A	5.50
286A	16.50
304TL	9.50
304TH	9.50
305A	30.00
313C	1.00
316A	.50
327A	4.50
371A	1.10
446A	1.25
450TH	35.00
531	4.50
559	1.25
701A	5.50
702A	3.00
704A	1.00
705A	1.35
708A	4.50
715A	5.50
715B	8.50
801A	.35
803	3.50
805	3.75
808	.75
809	2.50
811	2.50
826	1.25
827R	125.00
828	10.00
829	10.00
830B	3.00
835	12.00
836	3.25
837	1.35
860	4.50
866A	1.25
872A	2.25
874	1.10
876	.35
891R	175.00
905	3.00
920	2.50
954	.25
956	.35
958A	.60
1613	.75
1616	.75
1619	.25
1625	.35
1626	.35
1630	1.00
1631	1.00
1632	.75
1633	.65
1644	.85
2051	1.25
8020	1.25
9004	.50
9006	.25
CE2-A	1.50
CE2-B	1.50
CE2-C	1.50
CE2-T	1.50
CE25C	1.25
C1A	4.50
C1B	3.50
C5B	3.50
C6A	5.00
C6J	6.50
CK1005	.50
CRP72	1.25
EL6C	8.75
FG57	14.50
FG105	17.50
HY31Z	2.50
HY114B	.65
HY615	.25
KC4	35.00
QK159	45.00
RK34	.25
RK47	3.75
RKR72	1.10
RK73	.50
RX212	15.00
SC968	2.50
SD828A	.85
T200	15.00
VS1	12.50
VU508	1.50
WL251	95.00
WL481	1.50
WL532A	2.50
WL670A	10.00

MAGNATRONS:

Tube	Price
2J21A	10.00
2J26	20.00
2J27	17.50
2J31	15.00
2J40	35.00
2J61	30.00
2J61A	45.00
700A, B, C, D	15.00
718CY	35.00
725A	5.00
728AY	25.00
728BY	25.00
728CY	25.00
728DY	25.00
728EY	25.00
728FY	25.00
728GY	25.00

C.R.T.

Tube	Price
3CP1	1.75
3DP1	4.75
3EP1	4.75
5AP1	4.50
5BP4	4.50
5CP1	4.50
5HP1	8.75
7BP7	5.50
7HP4	7.50
9GF7	10.00
9LP7	6.50
10BP4	15.00
10CP4	15.00

SPECIAL: Ceramic disks, standard brand, 500 WVDC, all sizes in stock. Single size—$45 per M; dual—$55 per M.
Ceramic disks, standard brand, 1000 WVDC, all sizes in stock. Single size—$70 per M; dual—$80 per M.

All Radio & TV receiving tubes 50% off list. 25% deposit required on orders, rated firms send P.O. All merchandise guaranteed. Prices subject to change without notice. *Merchandise subject to prior sale.*

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R.C.A. Model MI-8167 TRANSMITTERS

Point-to-point communications

Freq. Range: 2000 to 20,000 Kcs.
Output: 350 Watts C.W. 250 Watts Radio telephone
Input: 190 to 250 Volts AC 50/60 cps.
Size: 60" high, 17" wide, 27" deep.
Tubes: 807s, 813s, 805s, 866s.
Crystal Oscillator unit built-in, fully shielded and stable. All self contained including antenna network. Master Oscillator unit (available) fits in place of Xtal unit. Speech amplifier is only external unit and has 110/220 v. AC input, four stages, high gain. Total net weight, 625 lbs.

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X Band, 1¼" x ⅝" guide, choke or plain flange, dissipates 350 watts average power continuously in still air, VSWR less than 1.15 between 7 and 10 KMC, weight 5¼ pounds.

X Band, ½" x 1" guide, choke flange, dissipates 250 Watts average power continuously in still air, VSWR less than 1.15 between 8.2 x 12.4 KMC, weight 3¼ pounds.

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4.35	340	1600	4220	20000	160000
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11.25	410	1800	4850	23325	190000
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81.4	645	1924	8000	41400	390000
88	649	1926	8094	42000	400000
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95	657	1980	8250	45000	420000
100	665	2000	8500	47000	422000
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103.2	673	2080	8770	48000	430000
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107	681	2145	9445	50000	470000
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120	689	2150	9710	52000	478000
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125	699	2180	9900	56000	510000
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1.39	2.11	3.5	5.5	8.02	30
1.4	2.2	3.673	6	8.5	
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Brand New
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STYLE	SIZE	Per/100	Per/500	Per/1000
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Sml G	1½SQx4½	1.35	6.50	12.45
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Mfd	Each	Mfd	Each	Mfd	Each
50wvdc		**1000wvdc**		**10000wvdc**	
4	.49	.45	.79	.03	3.49
150wvdc		2	1.69	**12000wvdc**	
1-1-3-5	.69	5	2.98	.02	4.98
250wvdc		10	3.98	**12500wvdc**	
2x.25	.35	15	4.98	.65	16.98
300wvdc		**1400wvdc**		2	95.00
1.2	.39	.25	1.29	**15000wvdc**	
400wvd		.5	1.39	.0016	9.98
.4	.49	**1500wvdc**		**25000wvdc**	
.5	.59	.5	1.59	.00025	7.49
1	.69	.75	1.69	1	95.00
4	1.69	1	1.79	**AC RATED 220vac/600dc**	
6	2.29	2	2.29	2	.69
8	2.49	5	3.49	4	.89
10	2.89	6	3.98	5	1.29
2x.1	.75	**1.8KV/2KVPK**		**225vac/630dc**	
2x.5	.94	28	10.98	3.3	.79
3x.1	.91	**2000wvdc**		**230vac/630dc**	
3x.25	.99	.1	1.49	5	1.29
600wvdc		2x.1	1.75	**330vac/1000dc**	
.034	.49	1	1.98	1.25	.79
.1	.64	2	2.49	1.5	.89
.25	.71	3	3.98	1.75	.98
.5	.75	8	9.49	2	1.03
1	.85	**2500wvdc**		2.5	1.09
2	.99	.25	2.29	2.8	1.15
3	1.08	**3000wvdc**		3	1.19
4	1.89	.1	2.49	4	1.29
5	2.29	.5	2.98	5	1.49
6	2.69	2	4.49	12	3.49
7	2.89	3	5.39	15	3.98
10	3.29	4	6.49	25	6.49
2x.1	.79	**4000wvdc**		40	9.98
2x.25	.85	2	8.98	**405vac/1200dc**	
2x.5	.98	**5000wvdc**		.15	1.29
2x1	1.19	.2	4.49	**600vac/1800dc**	
2x2	1.39	2	10.98	16	6.98
2x8	3.49	4	19.98	**660vac 2000dc**	
3x.05	.89	**7000wvdc**		5	4.49
3x.22	.98	.002	1.69	6	4.98
3x.25	1.09	.0075	1.98	10	6.98
700wvdc		.1	4.98	16	7.98
4	1.98	**7500wvdc**			
800wvdc		.03	2.98		
1	.69	.05	3.49		

HIGH CURRENT MICA CNDRS

CYLINDRICAL SIMILAR TYPE "G"

MFD	KV	AMPS	MC	EACH
.09	1.5	35	1	$14.98
2X.003	1.5	7	1	2.98
.0002	6	5	3	5.98
.01	10	30	3	49.50
.00005	20	4.5	3	6.98
.004	20	22	3	45.00
.0025	20	22	3	45.00
.005	15	30	1	48.00
.0025	12	20	3	28.95
.0015	5	3.3	.3	3.98
.001	30	30	3	110.00
.0005	35	13	3	39.95

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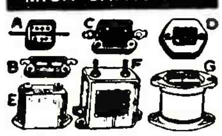

Fig. A. Postage & ½ Postage (*Silver Mica)

Mfd.	Each	Mfd.	Each
.00002	$0.09	.0011*	$0.17
.000022	.09	.0012*	.23
.000024*	.17	.002	.15
.000025*	.17	.0025	.15
.00004	.09	.003/1KV	.29
.00005*	.17	.0033*	.35
.000082	.09	.004	.22
.0001	.09	.004*	.43
.0003	.09	.005	.22
.0011	.09	.006	.23
.0002	.08	.01	.29
		.00015	.09

Fig. B. .001 mf. **10c;** .006 mf. **23c;** .01 mfd. **35c.**

Fig. C. Solder Lug Terminals & Mtg Holes

Mfd.	Each	Mfd.	Each
600 WV		**600 WV**	
.0001	$0.29	.02	$0.76
.001	.42	.03	1.19
.002	.45	**1200 WV**	
.004	.53	.002	.66
.005	.55	.004	.68
.006	.59	.005	.71
.008	.63	.01	.78
.01	.66	**2500 WV**	
		.00047	.59

Fig. D. Screw Term & Mtg

Mfd.	Each	Mfd.	Each
600 WV		**1200 WV**	
.0001	$0.29	.01	$0.78
.00055	.37	.013	.89
.00085	.42	.03	1.89
.0012	.44	.033	2.39
.003	.49	**2500 WV**	
.005	.54	.0004	.59
.015	.71	.002	1.09
.02	.78	.0022	1.09
.03	1.19	.0024	1.13
.033	1.29	.0035	1.19
.039	1.98	.0036	1.19
.04	2.09	.0043	1.29
.05	2.39	.005	1.45
1200 WV		.006	1.55
.001	.61	.01	1.89
.002	.66	.015	2.19
.0051	.71	**3000 WV**	
.0068	.75	.005	1.65

Fig. E. Upright Xmtg Micas

Mfd.	Each	Mfd.	Each
250 VDC		.0001	1.08
.05	$0.47	.0003	1.15
.2	2.59	.0007	1.19
1500 VDC		.0055	1.39
.04	.89	**3000 VDC**	
.05	1.08	.0055	1.35
2000 VDC		.008	1.79
.003	1.08	**3500 VDC**	
.005	1.19	.000033	.78
.006	1.25	**5000 VDC**	
.01	1.39	.000082	1.65
.015	1.68	.0001	1.79
.02	1.98	.00015	2.29
.03	2.35	.00018	2.39
2500 VDC		.0003	2.75
.0025	1.08	.00043	2.85
.006	1.65	.0006	3.59
3000 VDC		.001	3.89
.00005	.78	.01	4.79

Fig. F. Heavy Duty, Upright, Bklte Csd.

Mfd.	Kv.	Each	Mfd.	Kv.	Each
.003	6	$5.59	.01	8	$10.95
.0003	8	4.98	.0025	8	7.98

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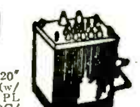

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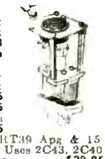

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